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Review

Factors of Weave Estimation and the Effect of Weave Structure on Fabric Properties: A Review

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Abstract: This paper provides a review of recent studies on the weave factor along with the effect of weave parameters and particularly the weave structure on various properties of woven fabric. The weave structure can be considered as one of the prime parameters that contributes to the dominant physical and qualitative properties of the woven fabric. This study analyzed not only the parameters that significantly influence the properties of the woven fabric, but also the weave factors for the estimation of the weave that were proposed by earlier scientists. This review paper highlights the impact of weave structure on the physical and mechanical, thermo-physiological and comfort properties, and some special application properties of woven fabrics. This work seeks to serve as a future reference for related research.

Keywords: woven fabric; weave factor; weave structure; fabric properties

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1. Introduction

There are seven main parameters that are used to evaluate the woven fabric, including the warp and weft count, the warp and weft raw materials, the warp and weft setting, and the type of weave. These parameters have a significant influence on the structure of the woven fabric. The evaluation of weave and fabric properties, such as air permeability, strength, elongation, etc., was studied by various authors [1–4]. According to previous studies, fabric properties are influenced by the structure of the woven fabric. Numerous studies have been conducted on the influence of weave structure on various properties and qualities of woven fabric [4,5]. It is widely known that majority of the mechanical properties of the woven fabric are influenced by the structure of the weave, which could be described by the Fabric Firmness Factor (φ), a measure that considers both the weave and the setting [5]. Similarly, air permeability is one of the most essential qualities of clothing in terms of the comfort it provides. Air permeability is an inherent attribute of fabrics that is determined by their structure and is directly proportional to the density of the weft and warp in a woven fabric. Experiments reveal that the fabric firmness factor can be used to evaluate the fabric structure throughout the weaving process, as well as some fabric properties. The results of the research reveal that the fabric firmness factor can be used to compare woven fabrics with different structural parameters [6].

Fabric structures are created by interlacing yarns or intermeshing loops to create two-dimensional (2D) flexible materials [7]. The most prevalent structure is woven fabrics, which are made up of two sets of perpendicular yarns that are crossed and interwoven to form a coherent and stable structure [8]. The ability of a fabric to provide the properties required for an end use determines its engineering potential [7,9]. Fundamental structural elements of woven fabrics consist of several terms used as: yarn count, thread density, areal density, weave repeat, weave factor, float, crimp, fabric specific volume, fabric packing factor, etc. [8,10]. Many of the structural features listed here are particularly useful in characterizing various crucial fabric properties, such as air permeability, moisture vapor permeability, protection (e.g., UV protection), transparency, etc. [8,10].

The authors have investigated the impact of spinning processes (ring spun (combed, carded) and open-end (OE)), and weave design (plain, twill, and satin) on the mechanical and surface properties of fabrics. The authors reported that the increased interlacing of the yarn causes greater crimp in the load carrying, resulting in poorer breaking strength. Fabrics woven with combed ring spun yarns exhibited higher tensile strength and elongation than those woven with carded ring yarns or OE yarns. Plain weave design also shows lower strength and elongation compared to twill and satin weave. Due to rubbing exposure of the float length with the abradant in twill and satin weave, the effects are contrary in the warp-wise and weft-wise directions. In plain weave, however, the interlacing is identical in both the warp and weft directions, so it has no effect [11].

Even though a few isolated research has been conducted in the past to link the weave structure to the mechanical characteristics of woven fabrics, they were lacking in detail and did not offer relevant insights. Our comprehension of fabric structure has increased with the addition of factors like the Floating Yarn Factor (FYF) and the Crossing over Firmness Factor (CFF), as suggested by Matsudaira [12]. The Fabric Firmness Factor (FFF), proposed by Milasius [5], is a parameter that considers both weave and sett. However, fabric sett is not taken into account by Matsudaira's specifications that is also identified by Milasius. Such drawbacks were also admitted by Matsudaira and agreed for further studies on this. Milasius took the main parameters of fabric structure into account when he proposed integrated factors of fabric structure. The weave factor has been shown to alter a number of fabric properties, including weaveability [13], beat up force [14], fabric breaking force, elongation at break [15], fabric breakage, and the relationship [16] between the raw material [17] used and the fabric structure factor [6].

V. Sankaran and V. Subramaniam investigated the effect of weave structures on the mechanical properties of fabrics [18]. The authors also agreed, based on their findings, that Milasius' method of expressing fabric structure is preferable and possible to quantify the fabric properties. The study claimed a positive correlation between CFF and bending and shear properties; similar for FYF and mechanical properties. Shear rigidity decreases if the float length increases, and conversely, for CFF. The study further claimed that the bending and shear parameters can only be predicted with the weave structures [18].

This paper provides an overview of the various weave factors along with the effect of weave parameters and, in particular, the weave structure on various properties of woven fabric. There have been several works conducted on analyzing the effects of yarn parameters on the strengths of fabric. However, to date limited studies have been conducted on weave factors and effect of weave structure and their correlation with properties. Therefore, this study highlights the impact of weave structure on the physical and mechanical, thermo-physiological and comfort properties, and some special application properties. The influence of weave on various properties of woven fabric is still not studied enough.

2. Weave Factors

The extent of yarn coverage in the woven fabric is known as the cover factor or weave factor. Maximum cover may be achieved when the yarns are in close proximity to the adjacent yarns and there are no air spaces between them. The weave factor indicates how much of the fabric is filled in by the weft threads in the direction of the warp threads and vice versa. The weave factor is a measurement of how much of a fabric's surface area is covered by a single set of threads. There are two cover factors in any woven fabric: a warp cover factor and a weft cover factor. According to the cotton system, the weave factor is defined as the ratio of threads per inch to the square root of the count of cotton yarns.

Different weave factors have been proposed to estimate the weave, which can be divided into two groups: some estimate simply the interlacing of a single thread, while others characterize the weave as a whole [4]. The weave factors proposed by Ashenhurst [19] and Galceran [2] are nominated for the first group. The commonly used weave factor is

Ashenhurst's [19] $F_{1(2)}$, also known as the average float length, and can be calculated as Equation (1).

$$F_{1(2)} = \frac{R_{2(1)}}{t_{1(2)}} \tag{1}$$

The Galceran's [2] weave factor Kl is similar and can be calculated using Equation (2).

$$KI_{1(2)} = \frac{\sum_{i=1}^{R_{2(1)}} t_{1(2)i}}{R_1 R_2} \tag{2}$$

Here, R_2 and R_1 are repeats of weft and warp, and t_1 and t_2 are the numbers of intersections of warp and weft, respectively.

The drawback of such weave factors is that they only describe the interlacing of a single thread, making it difficult to estimate all weaves using them.

