Proceeding Indonesian Textile Conference
(International Conference)
3rd Edition Volume 1 2019
http://itc.stttekstil.ac.id
ISBN : 978-623-91916-0-3

Absorption Coefficient of Tricot Warp Knitting Fabrics as Acoustic Textile Materials

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Abstract : Acoustic textiles generally use materials from natural or artificial fibers made by nonwoven or composite processes as sound absorption. The material has less aesthetic appearance, so it needs to be layered again with woven or knitted fabrics. This study, using 3 types 4-layered tricot warp knit fabrics with the characteristics related to thickness, density and porosity as the parameters for sound absorption material, aims to achieve a predetermined absorption coefficient value and have good aesthetics than nonwoven. The sound absorption test uses the impedance tube method at frequencies of 63 Hz to 6000 Hz with Retrieving data at a standard frequency of 100 Hz and a high frequency of 6000 Hz. The result shows that the structure of tricot with the highest density is the best fabric for sound absorption for it has the highest sound coefficient value.

Keywords: tricot knit fabric; acoustic textile; coefficient absorption

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1. Introduction

Sound pollution is caused by high-volume sounds that make the surrounding area noisy and unpleasant. The effect of sound pollution on the environment can interfere verbal communication, causing illness, stress, changes in blood pressure, and disorders of hearing such as temporary hearing loss, or permanent damage to the sense of hearing.

Acoustic textiles come from two words namely "textiles" and "acoustics". Textile is a flexible material made from woven yarn, knitting, and joining fibers. Acoustics is the study of sound, how sound is produced, propagation, and learning how the medium responds to sound, and the characteristics of sound. Acoustic textiles can be defined as flexible material from the process of weaving, knitting, and joining fibers which are used as a medium to respond to the sounds. Acoustic textiles are one part of the development of textiles namely technical textiles which have a special function as sound absorption. Sound absorption is a fabric absorbent material that can reduce noise.

In research on acoustic textiles many nonwoven and composite materials were used as sound absorption. The aesthetics of these materials are less good than woven and knit fabrics. Sound absorption materials from nonwovens and composites can be layered with woven or knit fabrics to add aesthetics.

This research uses material from warp knit fabric (3D fabric) which has better thickness and density than woven fabric as shown in Figure 1, and has a good aesthetic appearance. The thicker the fabric, the more the sound waves from sources that propagate through the media will be absorbed by the fabric (absorption). The thinner the fabric, the less sound waves that propagate through the media will be absorbed. The thickness of the fabric affects the value of the sound absorption coefficient. At low frequencies, in high fabric density, the sound waves will be reflected by the media (reflection) and in lower fabric density, the sound waves from sources propagate only through the fabric media (transmission). The fabric density greatly affects the coefficient of sound absorption at high frequencies.

