International Journal of Recent Advances in Multidisciplinary Topics
Volume 2, Issue 6, June 2021
https://www.ijramt.com | ISSN (Online): 2582-7839

The Mechanical Properties of Warp Knitted Lining Fabrics Used for Sportswear

V. Punitha[1], A. G. Ajaykarthi[2*], J. Saravanasastha[3], M. Srinivasan[4]
[1,2,3,4]Student, Department of Textile Technology, Bannari Amman Institute of Tecnology, Tirupur, India

***Abstract*: The lining plays a major role in the comfort property of the outer fabric, preferably for sportswear, conceals the construction details and raw edges of fabric after sewing. On the whole, it gives a neat appearance to the garment used for apparel application. Development in sportswear lining fabrics has been getting more priority to perform high functions and to enhance the comfort property of clothing. The contributing factors for developing the active sportswear lining fabrics are fiber material, fabric structure, fabrication, and finishing techniques to achieve qualified fiber, the modified structure of yarns, and fabrics. In this paper, the performance properties and influencing factors of sportswear lining fabric with different constructional parameters were discussed. Nowadays natural fibers are hardly used to construct lining fabrics as they possess high cost and impose difficulties in imparting appropriate finishes. Synthetic fibers are now widely accepted for manufacturing sportswear lining fabrics. Synthetic fibers can be produced with hydrophilic (wetting) or hydrophobic (non-wetting) functions. Synthetic fabrics are generally considered to be the simplest choice for sportswear lining fabrics as they are ready to provide an honest combination of moisture management, softness, lightweight, insulation, and quick-drying properties. It is generally agreed that fabrics with moisture-wicking properties can regulate blood heat, improve muscle performance and delay exhaustion.**

***Keywords*: abrasion resistance, air permeability, bursting strength, sportswear, warp knitting.**

1. Introduction

Sports fabrics are designed with ultra-breathability. They have high heat and moisture management properties along with high elasticity, lightweight, fast-drying performances. These fabrics even have superior strength and sturdiness. The newest sports textile materials are far more functional and fulfilling specific needs in several sports activities. Linings are considered as one of the functional parts of the garment. It is used to ensure the form of the garment, to enhance the hang and luxury of clothing as lining allows the garment to slip over other garments. The lining also improves the insulation property of the garment. They are usually made up of polyester, polyamide, acetate, and viscose fibers. Linings are an essential part of making suits, blazers, trousers, vests, skirts, and dresses. Cotton, polyester/cotton, wool, and wool mixtures are used as lining fabric when the clothes require decoration and a warm handle. Linings play a critical role to form sportswear easier and attractive. The roles of linings are; to enhance comfort in terms of thermal and wetness properties, to stop sensory discomfort from prickliness or roughness of sportswear fabrics, to assist sportswear to maintain fine condition or silhouette, to reduce wrinkling or residual deformation of the outer fabric, to improve durability, to enhance friction, to hide seams or interfacing, and to stop transparency of the sportswear. Warp knitting is a family of knitting technology, in which the yarn zigzags along the length of the fabric that is following adjacent columns (wales) of knitting, rather than a single row (course). Plain warp-knitted fabrics (nylon, wool, rayon, silk, or cotton) with a close inelastic knit have been used in clothing underwear. Tricot knit type of warp knitted fabrics have been used in the making of lightweight fabrics like panties, brassieres, camisoles, girdles, sleepwear, hook, and eye tape, etc. Raschel knitting technique is a type of warp knitting method that is used for making an unlined material for coats, jackets, straight skirts, and dresses. Raschel knits have been produced as a lacelike open construction, using heavy, and textured yarn, which is held in place by a much finer yarn. Raschel can be made in a variety of types, ranging from fragile to course, and usually have limited stretch. The material employed in lingerie is Milanese structure. This fabric is stronger, more stable, smooth, and costlier than tricot fabrics. These knit fabrics are produced by knitting two sets of yarn diagonally, which ends up within the face fabric having a fine vertical rib. Therefore the reverse has a diagonal structure and leads to fabrics of lightweight, smooth, and run-resistant properties. The Milanese structure is now virtually obsolete.

The objective of the study is to analyze the mechanical and thermal properties of warp knitted fabrics made for sports application.

2. Materials

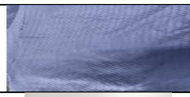
Warp knitted fabrics have been collected from the knitting industry for analyzing the correlation between structure and properties.

1) Material details

The fabric materials were sourced from the WALRUS clothing store located at Tiruppur district, in Tamilnadu state. Tricot and Raschel knit fabrics were sourced and analyzed for their comfort properties. The fiber type used for fabric production is 100% polyester.