For the second group of factors is nominated the most known weave factor F^m proposed by Brierley [1], where m depends on the weave groups and was determined empirically. The disadvantage of this factor is that m is calculated empirically, and it is not always clear to which weave group the weave examined should be assigned in all weave circumstances. Additionally, complications arise during the evaluation of rib weaves. Brierley describes weaves as very specific patterns for which a special value has been calculated. Milašius [4] proposed his own weave factor P, which can be determined using the weave matrix and analyzes the weave in its entirety. This factor also belongs to the second group of factors, that is, the ability to analyze a weave. Furthermore, Milašius [20] proposed a new method P' for calculating weave factor P. Factor P' indicates the integrated mean of the weave factors and is calculated in the warp (P_1) [21,22] and weft (P_2) directions, respectively. It gives the possibility to modify weave factor P' by every researcher using different percentage of P_1 and P_2 in P' calculation.

3. Weave Structure and Properties of Woven Fabric

3.1. Physical and Mechanical Properties

3.1.1. Physical and Mechanical Properties of Woven Fabric

Tensile, bending, shear, buckling, and compression are just a few of the mechanical properties that influence fabric performance in a variety of applications [23]. The mechanical properties of the fabric are greatly influenced by the fiber or yarn components. Fiber morphology, such as orientations, crystallinity, and amorphous regions, is a critical component in determining fiber properties, including strength, extensibility, stiffness, and so on. Similarly, twist, fiber length, and fiber orientation all have an impact on yarn properties, which, in turn, has an impact on fabric performance. The relative value of any of these properties is determined solely by the application's demand. When a fabric is used in a tensile structure, for example, strength is necessary, while moisture or liquid transmission is crucial for a fabric used in sports clothing [24].

As woven fabrics are easily bent and stretched, as well as heterogeneous, even at low stress and room temperature, they are highly anisotropic, non-linear, and plastic; they differ significantly from typical engineering materials. They have distinct qualities, such as the ability to accommodate movement and the ability to weave intricate patterns that meet the wearer's aesthetic criteria. The previous study of woven fabric mechanics goes back to early studies published in the German aerodynamic literature by Haas in 1912, at a period when the construction of airships sparked worldwide attention [25,26].

Previous researchers investigated the shear behavior of plain, basket, and satin cotton polyester blended fabrics. They discovered that the length of the yarn float and the twist of the yarn had a substantial impact on the shear behavior. Most of the mechanical properties of the woven fabric are influenced by the structure of the weave, as is widely known [27]. Wang et al. developed equations to predict the shear rigidity of short-float worsted fabrics based on simple fabric structural data [28]. Recently, Alam et al. developed a mathematical model to predict the shear rigidity of woven fabrics [29]. The study determined the highest shear rigidity in plain woven fabric after 2/1 twill woven fabrics. The authors reported almost the same shear rigidity on other weaves as 3/1 twill, 2/2 twill, 2/2 matt, and 5-end satin.

V. Sankaran and V. Subramaniam [18] demonstrated the impact of weave structures on low-stress mechanical properties using the crossing over firmness factor (CFF), floating yarn factor, fabric firmness factor (FFF), and their correlation. Among the two fabric groups used in their study, an excellent correlation was found between shear, crease recovery, tensile, and air permeability; however, a poor correlation was recorded between hand value and parameters. In addition, an excellent correlation between CFF and FFF is also established. Furthermore, the highest FFF was reported with a pick density of 173.2 compared to 126. Therefore, it was concluded that the method of Milašius' [5] was recommended to quantify the properties of the fabric [18].

Material buckling is an important issue in current textile applications. Due to developments in new materials and changes in their behavior under buckling stresses, the examination of buckling of diverse materials has been ongoing since 1757, when the Leonhard–Euler solution was proposed. In a variety of uses, the buckling of a fabric dictates its behavior under load. It has been discovered that a fabric's drape is determined by the forces operating on its ability to buckle the fabric in its plane [30,31].

The buckling properties of a woven fabric also influence the quality and stitching of the garment, which is becoming increasingly essential as robotized sewing operations become more common [32]. The authors of an earlier study focused on a quantitative comparison of the buckling of existing and new flexible textile materials, regardless of their composition, using an empirical technique. The study also demonstrated the correlation of the buckling coefficient with Young's modulus of the fabric, the flexural rigidity of the fabric, and the design of the fabric weave. The methods in the study included segments of the fabric buckling test, fabric modulus of elasticity, fabric bending rigidity on various weave structures, materials, and fabric specifications. The buckling characteristics of the woven fabric with and without holes were also investigated. The author also indicates that the angle of the twill line to the direction of the buckling force has a major impact on the structure of the twill. It has been established that fabric bending rigidity, fabric design, and hole volume to sample volume ratio are three key types of deformation in buckling of fabric with holes. According to the findings, the interlacement of warp and weft yarns is represented by the twill line. The fabric will stiffen in that direction due to the presence of the twill line. As a result, when the angle of the twill coincides with the direction of the buckling force, the buckling force of the fabric is highest and, when it is perpendicular to it, the buckling force of the fabric is smallest [31]. Unfortunately, the authors did not analyze the direct influence of some kind of weave factor on the present properties, although the influence of weave is evident.

3.1.2. Role of Weaves in Fabric Engineering

Fabric engineering plays an important role in all fabric design, but it is especially important in industrial fabric design, and it has to be concerned with every area of the fabric structure. The weave does not affect all fabric properties equally. The strength of the yarn determines the tensile strength in either the warp or weft direction in the fabrics, while the weave contributes only a small role. The weave has a large influence on other properties, such as tearing strength and bending length (stiffness). Taylor [33] and others have looked at the effect of weave on fabric properties, but almost all of the published research has focused on a small number of traditional weaves as plain, 2/2 and 3/1 twill, 5-shaft satin, etc. The study by another researcher also examined, through experimental findings, that weave has a very significant effect on both tearing strength and stiffness in fabrics woven according to a specific design [34].

The sett and construction of the woven fabrics are known to influence their tensile performance. Fabric structure, particularly the interlacement pattern and its distribution, are essential factors in woven fabrics, and a tool that can forecast changes in attributes as a result of a change in design should be valuable in woven fabric engineering. Peirce established geometric correlations between yarn spacing, yarn diameter, modular length, and weave angle as a way of understanding the behavior of a woven fabric in various forms of deformation [3]. According to the authors, the amounts of loads carried by interlacing yarns, their spacing and interlacement pattern, the crimp of the constituent yarns and their interchange throughout the tensile deformation process are the elements that influence the tensile properties of fabrics [35].

Other authors determined the relationship between fabric structure and weavability, taking into account weave factors, integrated fabric structure factors, and maximum weft setting. The findings showed that Brierley's group factors better reflect fabric weavability than Peirce's group factors and are a more precise and practical indicator for various fabric weaves [13].

3.1.3. Fabric Structural Factor and Tensile Properties of Fabric

The mechanical properties and strength of the woven fabric are influenced by various factors such as the strength of the yarn, the setting of the fabric, and the function of the coefficient of strength of the yarn. It has been proven that when the strength of the yarn increases, so does the strength of the fabric [36]. The strength of the tear and the rigidity of the bending were also evaluated by earlier researchers [28,37].

