



**ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE**

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## **Posudek disertační práce**

Uchazeč: Abdul Jabbar, MSc.

Název disertační práce: Characterization of mechanical and thermomechanical behavior of sustainable composite materials based on jute

Studijní obor \_\_\_\_\_

Školitel Prof. Ing. Jiří Militký, CSc.

Oponent: Prof. Ing. Michal Šejnoha, Ph.D., DSc.

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### **Aktuálnost tématu disertační práce**

komentář: Scientific relevance of the submitted work

Green composites made of natural fiber reinforcements bonded to a biodegradable matrix have been recognized as a suitable material for the replacement of more traditional synthetic fiber based composites in many applications thus reducing both the production cost and the environmental impact. However, a high variability of basic material properties such as stiffness and strength predestined these material systems to mostly non-structural application. For these materials to enter the field of structural applications requires a thorough research in the area of mechanical properties to identify various drawbacks and suggest routes for the stabilization and potential improvements of the mechanical behavior of such composites. Although limited mostly to experimental investigation, the present thesis opens the way to achieve such goals. The scientific relevance of the chosen topic is, therefore, undoubtedly high.

☒ vynikající    ☐ nadprůměrný    ☐ průměrný    ☐ podprůměrný    ☐ slabý

### **Splnění cílů disertační práce**

komentář: Goals of the work and their achievements

The main research objectives were clearly stated in the first chapter of the thesis. From the experimental point of view, their achievement presented undoubtedly a rather challenging task. Although the final summary of the results given in the last chapter of this thesis is less comprehensive, it is evident from the content of the thesis that all of the goals set were addressed and in the main part also successfully met.

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### **Metody a postupy řešení**

komentář: Treatment of the topic - methodical and conceptual approach

The scientific content of the work meets very high quality standards. In the first two chapters the state-of-the-art is broadly discussed including a large literature survey. Apparently, Mr. Jabbar had to devote a considerable amount of time to gain a sufficient scientific background, particularly in the field of experimental investigation of these material systems which in turn called for a sound knowledge of chemistry and mechanics of composite materials in general.

The principal findings of the present work are summarized in Chapters 3 to 6 addressing virtually all of the present issues concerning the improvement of the mechanical response broadly classified in Chapter 2. While Chapter 3 outlines individual types of experiments conducted in the course of this thesis, Chapters 4-6 provide summary of the achieved results for tested material systems. For the sake of clarity, these were

classified into three main groups. An extensive experimental program, though not fully consistent for all groups, was conducted to address the influence of matrix and reinforcement surface treatment on the mechanical behavior of the final product based on standard properties such as stiffness and strength but also from the long term behavior point of view by specifying the creep, fatigue and dynamic properties of the investigated systems.

The assumed list of experiments was correctly selected to allow for a clear distinction of various treatment techniques and their impact on the monitored properties and consequently to suggest the most promising technique, or their combination, for a particular application. However, a sufficiently broad discussion in this regard is missing. This invites a few questions whose answers, if included, would certainly improve the quality of the theses. In particular:

1. Chapter 4 is concerned mainly with the modification of the matrix properties while chapters 5 and 6 concentrate on the surface treatment of the jute textile reinforcement. A parametric study combining both techniques is missing. Could the author briefly comment on that during the thesis defense?
2. A detailed comparison of the two types of surface treatment discussed in Chapter 5 and 6 is also missing. A comment on that, at least from the common types of experiments conducted point of view, is also welcome. Choose, e.g. the strength and stiffness properties and make a quantitative comparison on a common graph.

Chapter 7 is therefore in my opinion too brief in comparison to the effort devoted to and the amount of results presented in the thesis.

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#### Výsledky disertace - konkrétní přínosy disertanta

komentář: Thesis results - author's specific contribution

The author examined most of the common treatment of green composites applied both to the matrix and reinforcements with particular application to jute. As mentioned above, the results provide bases for the selection of optimal technique and opens a way for numerical simulations, which should with no doubt support the experimental work. More complex creep models in case of theoretical approach and more elaborative dynamic analysis introducing a broad range of frequencies in case of experimental approach are just two specific examples of future research directions benefiting from the results achieved in the present thesis.

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#### význam pro praxi a pro rozvoj vědního oboru

komentář: Extent of new knowledge and contribution to the practice

I am not an expert in this field so I suggest the author to give, during the thesis defense, his own opinion on a potential applicability of the jute textile reinforced composites going beyond non-structural applications, which I suppose is the principal objective of the author's research effort.

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**Formální úprava disertační práce a její jazyková úroveň**

komentář: Organization of the work and overall comprehensiveness

The thesis are written in good English with only few grammatical errors limited mostly to the lack of articles. The thesis is well structured and easy to follow. A potential improvement of the clarity, which does not however reduce the thesis high standard, can be seen, e.g. in

1. Introduction of a list of abbreviations as a large number are used throughout the thesis and these are difficult to remember
2. Scales on some figures are in some cases difficult to see.
3. A comprehensive table summarizing the types of experiments selected for individual types of composites included for example in Chapter 3 would make easier to follow the subsequent chapters.