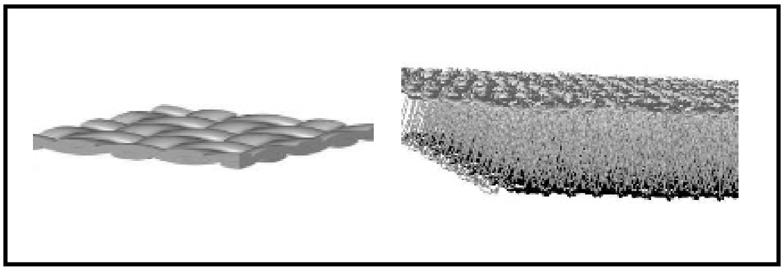


Figure 1. Difference in thickness of woven fabric and tricot warp knit fabric

2. Method

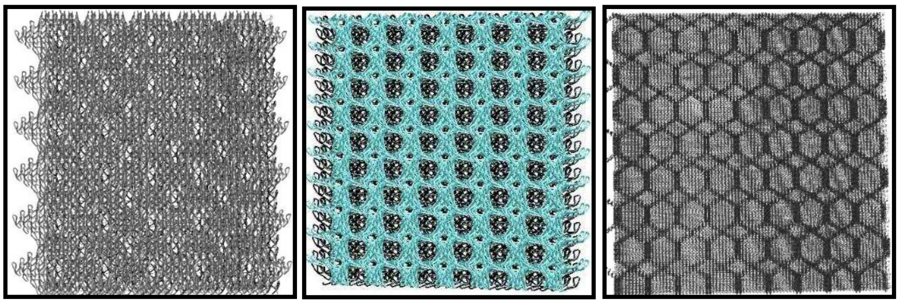
The acoustic testing method with the impedance tube method based on the ISO 10534-2 test standard was carried out on three samples of the tricot warp knit fabric with code names 93201A, 93127C, and 93172B. Each structure has a different density and porosity with the same fabric thickness of 2.4 mm. Knit fabric is made in warp knitting machine using 4 guide bars. The design of the tricot warp knit fabric is made using the ProCad warpknit 5 program. The yarn used in making the sample is polyester yarn.

Acoustic testing is carried out at low, medium and high frequencies with frequency ranges according to ISO 11564. To support the analysis of the sample, the fabric thickness will be tested, and the density and porosity will be calculated.

3. Results and Discussion

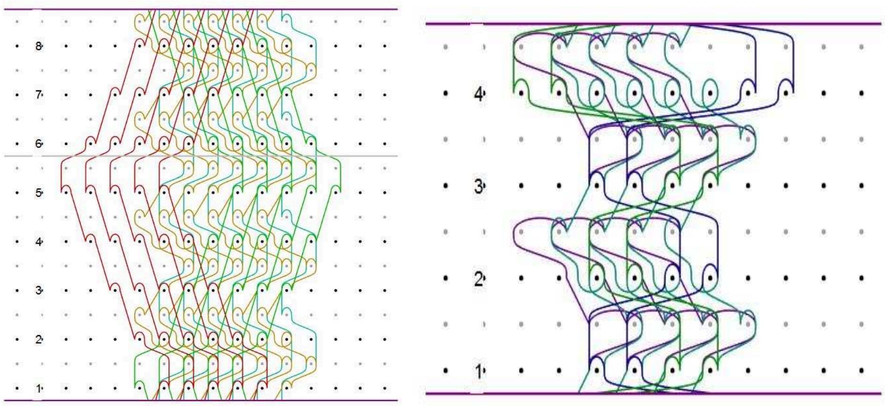
The fabric structure of the lapping diagram made can be seen in Figure 2. There is a difference in the structure of the three fabrics produced. Lapping diagrams of each fabric can be seen in Figure 3. Tricot warp fabric with four layers of fabric is used to obtain thickness and density of acoustic material that exceeds normal acoustic material. Absorption coefficients of the three fabrics can be seen in Table 1. Low, medium and high frequencies are given in tests with a minimum frequency of 100 Hz. and a maximum of 6000 Hz. Absorption coefficient graph at each frequency can be seen in Figure 4.

ISBN : 978-623-91916-0-3
DOI : 10.5281/zenodo.3470787

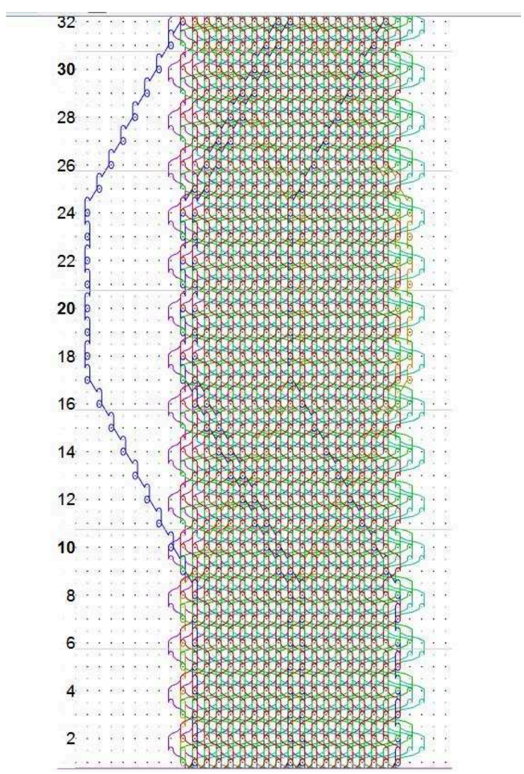


(a) (b) (c)