The interrelationships between fabric structure and its strength were analyzed in a paper [38]. It is evident from the findings that there is no relationship between the breaking force and the weave factor of the woven fabric. Although the elongation at the break depends on the weave of the woven fabric, the elongation at the break increases as the rigidity (φ) of the woven fabric increases. This may be due to the higher crimp in yarn generated from the rigid weave structure of the fabric and that eventually resulted in a higher elongation. The author further illustrated that the loss of breaking force caused by increasing the weft setting and at the same time the elongation at break escalated [38]. Further studies focus on investigating the physical properties of plain and diced fabrics by means of bursting strength, breaking strength, elongation at break, and impact strength. Diced woven fabrics were reported to have higher bursting and impact strengths than plain woven fabrics, but plain-woven fabrics had higher breaking strengths in both the warp and weft directions. Furthermore, the physical properties of the diced woven fabrics improved as the yarn densities increased [39].

Nikolic et al. have studied the tensile properties of woven fabric [36]. The authors suggested looking at the strength of woven fabrics as a function of thread strength, fabric density, and thread strength coefficient. It was discovered that as the strength of the thread grows, so does the strength of the woven fabric. The authors claimed that plain weave is the strongest among the twill and satin weaves used during their research, however, the tearing strength was lower as reported [40]. The study also reported higher stiffness, abrasion, and pilling resistance in plain weave than the other two weaves. Another study emphasizes the influence of the structure of the woven fabric (weave factor P_1) on its breaking force and elongation at the break. It was revealed that the fabric weave factor and the breaking strength of the woven fabrics are not related. Consequently, if the rigidity of the weave decreases, the elongation at break also decreases as the coefficient of weave increases [15].

A recent study also investigated the influence of weave design on the tensile properties of woven fabrics using polyester-cotton (50:50) plain, twill, and satin weave designed fabrics. These fabrics were made of various types of yarn, such as combed, carded, and OE (open end) in the weft, while warp parameters were kept constant with compact cotton ring spun yarn for all weave designs [11]. The study determined the higher tensile strength and elongation in the weft direction using combed yarn compared to other fabrics. However, for all weave-designed fabrics with OE yarns, this resulted in lower tensile strength and elongation than for ring-spun fabrics.

Furthermore, a lower tensile strength was reported in plain woven fabrics than in twill and satin weaves [41]. This may be due to a greater effect of contact friction, crimp, and binding on plain weave than on twill and satin weaves. These parameters create additional bending and weak points on tensile loads, and hence the plain weave structure results in lower tensile strength than the other two weaves [42]. However, the same study reported a higher elongation in plain weave than in satin and twill weaves. This could be due to the higher interlacement and the crimps that exist in the plain weave structure [42].

3.1.4. Weave Parameters and Tear Strength

R. Milašius et al. determined the weave parameters proposed by earlier researchers and their influence on the tear strength of woven fabrics. For the study, weave parameters, such as Brierley's factor F^m [43], Milašius' factor P [4,21], and P' [20], were used; however, the authors further modified the parameter P as P_{weft} for their work. In their study, two fabric groups were investigated, the rib-based group and the twill-based group. The study illustrated the influence of weave parameters on tear strength. The coefficient of determination (R^2) was found to be high and indicates the precision of the prediction of the strength of the tear. According to the modified parameter P'_{weft}, the determination coefficient obtained was higher than P'. The authors confirmed the correlation of Brierley's parameter F^m, as well as parameter P' and the prediction of tear strength; however, for the rib-based weave group, it is recommended to calculate parameter P' by altering the influence of the parameters P_1 and P_2 [44].

Vimal et al. investigated the effect of weave factor and weave parameters on cotton woven fabrics. Based on weave factors such as the crossing of firmness factor (CFF), floating yarn factor (FYF), fabric firmness factor (FFF) and weave factor (P_1), the tear strength of 11 cotton woven fabrics is investigated [45]. The methods applied by the authors included the determination of the weave factor calculated by the previous method [20], fabric processing, porosity measurement, thickness and areal density measurement, and tear strength measurement. The author reported a significant correlation of weave factor (P_1) [5] and weave parameters (CFF, FYF, FFF) with fabric tear strength in both the warp and weft directions of the fabric. The author further reported that the number of floats (FYF) [46] in the fabric is positively correlated with the weave factor (P_1) and in addition the weave factor (P_1) has also positively correlated with tear strength in both warp and weft directions. In contrast, while FFF increases, the tear strength drops [45].

Researchers investigated the tear damage of two plain and two twill-woven fabrics by experiments and the finite element analysis method. The authors reported significantly higher tearing strength of 1/2 twill than that of plain-woven fabric. The technical reason for this difference is due to the longer floats of 1/2 twill-woven fabric, which create lower friction resistance for weft yarns to be pulled from warp yarns. Similarly, compared to weft yarns, a high warp density comprises more interlacing points, resulting in stronger friction resistance. On the contrary, weft density has little effect on the tearing strength of woven fabrics [47].

A comparative study of tear strength methods was conducted by B. Witkowska and I. Frydrych. The study focused on the problems of tear strength, measurement methods, and the correlation between the findings of different tear test methods, such as static and dynamic tearing applied to protective textiles. A set of five fabrics was investigated by applying six methods and comparing the results of the tensile and tear tests. According to the findings reported by the authors, no correlation was found between the measurements [37].

The influence of woven fabric on the strength of the tear in the warp and weft directions was analyzed in the previous study and is shown in Figure 1. The longer the yarn floats in the weave design, the greater the tearing force, according to the study. This is possibly due to the applied force, the threads are free to move and will be close to each other, resulting in an increase in the number of threads sharing the load in the direction of tear, resulting in a higher tearing resistance. Alternatively, the tighter the structure, the less freedom to slide the yarn and the less resistance to tear the yarn [48].