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**Připomínky**

Comments and questions:

Apart from already posted comments the following questions are welcome to answer:

1. What is the reason for choosing the particular creep models if these are not generally possible to use in simulations. Among them, only the Burger's model can be extended into a chain model and modified to adopt the temperature shift factor. Can you comment on that?
2. The discussion related to Fig. 5.7 is related to the fact that the applied load is selected based on the tensile strength pertinent to a given composite according to Fig. 5.5. It can be expected that for e.g. the CF0 composite the fatigue live would increase if loaded by stress difference associated with the lowest strength observed for CF10 composite. Can you comment on that?
3. I suppose the composites labeled as CF0 in Fig. 5.6 and untreated in Fig. 6.3 are the same. Can you please make a comment on why there is such a big difference in flexural modulus while the strength is comparable?
4. I do not really understand the explanation regarding the decreasing strength with improving the interfacial properties in Fig. 5.5? Can you provide some numbers related to the strength of the matrix and reinforcements? Have you made the same type of measurements also for the composites discussed in Chapter 6? If the reasoning for the stress reduction was correct that this trend would be the same for any composite regardless of the surface treatment. A comment on that is again welcome.

**Závěrečné zhodnocení disertace**

Final statement:

Based on the submitted review, consisting of an assessment of the scientific relevance, fulfillment of the goals of the work, the quality of treatment of the topic and the extent of new knowledge, it is concluded that this work meets very high quality standards.

As it complies with the requirements for a Ph.D. work, I recommend the thesis for further defense and if successful to appoint Mr. Abdul Jabbar, MSc. the title


doctor (Ph.D.)

Doporučuji po úspěšné obhajobě disertační práce udělení titulu Ph.D.

ano ☒

ne ☐

Datum: 20.05. 2017

Podpis oponenta: .....  .....

## Assessment of PhD Thesis

<b>Aspirant:</b>	Abdul Jabbar, M.Sc.
<b>Thesis title:</b>	Characterization of Mechanical and Thermomechanical Behavior of Sustainable Composite Materials Based on Jute
<b>Specialization:</b>	Textile Technics and Materials Engineering
<b>Supervisor:</b>	prof. Ing. Jiří Militký, CSc.
<b>Reviewer:</b>	doc. Ing. Antonín Potěšil, CSc.

<b>Topicality of the thesis</b>				
Comment: The topic of this dissertation thesis is up to date and respects current and future innovative trends towards the use of bio-waste arising from textile technologies. The processors' efforts are subsequently utilized in a number of industries, including the development and production of new biodegradable products that do not degrade irreplaceable natural resources.				
excellent <sup>1</sup>	<input checked="" type="checkbox"/>	above standard	<input type="checkbox"/>	standard
			<input type="checkbox"/>	substandard
				weak

<sup>1</sup> Mark selected with a cross

<b>Meet the objectives of the thesis</b>				
Comment: The presented work has a very well described part and describes the approaches to the preparation and testing of bio-composites made of jute fibers of different character, which form the filler in the polymer composite. Work is also good factual content, specifying of laboratory technologies that are designed to improve the adhesive properties fills with polymer matrix. Samples prepared by the graduate were then tested in a variety of experimental methods. After studying the dissertation thesis as a whole, it was stated that the stated goals of the thesis and the intentions of the doctoral candidate were fulfilled.				
excellent	<input type="checkbox"/>	above standard	<input checked="" type="checkbox"/>	standard
			<input type="checkbox"/>	substandard
				weak

<b>Methods and solutions</b>				
Comment: In the characterization of the properties of the graduate-made bio-composite structures a number of standard test methods, procedures and measuring devices (SEM, FTIR, DMA, mechanical tests, etc.) were used. The thesis demonstrates the autonomy of the graduate's approach to these experimental activities.				
excellent	<input type="checkbox"/>	above standard	<input checked="" type="checkbox"/>	standard
			<input type="checkbox"/>	substandard
				weak



### Results of the Thesis - specific benefits of the student

Comments:

The main contribution of the dissertation is the identification and comparison of the mechanical properties of several types of bio-composites with a structure treated by different physical-chemical processes, even under different temperature and climatic conditions. The results of the experimental findings are processed by statistics and provide useful information for material engineers and product designers.

excellent    above standard    **X**    standard    substandard    weak

### Significance for practice and for the development of the scientific branch

Comments:

Work is a good starting point for further research and development activities in the field of bio-composite use in various industrial applications. I recommend that the follow-up work be deeper into the theoretical areas of physical properties of composite materials, both with regard to the follow-up processing technologies in the production of products and their industrial applications in a specific sense.

excellent    **X**    above standard    standard    substandard    weak

### Formal layout of the Thesis and its language level

Comments:

The work has a logical structure, the English text is comprehensible, the Czech text of the abstracts text has no editing errors.

excellent    **X**    above standard    standard    substandard    weak

### Comments and questions

1. The properties of prepared bio-composites are measured only in room and in elevated temperatures. The application in automotive and aviation industry requires knowledge of properties in the range from -60 to 90°C including coefficient of linear thermal expansion (CLTE). Did you run the experiments in subzero temperatures?
2. What method was used to set volume fraction of fibrous reinforcement and of matrix in prepared bio-composites? Explain the relation between mass and volume fraction of reinforcement and matrix in composite structure.
3. For any predictive CAE simulations it is necessary to describe composites as anisotropic, respectively orthotropic material continuum. What relations are in such cases used to describe relationship between stress and strain? Give examples.

### Final evaluation of the Thesis

Based on the above review I recommend submitted thesis for defense in front of the scientific committee for the defense of doctoral thesis.

I recommend after a successful defense of the dissertation grant Ph.D.<sup>2</sup>

yes

no

<sup>2</sup> Delete where applicable

Place and Date: In Liberec 18.05.2017

Signature: Antonín Potěšil

