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FABRIC HANDLE AND EFFECT OF FABRIC HANDLE ON DIFFERENT TYPES OF WOVEN AND KNITTED FABRICS.II

МЯГКОСТЬ И ЖЕСТКОСТЬ ТКАНИ И ИХ ВЛИЯНИЕ НА РАЗЛИЧНЫЕ ВИДЫ ТКАНЕЙ И ТРИКОТАЖНЫХ МАТЕРИАЛОВ. II

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1. EFFECT OF FABRIC HANDLE ON DIFFERENT TYPES OF WEAVES

Different fabric weaves differentiate the structure of fabrics, and these different structural properties of fabrics will cause the fabrics to behave differently from each other. In this way, woven fabric properties will differ by changing the weave pattern. A fabric pattern must be evaluated not only as an appearance property, but also as a very important structure parameter. Fabric properties are influenced with the wide range of this structure parameter [1].

1.1 Drape and bending rigidity of plain woven fabric:

In the plain weaves, higher values were found for bending rigidities of the fabrics woven with thicker weft yarns and at higher weft densities in the warp, weft and overall bending rigidities.

It was seen that bending rigidities of the fabrics in the warp direction increased as warp tension increased. This increase occurred at higher levels in fabrics woven with thicker weft yarns and at higher weft densities. Considering warp crimps of these fabrics, having the same structural parameters but woven under different warp tensions as the only exception, warp crimp decreased as warp tension increased. This made these yarns more resistant to bending in the fabric and, thus, higher bending rigidity was achieved in the warp direction. Bending rigidity in the weft direction is not showing any significant change, such as an increase or decrease depending on any change in warp tension.

Overall fabric bending rigidity is the geometrical mean of bending rigidity in the warp direction and bending rigidity in the weft direction. In the case of fabrics woven with thicker weft yarns, as warp tension increased, overall fabric bending rigidity increased. The increase in bending rigidity in the warp direction of the fabrics woven with the thinnest weft yarn, except those woven with a weft density of 26 threads/cm, depending on the increase in the warp tension, increased at lower levels compared with the increase that occurred in bending rigidities of the fabrics woven with other weft yarns, while bending rigidity in the weft direction did not vary significantly as the warp tension increased and, therefore, overall fabric bending rigidity did not vary significantly despite a very insignificant increase.

Considering drape coefficients of the fabrics, it was observed that the drape coefficient increased as the weft density increased and weft yarn became thicker. The drape coefficient did not significantly vary depending on the variations in the warp tension. This study has evidenced once more that the effect of the bending rigidity of a fabric on its drape feature is quite significant. In this study, the fabrics woven with thicker weft yarns at higher weft densities gave higher bending rigidities and drape coefficients [2].

1.2 Compressional behaviour of woven fabric:

The response of a fabric to applied forces normal to its plane is known as fabric compressional behaviour. It is characterised in terms of fabric thickness as a function of varying normal pressure. Fabric thickness and compressibility are strongly related to comfort and thermal conductivity behaviour. Fabric warmth is largely a function of airspace and its distribution in the structure compressional behaviour of fabrics, along with the bending, tensile, shear, and surface characteristics, is closely related to fabric handle, drape, tailorability, or making-up properties. The most commonly used instruments to measure compressional properties of fabrics are part of the KES-F (Kawabata Evaluation System for Fabrics) and FAST (Fabric Assurance by Simple Testing) systems.

In a woven construction, warp and weft yarns are compressed due to inter-yarn pressure. The softness of the fabric is determined by its compressibility, which in turn depends on the compressibility of yarn and the fabric construction. Compressibility of a fabric has been seen as an integral component of fabric hand. Tailorability of cloth depends significantly on fabric compression behaviour. The compressibility of fabrics significantly influences drapeability. When a fabric is draped on the edges of a contour, there is compressional deformation at the point of bending. Fabrics with higher compressional energy have a higher drape coefficient.

A highly compressible fabric has high compressional energy and can absorb or withstand compressive forces to a greater extent at the deforming points. This prevents folding at the deforming points and a higher drape coefficient results. In the case of industrial and technical applications such as geotextiles, filter fabrics, floor coverings, paper making felts, and many household applications, fabrics produced by weaving and nonwoven technology are subjected to compressive loads. The compression and recovery behaviour of these fabrics is extremely important in these applications [3].

1.3 Shear rigidity

Fabric shearability is one of the major concerns when making-up a garment, as the fabric needs to be stretched and sheared to a certain degree in order to conform to the intended garment shape. If the shear rigidity is too low, then the fabric is easily distorted and can skew or bow during handling, laying up and sewing. If the shear rigidity is too high, the fabric will be difficult to form, mould, or shape at the sleeve head.

1.4 Formability

Fabric formability can be used to predict the limit of overfeed before buckling. The lower the formability the more likelihood of seam pucker because a fabric is unable to accommodate the small compression placed on the fabric by the sewing thread.