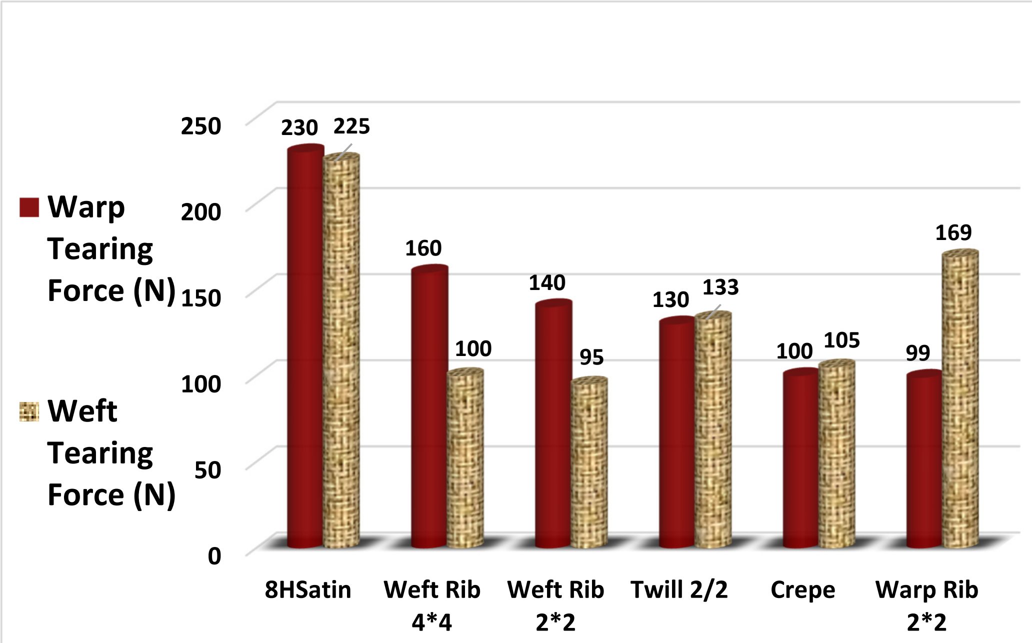


Figure 1. Effect of fabric structure on the tearing force in the warp and weft directions. Reproduced with permission from [48]. Copyright 2018 Elsevier.

The mobility of the yarns within the fabric structure also determines the tear strength of the fabric. Due to loss of movement, the plain fabric had poor tearing strength. The fabric's tearing strength is influenced by the weave pattern, which controls the number of yarn crossing spots. This has a direct impact on the fabric's ability to bend and on the quantity of yarns that break apart. As reported by the authors, due to the variation in construction, rib fabrics have stronger tear resistance than plain weave fabrics because two yarns work together to resist tear [49].

3.1.5. Weave Structural Parameters and Fabric Friction Properties

Fabric friction can be defined as the resistance to motion and can be detected by mechanical rubbing against itself [50,51]. The nature of the textile, the moisture level of the skin and the ambient humidity all influence the coefficient of friction of the textiles against the skin [52,53]. In the measurement of surface friction properties, the physical characteristics of the yarns (fiber fineness and composition, yarn count, and twist), as well as their alignment and arrangement in the fabric structure (density, yarn crimp, weave pattern, fabric balance, and fabric thickness) are crucial [52,54–56]. Wilson [57] investigated the kinetic coefficient of friction in plain, twill, and satin weaves. The study claimed that the fabric frictional characteristics are influenced by the apparent contact area and that Amontons' second law fails for the majority of the fabric investigated. Carr et al. [58] also analyzed how fabric friction was affected by weave structure, fabric weight, warp/weft orientation, and normal stress (pressure) and agreed the effectiveness of Amontons' laws for fabrics in their work. The influence of fabric structure on surface friction resistance was determined in another study [59]. The study reported that fabrics woven from continuous filament yarns have friction resistance that is determined by both the direction of rubbing and the weave structure. The study revealed that the friction resistance of mono-filament fabrics is affected by the variation in mesh size [60].

The fabric–fabric friction in warp and weft ways of twill and broken twill for suiting fabrics was determined in a study by Das et al. [61]. The study reported that the warp-warp friction is higher than the weft-weft friction for a weft-dominated twill-woven fabric. It claims higher frictional resistance in the warp direction, since the fabric is weft dominated. On the other hand, warp-dominated broken twill-woven fabrics resulted in minimum friction resistance values. The study also reported that the static frictional force is higher than the kinetic frictional force for all fabrics tested in the study [61]. Similar studies were conducted by Jeddi et al. [62] and four types of woven fabrics (plain-weave, 3/1 twill, 2/2 twill, 2/2 weft rib) were analyzed in the study. According to the reported findings, the friction resistance increases with increasing weft density and linear density of weft yarns in fabrics. In a separate study, the authors investigated the relationship between friction and tactile properties of plain-woven and knitted fabrics. The study reported a correlation between fabric friction and touch properties for knitted fabrics; however, the opposite result was found for plain woven fabrics [63].

3.1.6. Shear Properties and Fabric Structural Factor

The shear behavior of woven fabrics is a mechanical characteristic that defines the suitability of the fabric for garments. Fabric shear behavior affects drape, handling, and pliability, among other properties [64–67]. Fabric shear rigidity, which is substantially lower than fabric tensile rigidity, has an impact on woven fabric strength and bending capabilities [68]. The effects of weft density, weft count, and fiber type on woven fabric shear behavior in the main fabric directions were statistically examined by M Shanbeh et al. The findings of the univariate test revealed that weft density is the most important factor that influences fabric shear characteristics. The shear behavior in woven fabrics with cotton weft yarns is poor, according to multiple linear regression analyzes. The fabric firmness factor, the fabric cover factor, and the shear rigidity of the fabrics in the main directions were found to have a strong association [69].

3.1.7. Weave Factor and Slippage of Yarns in Fabrics

In woven fabrics, the slip resistance of the threads near the seams is a critical aspect, and very rigorous claims are made for this property. The author aimed to determine which weave factor is most appropriate for describing the resistance to slippage of yarn at a seam in balanced weave materials. A new weave factor, NPR, has been proposed to estimate slip resistance. The influence of weaving on slippage is better described by this weave factor than by other known weave factors (V. Milašius factor P [4] or Ashenhurst factor F [19]). From the perspective of thread slippage, a polynomial of the second-order equation of the new weave factor best characterizes balanced fabric structure, and the determination coefficient was quite high, at 0.9102 [70].

When the fabric is subjected to a particular load in the weft direction, seam slippage is a measure of the ability of warp yarns to slip over weft threads near the seam, which extends in the warp direction (and vice versa). The slippage of woven fabric yarns [71–75] and the effect of weave on the slippage of woven fabric yarns [76] have been extensively studied by previous authors. Seam slippage has been shown to affect the weave factor in both the slip and normal directions. According to the author, the weave factor in the slip direction influences seam slippage by 81% and the weave factor in the normal direction by 19%. However, this model still shows limitations to describe rib fabrics [76].

3.2. Comfort Related Properties

3.2.1. Weave Structure and Thermal Properties

Thermal comfort, which is defined as a sense of contentment with the thermal conditions of the environment, is closely related to physiological comfort [77–79]. Thermal insulation is directly influenced by the type and structure of the fabrics. The thermal resistance of the fabrics, the resistance to water-vapor, and the permeability of the air are all important comfort attributes [80–83].

Clothing that provides thermal insulation is critical because it acts as a barrier between humans and their surroundings. The effect of clothing on a person's comfort is a complicated phenomenon influenced by the material and structure of the garment [80]. During heat convection, the authors studied the air permeability and thermal resistance of the textile. The heat resistance of the textiles was evaluated using a newly created instrument.

It has been demonstrated that as the pore size and the ratio of the pore area to the total fabric area increases, air permeability increases, while thermal resistance decreases.