*Corresponding author: ajaykarthi.tx17@bitsathy.ac.in

Table 1

S. No.	Yarn Count	Materials	Fabric composition	Areal density
Fabric 1	70 Denier		100 % Polyester	190 GSM
Fabric 2	75 Denier		100 % Polyester	200 GSM

3. Methodology

1) Air permeability test

The liner fabric size is kept consistent with the dimensions of the specimen fixing plate. A circle of 2.54 centimeters is marked on the fabric material. Enough clamping margin is additionally left with the specimen. If an oblong fabric was prepared that has a length and width of 2.54 centimeters and an additional clamping margin, then it might be preferred to use the fabric directly without cutting into a circular form. Five specimens were prepared for this study. The specimen clamp 'J was opened and it was tightened securely after placing the fabric specimen on the specimen fixing plate 'I'.

After connecting the instrument with an appropriate electrical power supply, the facility supply was switched on. The air pump began to suck the air through the fabric specimen. There were four rotameters connected with the air circuit. Initially, rotameter ' A' was brought into the circuit by turning a knob. The selected pressure drop between two fabric surfaces (face and back) was achieved by regulating the valve given in the instrument. The reading showed in the Rotameter was observed across the highest float. If the speed of airflow through the specimen was too low to supply a sign on the Rotameter 'A', it was switched to subsequent Rotameters B, C, & D in a sequence. This was done until the indicator starts showing the signal. The precise pressure drop is kept at 10 mm of water head. When the precise pressure drop was achieved properly, the reading in the Rotameter was recorded. All five test specimens for each fabric type were tested. A condition of 20° ± 2°C temperature was maintained during the test. A Rubber gasket was employed to stop the air leakage. The mean of all five readings was calculated and recorded as the final air permeability value.

2) Thermal conductivity test

The sample was taken from the fabric in the disc shape and tested in Lee's Disc instrument. The sample was kept between the two apparatuses. Then the water filled in the cylinder was heated and thermometers were placed in it. As the heat gradually increases up to a certain temperature, and the temperature gradually decreases, time and temperature values were recorded manually.

$$K = \frac{MS(d\theta/dt)d(r+2h)}{\pi^2(\theta 1-\theta 2)(2r+2h)} \text{ W -m}^1 \text{ -K}^1$$

4. Results and Discussion

1) Thickness

The thickness of cloth is one among its basic properties giving information on its warmth, heaviness, and stiffness in use. Samples thickness values play a crucial role within the other property evaluation, like air permeability and thermal resistance. The yarn count (denier) and mesh structure are affecting the material thickness (mm). As the increase in value of yarn counts, the thickness value increases. Knitting with longer underlap's results in more yarn to be fed into the material. It covers more wales on its way, leading to heavier, thicker, and denser fabric.

Table 2

S. No.	Thickness
1	0.46mm
2	0.49mm

2) Air permeability

Air permeability is a measure of how well air is in a position to flow through a cloth. The passage of air is an important parameter for a variety of cloth. This test was administered for all samples. It shows an indirect correlation between air permeability values ($cm^3/cm^2/s$) and thickness (mm) and air permeability is inversely related to fabric thickness. It decreases with an increase in thickness, increase in compactness, and reduction in air space (R^2=0.9303).

Table 3

S. No.	Thickness	Air Permeability
1.	0.46 mm	400 (cm3/cm2/s)
2.	0.49 mm	360 (cm3/cm2/s)

3) Thermal conductivity

Thermal conductivity is known as the amount of heat transferred through the fabric.

When, θ_1 =368 K, θ_2 =350 K, d = 0.77$\times -10^3 m$, r = 5.5$\times -10^3 m$, M = 810 $\times -10^3 kg$,

S = 3733 -kg¹ -k¹, h =10.90 $\times -10^3$m,$(d\theta/dt)$ = 0.038 k/s,

$$K = \frac{MS(d\theta/dt)d(r+2h)}{\pi^2(\theta 1-\theta 2)(2r+2h)} \text{ W -m}^1 \text{ -K}^1$$

The result is, K= 0.17487 $Wm^{-1}K^{-1}$ (Sample 1)

K= 0.18267 $Wm^{-1}K^{-1}$ (Sample 2)

4) Bursting strength

Table 4

S. No.	Areal density	Bursting-strength
1.	190	9.60 sq/cm^2
2.	200	9.80 sq/cm^2

Strength may be a measure of the coherence of cloth and is governed by numerous factors including the fiber type and regularity in diameter, knitted structure. For the model nets, a higher denier provided higher bursting strength and tensile strength. Each increase within the extent of the underlap tends to form the structure stronger, more opaque, and heavier. The increasing float length of the underlap features a more horizontal appearance, while overlaps produced by an equivalent yarn are going to be separated from one another at courses by an additional wale in breadth.