Figure 2. Structure of the tricot warp knit fabric, (a): 93201A, (b): 93127C, and (c): 93172B



(a) (b)



(c)

Figure 3. Lapping Diagram of the tricot warp knit fabric, (a): 93201A, (b): 93127C, and (c): 93172B

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Sample number 93172B gives a relatively high sound absorption coefficient value of 0.72 α. Tricot warp knit fabric 93127C provides sound absorption coefficient with a value of 0.49 α. As for the tricot warp knit fabric 93201A structure has a relatively low value with a value of 0.30 α. Tricot warp knit fabric 93172B has the highest absorption coefficient compared to other warp tricot knit fabric. This is because the tricot warp knit fabric 93172B has high density and good porosity compared to other fabrics.

Table 1. Test results on tricot warp knit fabrics

F (Hz)	93201A	93127C	91372B
100	0.2443	0.1219	0.1349
124	0.0929	0.0660	0.1319
160	0.1190	0.0715	0.1439
200	0.1262	0.0579	0.1385
250	0.1327	0.0496	0.0973
314	0.1538	0.0698	0.1750
400	0.1608	0.0370	0.0797
500	0.0041	0.0343	0.0293
630	0.1426	0.0691	0.1895
800	0.2152	0.0643	0.1658
1000	0.1056	0.1099	0.1411
1260	0.1230	0.1449	0.1760
1600	0.1385	0.1167	0.1603
2000	0.1237	0.1627	0.1500
2500	0.1273	0.1539	0.1815
3160	0.1968	0.2026	0.2867
4000	0.2611	0.3048	0.4375
5000	0.3721	0.3768	0.5682
6000	0.2443	0.1219	0.7204

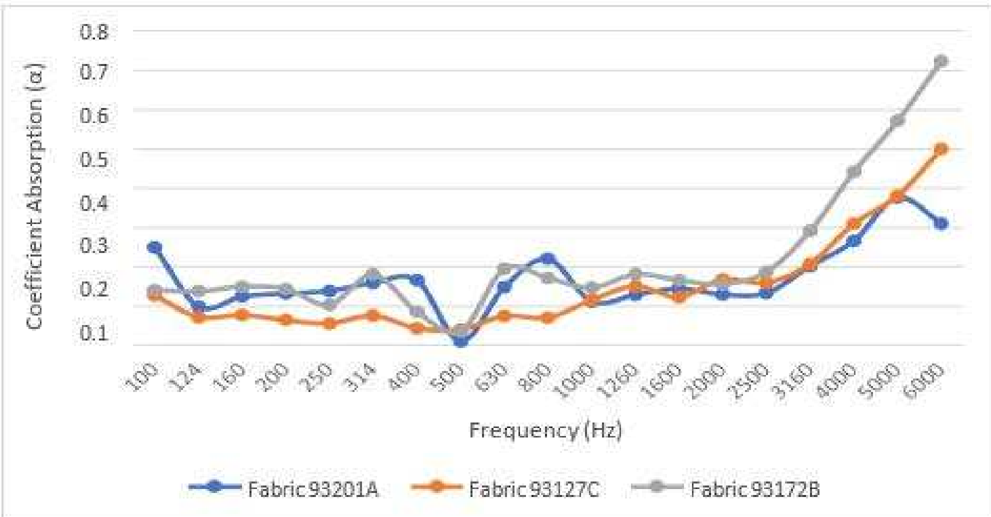

Figure 4. Relation of frequency to sound absorption coefficient

The results of the porosity and density calculations of each fabric are shown in table 2. The relationship between fabric density and sound absorption coefficient, and fabric porosity and sound absorption coefficient can be seen in Figure 5.