Several research studies on thermal resistance were conducted and thus published [84–90]. It has been reported that the porosity and thickness of the fabrics influence the thermal resistance. Thermal conductivity and thermal resistance have a positive relationship with porosity. If the porosity of a fabric is higher, it can allow more air to enter the environment. The thermal resistance of the fabric is likely to be reduced as a result of this [91].

The porous nature of the samples has a predominance of low enclosed air conductivities, and fabric conductivity is essentially consistent for fabrics of various thicknesses. Therefore, the heat insulation is proportional to the thickness of the fabric. Zhu et al. [92] pointed out that both porosity and thickness affect heat resistance. Although porosity and thickness were shown to be highly associated with thermal conductivity, no association was found between weave parameters and thermal conductivity. Studies reported that plain fabric had the lowest thermal resistance, whereas 8-thread Brighten honeycomb fabric had the highest thermal conductivity and had been collectively influenced by weave structures. This is due to the lower porosity and thickness of the plain fabric compared to other weaves [91]. This contradicts Matusiak and Sikorski's findings [93].

Other researchers also claimed higher thermal conductivity and thermal absorptivity and lower thermal resistance of plain fabrics than twill 3/1 S, twill 2/2S, rep 2/2 (2), rep 1/1 (0,1,0) and hopsack 2/2 (0,2,0) weaves with identical warp and weft thread specifications. The thermal properties of woven fabrics are greatly influenced by the weave and the linear density of the weft yarn, according to statistical investigation [93]. Similar findings on plain fabrics were also reported in a recent study [94]. The study claimed that the plain-woven fabric showed the highest thermal conductivity and the lowest thermal resistance, whereas the hopsack 2/2 (4) woven fabric resulted exactly in reverse as the lowest thermal conductivity and the highest thermal resistance.

3.2.2. Weave Structure and Air Permeability

Permeability is an important factor in comfort when it comes to clothing fabrics. With respect to technological materials, permeability may be the most important attribute in terms of fabric function (for example, filters, parachutes, and airbags). The primary feature of the structure of the textile material is the air permeability. Previous studies have shown the relationship between weave structure and air permeability properties of woven fabrics [95–99]. Milašius et al. determined that air permeability decreases as the woven fabric structure becomes denser, but abrasion resistance increases as the woven fabric weave becomes stiffer [100].

Porosity is a quality that is typically described by the structure of the fabric [101–103]. Fabric porosity is classified into two categories: horizontal and vertical porosity. Horizontal porosity is a two-dimensional concept of porosity that is a horizontal projection of the fabric. M. Havlová studied the effects of fabric porosity on air permeability. The author proposed an elliptical model of the vertical pore, which is also a two-dimensional model of porosity, but it is a projection of the fabric onto the vertical plane [104]. The author reported that the measured permeability values and the computed vertical porosity values have a high correlation. Vertical and horizontal porosity were calculated according to Equations (3) and (4).

$$P_{ver} = \frac{E_O + E_U}{S_{FO} + S_{FU}} \tag{3}$$

$$P_{hor} = 1 - (d_O D_O + d_U D_U \pm d_O d_U D_O D_u) \tag{4}$$

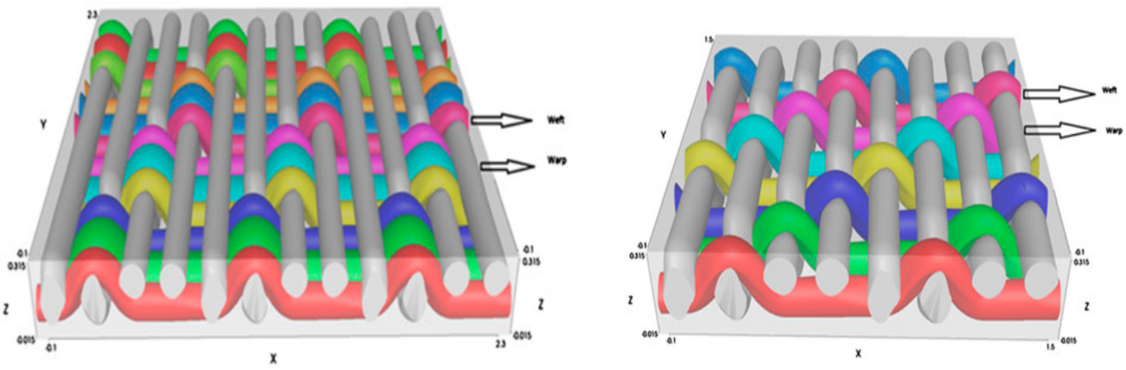
where, d_O & d_U in m are the diameters of warp and weft yarns, respectively, and D_O and D_U in 1/m are sets of warp and weft yarns, respectively. S_{FU} is the total projection area of floating weft yarns in 1 cm^2 of the woven fabric, and S_{FO} the total projection area of floating warp yarns in 1 cm^2. E_U is the total area of all the vertical pore cross sections under weft yarns in 1 cm^2 and the total area of the warp vertical pores in 1 cm^2 is expressed as E_O.

The third dimension of the fabric, as well as changes in pore shapes due to different weave types, are completely ignored in this porosity model.

The horizontal porosity model is inadequate to describe the link between the permeability of the woven fabric and its structure, as shown in earlier studies [105].

Unlike CFF and FYF, the vertical model of the inter-yarn pore provides a quantitative description of the dimensional properties of pores created between yarns in the vertical direction, which can be particularly valuable in the design of filters. Pressure loss, for example, can be reduced while still retaining some filtering capability [104].

The study by Umair et al. focused on improving the thermo-physiological comfort and air permeability of selectively designed woven fabrics. The weave designs were 3/1 twill and 1/1 plain weave with three pick sequences for each design as single pick insertion (SPI), double pick insertion (DPI) and three pick insertions. Among the designs experimented by the authors, compared to plain weave design and those with SPI or DPI, a significant improvement in air permeability, less wetting time, and improved water spreading rate was achieved in twill weave fabrics and with simultaneous 3PI [106]. Figure 2 describes the cross-sectional view of (a) 3PI with 3/1 twill weave design and (b) 3/1 twill weave design. The interrelationship between the structure of a woven fabric and its air permeability of a plain-woven fabric of 58 experimental and 13 control fabrics was determined by M. Havlová. The author proposed the relationship of the prediction of the air permeability of the fabric in his study. Although two fabrics may have the same flat covering value, their air permeability differs drastically [105].



(**a**) (**b**)

Figure 2. Cross-sectional view of (**a**) 3PI with 3/1 twill weave design and (**b**) 3/1 twill weave design. [106] Effect of woven fabric structure on the air permeability and moisture management properties Umair et al., The Journal of The Textile Institute. Copyright © The Textile Institute, reprinted by permission of Taylor & Francis Ltd., http://www.tandfonline.com on behalf of The Textile Institute.