5) Abrasion resistance

Abrasion resistance can be known as the ability of a surface to resist by rubbing or friction. The abrasion resistance is affected by the conditions of the tests such as the nature of the abradant, the tension on the abradant, the pressure between the specimen and the abradant, and the dimensional changes in the specimen.

Table 5

S. No.	Weight of fabric (Before abrasion process)	Weight of fabric (After abrasion process)
1.	0.321 gm	0.317 gm
2.	0.296 gm	0.296 gm

5. Conclusion

We have tested two types of warp-knitted fabric for lining application in sportswear garment. And as we compare the properties of the two fabrics, Sample 1 shows better air permeability compared fabric 2 shows as their thickness and areal density influences. Fabric 1 and 2 both can be used as liner material for sports application. However fabric 1 is best suited for lining quality, in thickness, air permeability and thermal insulation retention. But the results can be concluded clearly when more number of different structures and fabric parameters are analyzed.

References

[1] S. Raz, "Warp Knitting Production", Verlag Melliand Textilberichte GmbH, Heidelberg, 1987.

[2] S. Raz, "Advanced Knitted Structures for Composites: An Outlook, Proceedings of Texcomp-2", 17–19 May, Leuven, 1994.

[3] S. Raz, “The Karl Mayer Guide to Technical Textiles“ edited by Karl Mayer Textilmaschinenfabrik GmbH, Obertshausen Copyright Germany We 208/1/4/2000. A". ASTM Inc., West Conshohocken, PA.

[4] Haven G. B., (1933). New Fabric Thickness-Measurer. Textile Research Journal, 3, 229-237.

[5] Mayer-Gall T, Gutmann JS and Textor T. New method for damage assessment n Martindale abrasion testing. Melland int. vol. 1, pp. 36–38, 2018

[6] Chippindale P. 40—wear, abrasion, and laundering of cotton fabrics. J Text. inst. Trans, vol. 54: pp.445–463, 1963

[7] Charles H. Lees, J. D. Chorlton; LIV. On a Simple apparatus for determining the thermal conductivity of cements and other substances used in the Arts; Philosophical Magazine; vol 41, no. 253, 1896.

[8] ASTM D737 – 04 (2012). "Standard Test Method for Air Permeability of Textile Fabrics". ASTM Inc., West Conshohocken, PA.

[9] ASTM D3786 / D3786M – 13." Standard Test Method for Bursting Strength of Textile Fabrics Diaphragm Bursting Strength Tester Method". ASTM Inc., West Conshohocken, PA.

[10] Schiefer HF and Werntz CW. interpretation of tests for resistance to abrasion of textiles. Text Res J, vol. 22, pp. 1–12, 1952.

[11] Sports and recreation textiles, http://www.technicaltextile.net - Assessed onv 20.12.2012.

[12] Ishtiaque, S. M., "Engineering Comfort, Proceedings on Smart Textiles, their production and market Strategies", Ed.: S. Gupta, NIFT, New Delhi, India, 2000.

[13] Development Active Sportswear Fabrics and Synthetic Fiber Producers, JTN, Dec. 1983.

[14] Kalaoğlu, F. and Meriç, B., "Investigation of the Performance of Linings", International Journal of Clothing Science and Technology, vol. 17, no. 3/4, 2005.

[15] Kawabata, H., Obara, K., Komiyama, H., and Narumi, T., "The Effects of Skirt Lining Properties on Comfort and Movement", International Journal of Consumer Studies, vol.25, no. 4, 2001.

[16] Tondl, R.M., "Lining a Jacket or Coat", http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article 2382 and context extensionist (24.01.2011), 1993.

[17] D’Silva, A. P., and Anand, S. C., "Responsive Garments for Sportswear, Proceedings on Smart Textiles, their production and market Strategies", Ed.: S. Gupta, NIFT, New Delhi, India, 2000. Anonymous 1996. World sports activewear. http://www.sportstextiles.com.

[18] Adanur, B.S.S. and W. Sears, Handbook of Industrial Textiles. Technomic Publishing, Inc., USA, 1995.

[19] Behera, B. K., Mani, M. P., Mondal, A. K., and Sharma, N.," Comfort Behaviour of Cotton Polypropylene based Bi-layer Knitted Fabrics", Asian Text. J., May 2002.

[20] Buhler M. and Iyer C., "An Investigation into Opportunities for Further Developments of Functional Knitwear for the Sportswear Sector, Knitting Technique", Germany, vol. 10, no. 5, 1998.