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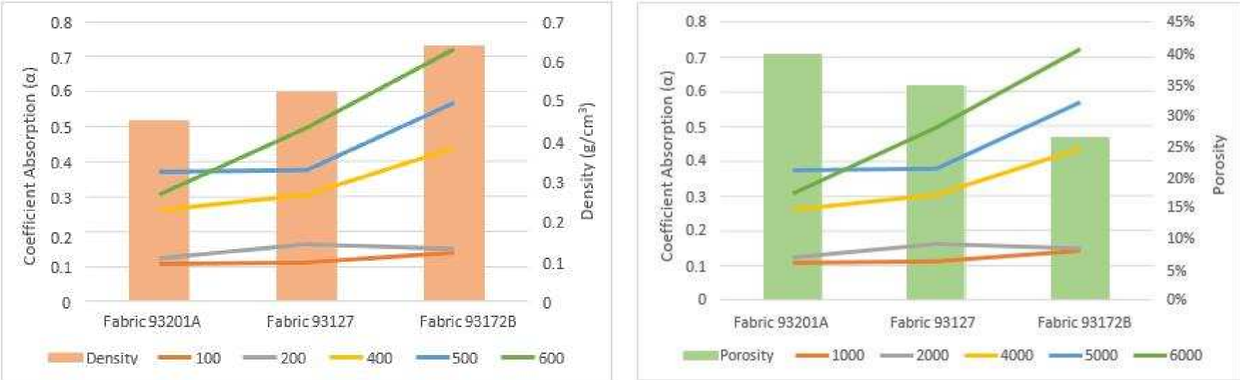
Table 2. Density and Porosity on tricot warp knit fabrics

Type of Fabric	Thickness	Density	Porosity
93201A	2.4	0.4505	0.3982
93127C	2.4	0.5227	0.3459
93172B	2.4	0.6379	0.2624



(a) (b)

Figure 5. The relationship of fabric density to sound absorption coefficient (a) and porosity relationship to sound absorption coefficient (b)

Sound absorption coefficient values increase in fabric samples that have high density values. The higher the fabric traffic value, the better the sound waves from the source propagating through the media will be absorbed by the fabric. Moreover, the smaller the fabric density, the less the sound waves propagating through the media will be absorbed (only partially). It means that the rest will be transmitted so that the absorption value is smaller. Material density shows the mass concentration of a material, which is measured as mass per unit volume. For materials with porous structures, material density is important in acoustic absorption. When the density structure is high, the sound absorption value will be high. High density materials are used to absorb high frequency noise. If the density structure is small, the sound absorption produced is small. This is related to the fabric porosity.

In inverse proportion to density, the value of sound absorption coefficient increases in fabric samples that have a small porosity value. The smaller the porosity value of the fabric, the more sound waves from sources that touch the fabric surface will be reflected (reflection). However, the greater the porosity of the fabric, the more sound waves that touch the fabric will be transmitted (transmission) by the fabric. The porosity of a material indicates the amount of empty space or emptiness in a structure. In the case of porous sound absorbers, the type, size and number of pores affect sound absorption. The higher the number of pores in a large structure or porosity, usually the smaller density of the mass of small porous material will be, which enable the sound absorption to be large. Conversely, the lower the porosity of a small structure, the bigger the mass density will be, so the sound absorption will be small because the sound through the fabric is mostly reflected back.

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4. Conclusion

Tricot warp knit fabric can be used as a sound absorbent. Thickness, density, and porosity affect the sound absorption coefficient. The higher the density is, the higher the absorption coefficient will be. Otherwise, the higher the porosity is, the lower the absorption coefficient will be. A combination of nonwoven or composite with a tricot knit fabric can be proposed to become an alternative sound absorbent that has a function as a good sound absorber and also a good aesthetic function.

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