A cloth with a larger number of smaller pores or a smaller number of larger pores may be used. The area of yarn hairiness has a greater or lesser effect on the space of each inter-yarn pore in fabrics created from staple yarns. If the inter-yarn pores are large enough and the air has enough area for unimpeded passage, it will flow predominantly in that direction [107]. This area cannot be considered completely impermeable or completely porous; rather, it functions as a 'transition zone'. The study illustrated that the inter-yarn pore area is extensively overlapped by yarn hairiness. The hairiness zones of two adjacent threads overlap due to their near proximity. The size of one pore then increases, while the size of the next pore is reduced because of the unevenness of the fabric structure. The study proved the hypothesis that the mutual link between permeability and fabric structure cannot be investigated solely on the basis of the fabric porosity characterization [105]. The author has also determined the influence of the vertical and horizontal porosity of woven fabrics on air permeability. Vertical porosity and FYF (Floating Yarn Factor) have a definite positive relationship, with vertical porosity increasing as FYF increases [104,108].

Fabric density, warp and weft linear densities, and weave are the key structural characteristics that affect fabric air permeability [109]. In fact, the air channels that exist between the two surfaces of the fabric determine how easily air can move through it [110,111]. The study claims that the air permeability of the fabric is determined by the weave structure and its characteristics. The author further claims that the crossing-over firmness factor (CFF) and floating yarn factor (FYF) are weave structure factors to predict air permeability [98].

The improvement of the air permeability model was proposed in previous studies. The model proposed by Robertson [107] was based on the pore space between the cross-over of yarns, which contains errors. Hoerner [101] proposed an airflow and pressure drop model that also contains some inaccuracy. The model based on parameters such as air viscosity, fabric density, void geometry, and air velocity proposed by Saidenov [112] and this model have some limitations, as it is designed only for plain-woven filament fabric. The model proposed by R. Milašius [4,5,113] focuses on the dependence of air permeability on various integrated fabric firmness as a function of yarn counts and fabric density. This model creates some complexity on the application as it depends on several parameters. Additionally, Ogulata [114] proposed the model on the parameters of air flow velocity, cross-section, and perimeter of the pore. He incorporated the capillary model of porous systems into Darcy's law to establish the model. However, this model is also limited to use for other weaves in addition to plain weave.

Furthermore, Fatahi [115] proposed the model in relation to parameters such as fabric weave, yarn densities, and fabric densities.

In earlier studies, the authors investigated the influence of weft density and weave factor P_1 on the air permeability of the fabric. Experiments have shown that, while fabric air permeability is dependent on the weft set and the weave factor P_1, it is possible to attain the same air permeability for fabrics of different weaves by calculating the weft set S_2 for each weave when ϕ = const. Among the structural factors, by Milašius [4,5,21], Brierley [1,2], Galuszynski [116] and Galceran [2], except for weft ribs 2/2, all weaves are evaluated the best by the Milašius factor (ϕ). Therefore, a fabric can be designed according to the required air permeability [117]. The physico-comfort properties of three weave structured fabrics, such as twill, herringbone, and diamond, were investigated by Sunita et al. Diamond weave resulted in higher tensile strength and abrasion resistance followed by herringbone and twill. This could be due to the compact structure and higher density of yarns in the Diamond structured fabric. On the other hand, twill woven fabrics showed the highest air-permeability [118].

3.2.3. Weave Structure and Comfort Properties

Comfort is a physiological and psychological phenomenon that describes the wearer's state of ease or well-being impacted by the properties of textile material [119]. It is a blend of sensory, psychological, and thermo-physiological characteristics [120,121]. The air permeability (AP), moisture management, and heat transmission qualities of the garment determine the thermo-physiological comfort of the garment [122,123]. Eliminating excess heat and moisture from the body helps improve overall comfort. As a result, in a hot and humid atmosphere, a greater AP in the fabric improves comfort [122], that is, the psychological and physical balance of the microclimate of a person [123]. When perspiration is retained adjacent to the skin during physical exercise, it can raise body temperature, resulting in dehydration, fatigue, and poor performance. When perspiration is retained adjacent to the skin during physical exercise, it can raise body temperature, resulting in dehydration, weariness, and poor performance [119,123].

The comfort and appearance properties were analyzed in a recent study [124]. Analysis was carried out on three fabric structures, such as plain, twill 2/2, and hopsack 2/2. The study concluded that the crease recovery angle, flexibility, air permeability, and water permeability of fabrics can be improved by open structure and yarn movements. However, the comfort properties, as well as appearance of fabrics, also affected by the spinning system of yarns that are used in making the fabrics [124]. The comfort properties of automobile seat cover fabrics were determined in a recent study. In their study, plain, weft rib 2/2, basket 3/2, and twill 3/1 structured fabrics were investigated. Higher water vapor permeability and lower thermal resistance were reported in fabrics with low thickness and weight per unit area fabrics, while higher air permeability was observed in fabrics with long floats in their structures [125].

In earlier studies, the authors investigated the comfort properties of bilayer-woven fabrics by considering fabric properties such as water vapor permeability, moisture management capacity, air permeability, thermal resistance, etc. Bilayer woven fabrics are made up of four different materials, such as cotton, polyester, micro polyester, and nylon, with two types of twill weave design (2/2 and 3/1) on the back layer and plain woven with cotton yarn on the face layer of the fabric. Among the weave designs and types of fibers used in this research article, it is seen that both layers of the fabrics showed functionality in improving comfort properties. However, in the bottom layer, the 3/1 twill weave resulted in better comfort properties than the 2/2 twill weave due to its longer float and that makes advanced contact between the fabric and the skin, resulting in surpassed sweat wicking heading to the face layer [126].

3.2.4. Weave Structure and Moisture Transport and Microbial Barrier Properties

There are two sequential processes involved in the transfer of moisture through porous textile materials, such as synchronous wicking–evaporation and evaporation alone. A recent study analyzed the water transfer process on eight different woven fabrics. The study defined two phases of water evaporation as Phase I and Phase II [127]. However, the results claimed that the whole wicking–evaporating process is dominated by Phase I and the speed of moisture movement also differs as per the fabric structures. However, moisture transfer in Phase II remained constant for all fabric structures. Moreover, fabrics having more floats in their structure showed a higher speed of moisture transfer in Phase I, this could be because of their loose structures.

A recent study determined the permeability of the microbial barrier in six different structured basic weave fabrics: satin weave (S), twill weave (T), plain weave (P), warp rib weave (R1), weft rib weave (R2), and basket weave (B). Among these weave designs, the highest permeability of microorganisms was observed on basket weave than the other weaves [128].

