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Review to the thesis of *Hafiz Faisal Siddique, M.Sc., entitled "Tensile Characterization of Compression Sock's Ankle Cut-strips and Development of Models to Approximate the Laplace's Law"*

Dear Ladies and Gentlemen,

The dissertation of Mr. Hafiz Faisal Siddique is dedicated to creation and improvement of model for computations of medical compression socks.

It is written on 55 pages of text, distributed in 8 chapters. The literature research covers 90 sources of international journals.

The dissertation is mainly devoted to the two different and unique areas of medical class I compression garments (according to MDR), especially to varicose compression stockings useful for the mitigation of venous ulcer and to regulate or streamline the blood flow from lower extremity to upper extremities.

The literature shows that only a few studies exists in which the tensile properties using uniaxial tensile testers is used for the measurement of the tensile indices values of the compression socks rather than biaxial tensile testers. In this dissertation, the tensile properties, especially loading energy, unloading energy, hysteresis, tensile linearity are compared, to force at practical extension and compression pressure statistically using linear regression analysis which is not done before.

The applicant demonstrate understanding of the basic scientific laws of physics

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and was able to reproduce the derivation of the Laplace's Law based on analysis of the forces and geometry. The elasticity behaviour of the fabrics is introduced in the Laplace law. The main contribution are the large set of experiments and the finally performed correlation analysis, which allows the introduction of a correction coefficient 1.08 into the Laplace's law. It remains unclear if the 8% correction are based on the deviation of the material parameters, of the friction or it indeed considers some additional nonlinearities in the contact between the material and body, which are not considered in the idealized Laplace Law.

The material and methodological part is well explained and the author remained concise and briefly described the sock's physical and fabricated specifications. I must add the missing of the functionality of sock's knitting machine? and their specifications including models; diameters and related data. The results and discussion part is also written in a good way and all statistical tools are applied and explained scientifically used to explain the significance between dependent and independent parameters. Both parts of this dissertation are very interesting and helpful for the commercial use.

The publication record of the applicant is as well very good, he is first and corresponding author of 11 journal papers in internationally recognized peer review journals like Textile Research Journal, Autex Research Journal, Fibers and Polymers, Fibers and Textiles, which confirms the value of his research.

I have few minor remarks and suggestions required to be answered by the candidate:

Why the strips only selected at ankle?

Why these are only hand washed?

What kind of pressure devices exists and why you have chosen this? The working principle of this device should be explained?

Will be a difference in the results if you use cylindrical coordinate system for the prediction of the compression? This is usual for such kind of geometry. And principally the derivative of the Laplace Law is provided in several books, it is great, that you have succeed to document it, but I can not consider it as contribution and you should provide citation.

Which therapeutic tool is more useful and helpful; bandage or varicose

socks? and why?

What is the working life of compression socks? Can some of your investigated parameters be used for its prediction?

Did you considered the hysteresis in the results?

Are the values of the pressure time dependent? From which parameters of the material can be obtained the time dependence and how you can investigate this?

I recommend the dissertation submitted by Hafiz Faisal Siddique M.Sc for the dissertation defense and at the same time recommend to award him the PhD degree if he succeed to answer my questions for satisfaction of the committee.

Best regards



Prof. Dr.-Ing. habil. Yordan Kyosev

Hafiz Faisal Siddique dissertation review

The present topic presents a complex analysis of the deformation of compression socks for optimal radial pressure development. In the first part, the author conducted an experimental study to measure the mechanical properties of selected commercial socks and in the second part, he empirically modeled the compression pressure using Laplace's relation.

In the first part, the author reviewed the application of Laplace's law in biomedicine and further introduced the basic mechanical aspects of compression socks and presented the necessary mathematical relationships between the mechanical quantities. Here, the opponent pauses on the connection of 'tensile linearity' as a quantity that is comfort dependent. The relationship to linearity of what and the range of units is not clear. Such a delicate unit should be better explained and substantiated. For example, similar to the description of 'hysteresis', which in contrast is quite clear and clearly deserved a coarser description.

In the experimental section, the author carried out a number of experiments to analyse the textile properties of the socks and then delved into tensile tests. The author considered a number of load/unload cycles, but it is not clear how he chose them and why, for example, he took data from the 5th cycle. It is also not clear what the diagram in Figure 10 is ultimately for. Was this data used in the next part of the paper?

It is not clear how the author intends to use regression modeling as a tool to analyze the statistical properties of the data he obtained from the experiments. From this perspective, the statistical analysis is very grossly underestimated.

What is the point of relating hysteresis and radial pressure and force? The experimental section does not define the strategy and significance of each experiment relative to the previous sections of the paper. Figure 17 rather suggests that the relationship between pressure and tensile linearity is non-linear. Why was a linear curve used as an approximation? It is surprising that the determination ability of the newly developed TYM model is worse than that of the original model. Why is this so? The referee appreciates that the author compared other models from the literature.

The results show that the accuracies of the proposed models are at a similar level to Laplace's model and other models in the literature. In the discussion of the thesis, the author does not mention the reasons why his models are at the same level as the others. For example, the author does not qualitatively discuss the proposed models that he composed by comparing the forces calculated from the radial progression with the forces from Hooke's definition. Although this is formally permissible, the opponent is not clear about the validity of such an approach. The conclusion of the paper also lacks a deeper comparison with other models. For example, why were the other variables not automatically considered already in the proposed models?

Overall, the thesis appears coherent. In particular, the review part of the thesis is well outlined and the author has thus prepared a very good springboard for his own scientific work. However, from the opponent's point of view, the author's own scientific approach is disjointed. In particular, because the mathematical models are set up vaguely without deeper justification. In the experimental part, many results are combined with regression analysis but without direct connection to the analytical models. From a scientific point of view, the work looks inconsistent with insufficient description. The statistical treatment and conclusion of the thesis are inadequately addressed. Despite the obvious shortcomings, the referee still believes that the author should be awarded the academic degree of Ph.D.

14.11.2025

Petr Henyš

