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UNIVERSITY
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Subject: Review for the Ph.D. thesis of MSc. Bethalihem Samuel.

The dissertation of M. Se. Bethalihem Samuel to award a doctoral degree in engineering sciences in the discipline of materials engineering has the title "Acoustic Properties of Weave Structure Depending on Their Internal Geometry".

The science of acoustics, the interplay between materials and their acoustic properties, has garnered significant interest. This becomes especially intriguing when considering materials with intricate structures, such as woven fabrics. Weaving has diverse internal geometries, determined by the type, arrangement, and interlacing of yarns. Such weave structures are not just of aesthetic value but can significantly influence the acoustic behaviour of the material. This thesis has a deep dive into this intricate intersection of material science and acoustics. It suggests an exploration of how the internal geometric configurations of woven fabrics can shape their acoustic properties, potentially leading to innovative applications in areas such as soundproofing, architectural acoustics, and even wearable technology.

The primary goal of the thesis is to boost the acoustic performance of woven fabrics by focusing on their internal weave geometry, yarn characteristics, and overall assembly layout. This endeavour stems from the potential advantages of enhancing fabric performance in the acoustics sector, particularly in amplifying the applications of porous materials. Emphasis is laid on optimizing absorption, especially at lower frequencies, which necessitates an in-depth study of both the geometrical and raw material properties of the fabrics. To realize this overarching aim, several specific objectives were outlined.

The research aims to validate hypotheses related to how woven fabrics enhance sound absorption in porous materials, especially at lower frequencies, the sound absorption capability of multilayered fabrics and the influence of roughness properties. The candidate's hypotheses would have been more significant with the inclusion of the yarn structure effect.

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The literature review starts with exploring the fundamentals of sound propagation in various mediums and delves into the acoustic properties of materials, outlining how different attributes, such as thickness and density, affect sound absorption, reflection, and transmission. And looking for different porous materials (Composite, Nonwoven and Woven Fabric) and checking the effect of Mass, particle size, porosity, air permeability, fabric thickness and Yarn and Fiber characteristics on the acoustic properties. In this part, the candidate did not check the literature on the influence of fiber properties on acoustic properties. Also, it would be appreciated if he highlighted the fabrication method of nonwoven.

The literature also covers different measurement methods of sound absorption and material characteristics. The literature part concludes with highlights of the importance of porous materials, especially woven fabrics, in acoustic applications for noise control. While nonwoven fabrics are limited to higher-frequency sound absorption, woven fabrics offer benefits like mechanical strength and aesthetic value. The study aims to fill a research gap by examining woven fabrics made of polyester fibres with varying weave structures, using an anechoic chamber and impedance tube measurements to assess their acoustic properties. The goal is to improve the performance of porous materials across a wide range of frequencies.

The experimental part is covered in three chapters, starting by using an anechoic chamber, with descriptions of the yarn used and fabrics produced, and also the testing methods. Where he evaluates the acoustic properties of woven fabrics made from different yarn types like PES staple and twisted yarn, using an anechoic chamber for measurements. Fabrics from staple yarn showed low sound attenuation but high air permeability, whereas twisted-yarn textiles were more effective at sound reduction. The anechoic chamber allows for multi-angle measurements, revealing that sound pressure reduction varies depending on the incidence angle. Overall, the type of yarn and its characteristics, as well as the angle of sound incidence, play crucial roles in the fabric's acoustic performance. Abd it was more relevant to have some discussion about the thickness and grammage.

The chapter four, he used an impedance tube for a sound absorption test using different hybrid textile structures: standalone woven, woven with nonwoven, and woven with an air gap. Variant II (woven with nonwoven) performs the best in sound absorption, particularly at higher frequencies, while variant I (only woven) shows poor results. Factors like surface roughness and fibre content significantly affect the Noise Reduction Coefficient (NRC). The combination of woven and nonwoven materials not only enhances sound absorption. However, the candidate mentions in the conclusion that this combination improves mechanical and aesthetic properties without explaining how the evaluation is made.

The last part of the experiment is about the optimization of porous sound absorption performance in multilayer porous fabrics, particularly woven fabrics, across various frequency ranges. The arrangement of woven and nonwoven fabrics significantly impacts sound absorption, with certain combinations exhibiting higher performance in specific frequency ranges. Adding an air gap to the fabric layers enhances absorption at low and medium frequencies and offers economic benefits by reducing the need for extra porous material. The study also found that fabric layer thickness doesn't significantly affect sound absorption, but the porosity of the plain fabric (TP) impacts the sound absorption performance. It was apricate dim this part that the use of modelling or simulation goes deathlier in the optimization.

The summary of the thesis provides a clear understanding of the findings. The author discussed the different factors that affect sound absorption and disproved the theory that adding layers enhances absorption. However, the author confirmed that the arrangement and type of materials used are essential.

The candidate's five articles and three conferences demonstrate the significance of their research.

The dissertation of Mr. Bethalihem Samuel makes a significant contribution to the development of the scientific discipline of materials engineering at the same time, meets the formal requirements for dissertations for the degree of doctor, in accordance with the regulations on scientific degrees and titles contained in the Law of July 20, 2018. Art.187 pt.1 and pt. 2 "Law on Higher Education and Science". I hereby request the Council of Disciplines of Materials Engineering of the Lodz University of Technology to admit the Author to further stages of the doctoral dissertation.

Sincerely yours,

Nawar Kadi,
Professor
Department of Textile Technology/ The Swedish School of Textiles
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