3.2.5. Weave Structure and Water-Vapor Transport and Liquid Moisture Transport

The movement of liquids occurs from their first behavior when they come into contact with fabric through their final behavior when they evaporate into the atmosphere [129]. Both vapor and liquid moisture can pass through textiles. Wetting and wicking are two consecutive processes that move liquid water [130]. The most crucial factors for fluid absorption and transmission in textile clothing are generally regarded as wetting and wicking [131]. Diffusion, absorption–desorption, and forced convection are three alternative methods to move liquid vapor across textile layers. According to Fourt and Harris's study of the diffusion of water vapor through woven fabrics, the type of fiber, fabric thickness, and weave tightness all affect how well a fabric resists the transfer of moisture vapor [132].

Clothes serve as the second skin of the body, controlling the environment and adapting to the weather. The comfort of clothing has a direct impact on both physical and psychological health [133]. Heat is produced by human activity and is released from the skin's surface through sweat, which is subsequently absorbed by the fabric that covers the skin and released into the surrounding environment. Factors affecting human comfort are produced by the entire process of heat and moisture transmission between the skin and the fabric [134]. The capacity of a fabric to convey heat and water vapor is characterized by its thermal conductivity and moisture permeability. When there is a temperature difference between the two sides of the samples, thermal conductivity is used to express the heat flow that was transferred through the unit area and thickness of the fabric. A recent study has determined contact coolness, thermal-physiological comfort properties, and liquid moisture management properties in plain, 2/1 twill, and mesh weave structures [135]. It was found that weave structures had a significant influence on the liquid moisture management properties of fabric. The authors claimed the worst wettability and hygroscopicity properties on the mesh structure. On the other hand, plain woven fabrics showed the best liquid moisture management compared to 2/1 twill and mesh structured fabrics. The worst wettability and hygroscopicity may be caused due to the difficulties of liquid absorption and spread in the plane with the irregular capillary in the mesh structure. Furthermore, 2/1 twill weave resulted the best contact coolness may be due to more contact points between the weft yarns and the skin. Although the irregular capillary in the 2/1 twill and mesh structure was not suitable for wetting and water absorption in plane, they promoted water transport vertically due to the float yarn on the surface.

3.2.6. Weave Structure and Compressional Properties

One of the most essential characteristics of clothing textiles is their compressibility. The compressional qualities of the fabric are influenced by several factors, including the compressional characteristics of the constituent yarns and the fabric structure. According to Wyk's [136] law, Jong et al. [137] proposed a mechanical model for the lateral compression of woven fabrics. The study confirms that the mass of fibers in the surface layers that are being compressed, as well as the fiber orientation factor, is proportional to the compression energy. Other studies discovered that the difference between static and kinetic frictional force increased due to increasing fabric compression [138]. The compression properties that are affected by abrasion were investigated by Ukponmwan [139]. Significant differences in compression behavior were reported between unabraded and dry-abraded fabrics. However, at higher pressures, the damp-abraded fabrics resulted in remarkable changes in compressional properties compared to the wet-abraded fabrics, compared to the unabraded fabrics [140]. A recent study investigated the effect of weave structures (plain, hopsack 2/2, twill 2/2, twill 3/1, warp rib 2/2) with various weft densities on compressional properties [141]. The study determined that the dissipated compression energy and the compressibility of the fabric are reduced as the weft density increases, while the recovery of the fabric thickness increases. Furthermore, at maximum thickness recovery, among the experimented fabrics, the plain-woven fabric resulted in the least dissipated compression energy and compressibility.

3.2.7. Weave Structure and Fabric Elasticity

The fabric structure and its impact on numerous fabric properties have been studied by several authors. The physical properties of the fabric are greatly influenced by the weave patterns. The strongest load resistance is found in a plain weave, which has a smaller elongation at break due to the higher breaking force [142]. Compared to a plain weave, a twill weave has a lower breaking force and greater elongation upon break [35].

3.2.8. Weave Structure and Fabric Roughness

Roughness refers to the vertical deviations of a fabric surface from its ideal shape and is used to quantify the texture of a fabric surface. The surface is rough if these variances are considerable; the surface is smooth if they are minimal [143–145]. The surface roughness of woven fabrics has a significant impact on how different fabric products interact with their surroundings [143,144,146,147]. A recent study determined the effect of weaves such as plain 1/1, twill 1/3, and sateen 8/3 on the surface roughness of cotton fabrics. The study reported that all levels of roughness of the fabric surface progressively increased; however, the weft direction has a rougher surface than the warp direction [148].

3.2.9. Weave Parameters and Drapability of Fabric

The ability of a fabric to deform in space when bent under its own weight is known as drape. In an earlier study by Perice [149] in 1930, it was discovered that the draping quality of a fabric had a substantial impact on its bending length and created the cantilever method for measuring the bending properties of fabric [3,149]. Consequently, several methods were developed by other researchers to measure the three-dimensional drape using the FRL drape-meter, the drape coefficient, etc. [150–152]. Further studies explored the correlation between drape coefficient and static drapability parameters of the fabric, for example, bending length and shear stiffness [150,153,154]. Other researchers investigated the static and dynamic drapability of novel synthetic fiber fabrics using physical properties such as bending rigidity, bending hysteresis, weight per unit area, shear stiffness and shear hysteresis [155,156]. Although many studies have used the static drape-meter to analyze static drape behavior, the static drape coefficient cannot accurately reflect dynamic real-life performance [17–161].

Based on the Kawabata Evaluation System for Fabrics (KES-F), four natural-fiber woven fabrics were compared in terms of fabric drape coefficient and sixteen physical properties. The results revealed that, apart from the wool fabric, the static and dynamic drape coefficients of these four natural-fiber woven fabrics at 100 and 125 r.p.m. did not have a particularly good correlation. The author reported the static and dynamic drape coefficients for the test fabrics that were found to be more strongly related to the bending and shear blocking characteristics [162].

Shafagh et al. [163] analyzed the effect of weave structure on the properties of bending rigidity. The study experimented with five woven fabrics that are structured as plain weave, 1/2 twill, 1/3 twill, 1/4 twill and 1/5 twill weaves. According to the findings, the increase in float yarns in both the warp and weft directions of the fabrics resulted in a marked decrease in bending rigidity. Moreover, the bending rigidity was higher on the technical back side than on the technical front side of the fabrics. The drape capacity of the materials is influenced by the structural features of the woven fabrics. The study reported that the 3/1 S and 2/2 S twill weaves had the highest drape coefficient K, while the rep 2/2 (2) weave had the lowest. Furthermore, according to the statistical study, there is a link between weft filling and drape coefficient K. The findings also revealed that the drape coefficient K and the stiffness of the fabric had a substantial and statistically significant negative relationship. The results showed that stiffness is the most important attribute that affects the drapeability of the fabric for the group of materials studied [164]. Studies further reported that as weft density and weft yarn thickness increased, the drape coefficient increased. Furthermore, variations in warp tension had no effect on the drape coefficient [121].

3.3. Special Application Properties

3.3.1. Weave Structure and Ballistic Effects

Body armor [165], fan blade containment systems [166], and orbital debris protection [167] use high-performance ballistic textiles [168,169]. Aramids (such as Kevlar) [170] and ultrahigh molecular weight polyethylene (UHMWPE, such as Spectra) [171] are the most effective material types in terms of protection per unit mass. Several authors [172–176] have emphasized the relevance of fabric geometry and several studies give test results to support their claims. The effects of 1.1 g fragments replicating bullets on targets was reported by Figucia [176]. The V_{50} of the satin weave cloth was 4% higher than that of the plain weave and 11% higher than that of the basket weave. As a result, the satin weave appears to function better. Chu and Chen's study [177] discusses the impact tests on a set of six Kevlar 29 fabrics, comprising one plain, one harness satin, two twill, and two basket weaves. Furthermore, it should be noted that the authors found that a 2 × 2 basket weave worked well in their tests, with around 8.4 yarns that span the diameter of the projectile due to the combination of the diameter of the projectile and the count of yarns [178].

Another study investigated the ballistic performance of four types of weaves, plain, twill, basket, and HS4 (harness satin 4 weave). According to the reported findings, the harness satin weave and plain weave materials have the best ballistic performance, while the basket weave fabrics have the poorest and the twill weaves fall somewhere in the middle. Moreover, the best performance was achieved in a harness satin weave fabric consisting of Spectra 900 [179].

Three different woven structures (plain, twill, and satin) with identical yarn and fabric settings were used to investigate the impact of the weave structure and the variation in their associated energy absorption mechanisms for ballistic impact. According to the findings, plain weave provided the best resistance to bullet projectile among the three fabric structures [180].

3.3.2. Weave Structure on Woven Pressure Sensor and on Acoustic Properties

Multilayer textiles with threads that interlock two or more layers are called three-dimensional weaving. The Jacquard shedding mechanism is used to weave multilayered structures [181]. A recent study distinguished the performance of the 3D woven pressure sensor using three-layered fabric structures in which the face and back layers of the fabrics were used as plain weave and the middle layer of the fabric was designed as plain (P), matt (M), twill (T), and satin (S), respectively [182]. According to the reported findings, all structures demonstrated the possibility of being used as a pressure sensor up to 500 g. However, the plain–twill–plain structured fabric showed the maximum potential as a pressure sensor up to a load of 5500 g. Noise pollution is one of the most serious problems that has a considerable impact on human comfort and safety [183]. Due to their porous properties, fibrous materials have been frequently used in noise reduction [184]. Researchers are continually developing new materials to absorb sound energy. The composite material consists of 40% textile waste and 60% rigid polyurethane foam, which resulted in a remarkable noise reduction coefficient that is twice that of the 100% rigid polyurethane material [185]. Recent studies investigated the influence of weave structure on acoustic properties using ten different fabric structures such as double cloth, back weft, canvas weave, honeycomb weave (with 4 different wefts), plain, twill, and satin [186]. The study claimed that satin, double cloth, and back weft structured fabrics showed the best performance in sound-absorbing properties; this could be due to their compact structures. However, the honeycomb structures resulted in poor sound absorption performance. Furthermore, Huiqin Li et al. investigated the factors of woven fabric that affect the acoustic absorption by using two types of yarns in the fabric such as type $1^{\#}$ having circular cross-section and $2^{\#}$ triangular cross-section of polyester yarns, respectively. A prominent sound absorption performance can be seen in fabrics made of yarn $2^{\#}$ and the highest acoustic performance is reported in plain fabrics [187].

4. Conclusions and Recommendation

Among the seven main parameters used to evaluate the woven fabric, the weave structure has a significant influence on the properties of the woven fabric. Many authors have carried out relevant studies; however, there is still a lack of articles that have accumulated and compiled all the findings. Therefore, this work attempted to organize those published findings and analyze any gaps in the existing literature. This study reviewed the weave factors that were proposed and established by previous researchers. The limitations of such weave factors were also studied. This paper emphasized more on the impact of weave structures on the important properties of woven fabrics such as physical, mechanical, thermo-physiological comfort and special application properties, etc.

According to the reviewed articles, various weave structures have a substantial impact on fabric properties. The highest shear rigidity was determined in plain woven fabric after 2/1 twill woven fabrics, while almost the same shear rigidity was found in other weaves as 3/1 twill, 2/2 twill, 2/2 matt and 5-end satin. The model used by the authors was recommended to predict the shear rigidity of any woven fabrics; therefore, the applicability of the fabric can be predetermined for specific application. Correspondingly, the greater resistance to bullet projectiles reported on plain weave than twill and satin weaves. Moreover, the maximum potential as a pressure sensor was claimed using three-layered fabric structures such as plain–twill–plain. Furthermore, higher thermal conductivity and lower thermal resistance were reported in plain woven fabrics than in hopsack 2/2 (4) fabric.

It is understandable that the strength of woven fabric increases while strong yarn is used in weaving. Some weave structures and other setting parameters also often contribute to fabric strength and elongation. In general, an increase in the rigidity of a fabric is the result of a decrease in its elongation at break; conversely, the study claimed that the elongation at break increases with increasing rigidity of the woven fabric. Technically, this may be due to more yarn crimps created from the rigid weave structure of the fabric and that ultimately resulted in higher elongation. Furthermore, higher elongation was reported in plain weave than in twill and satin weaves, and this may be due to the higher interlacement and crimps created in plain weave design. Logical findings were also reported as: the dense weave structure resulted in poor air permeability as well as poor drapability, while higher abrasion resistance was found in the stiffer weave structured fabrics. Similarly, the best performance on sound absorbance was resulted in satin, double cloth, and back weft structured fabrics; this could be due to their compact structures.

The highest and lowest buckling force was determined when the angle of the twill coincides with the buckling force and when it is perpendicular, respectively. However, although the influence of weave is evident, the authors did not analyze the direct influence of various types of weave factor on current properties. Accordingly, a bilayer fabric made of two twill weaves and one plain weave improved functionality in comfort properties. Furthermore, the 3/1 twill weave showed more comfort performance than the 2/2 twill weave; this may be due to the longer floats of the fabric, as it has more contact area with the skin.

Through previous studies, it can be said that the fabric properties are influenced by the weave structures. However, now there is an urge to develop a common statistical model that may be able to simulate and predict most of the fabric properties including physio-mechanical and functional properties corresponding to the weave structures. Thus, the authors in this study suggest developing an easier and time-saving model for designers that will help to select fabrics for the particular end uses. It is widely known and established that the inherent properties of textile fibers have a great influence on their final materials and products. In addition to that, the selective type of weave structures propagates those properties in many ways. Therefore, such model development may be applicable not only for the basic applications such as wearable clothing materials but also for the technical purposes where weave structure plays a significant role. So that the manufacturers can predict the final properties and decide on making their textile end products. Moreover, there are still gaps for determining the effect of weave structures on various chemical finishing on fabrics; hence, further study on this topic can bring prospects to the industry.

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