The values of Formability ranged from 0,07 mm^2 to 0,17 mm^2 in warp and 0,14 mm^2 to 0,35 mm^2 in weft. The maximum and minimum limits of fabric formability will also depend on the sewing thread, needle size and thread tension, as well as the skill of the operators. For shirting fabrics, the minimum limit of fabric formability is reported to be a bit lower than that of the lightweight suiting (0,25 mm^2 in both directions). Puckering or sleeve-setting problems are known to occur easily only in fabrics with formability less than 0,18 mm^2 in both directions.

2. EFFECT OF FABRIC HANDLE ON DIFFERENT TYPES OF KNITTED FABRICS

Knitted fabric is structure that is formed by the intermeshing of loop yarn (Denton & Daniels 2002). There are two types of knitted fabric structure: weft knitted and warp knitted. Weft knitted fabrics is produced by a system of interlocking loops in the weft direction. The loops are in horizontal courses with each course built on top of the other and all the stitches in the course are made by one yarn. Warp knitted fabrics are produced by a system of interlocking loops in the warp direction. Fabric is produced by several parallel yarns that form one stitch for each yarn in each course. Each stitch in a course is made of different yarns (Gioello 1982). Knitted fabric possesses high stretch and recovery, providing greater freedom of movement, shape retention and tailored fit. Knitted fabrics also have relatively uneven surfaces, which make them feel more comfortable than smooth-surfaced woven fabrics of similar fiber compositions. This effect results from the fact that fabric that has uneven surfaces has less direct contact with the skin (Higgins & Anand, 2003). Knit fabrics provide outstanding comfort qualities and have long been preferred as fabrics in many kinds of clothing. Since knit fabrics are produced on different machines with different knit stitches and conditions to create different patterns and fabric types, we expect them to have different qualities (Chen *et al.*, 1992). The commercial design of knitted garments is a process that shares many important characteristics with other types of aesthetic design and engineering (Eckert and Stacey, 2003). In apparel design and garment manufacturing, fabric characteristics are usually dictated by a specified end-use. Understanding the relationship between the fabric end-use and fabric properties becomes fundamental for classification, selection, search, and purchase control of apparel fabrics (Chen and Collier, 1997). Tactile (hand) and appearance properties are very important in all classes of fabrics (Fuchs *et al.*, 1993).

Knit fabrics provide outstanding comfort qualities and have long been preferred as fabrics in many kinds of clothing. Since knit fabrics are produced on different machines with different knit stitches and conditions to create different patterns and fabric types, we expect them to have different qualities [4]. The commercial design of knitted garments is a process that shares many important characteristics with other types of aesthetic design and engineering [5]. Although many CAD systems are commercially available for the artistic design of fabrics, none is commercially available for the engineering design of fabrics to meet their end use performance requirements [6]. In apparel design and garment manufacturing, fabric characteristics are usually dictated by a specified end-use. Understanding the relationship between the fabric end-use and fabric properties becomes fundamental for classification, selection, search, and purchase control of apparel fabrics [7]. Tactile (hand) and appearance properties are very important in all classes of fabrics [8]. Appearance retention is directly related to the longevity and serviceability of fabrics. A fabric may loose its aesthetic appeal due to wear, which is a combined effect of several factors like abrasion, repeated laundering, the application of forces in dry and wet states etc. arising from everyday use and service. Surface abrasion is considered perhaps the most important of these factors, and so it has become routine in fabric testing [9]. The effects of various knit structures on the abrasion strength have been analysed by a lot of researchers [10…12].

Plain is the base structure of ladies' hosiery, fully fashioned knitwear and single-jersey fabrics. Its use in ladies‟ suiting is known as the "Jersey Lily". Other names for plain include stockinet, whilst in the USA the term "shaker stitch" is applied to it when knitted in a coarse gauge of about 31…32 needles per inch (25 mm). The simplest rib fabric is 1 X 1 rib. The first rib frame was invented by Jedediah Strutt of Derby in 1755, which used a second set of needles to pick up and knit the sinker loops of the first set. It is now normally knitted with two sets of latch needles. 1 X 1 rib is production of by two sets of needles being alternately set or gated between each other. Relaxed 1 X 1 rib is theoretically twice the thickness and half the width of an equivalent plain fabric, but it has twice as much width-wise recoverable stretch. In practice, 1 X 1 rib normally relaxes by approximately 30 percent compared with its knitting width (see fig. 1).

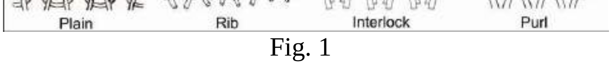

Fig. 1

The interlock structure was knitted almost solely in cotton on 20 gauge (needles per inch) machines for underwear, a typical weight being 5oz per square yard (170 g per Square meter) using 1/40s cotton, but from the 1950s onwards, 18 gauge machines were developed for knitting double-jersey for semi-tailored suiting because the open-width fabric could be finished on existing equipment. As the machines became more versatile in their capabilities, the range of structures became greater.

2.1 Fabric stiffness:

Stiffness is a property of a material to resist the deformation under stress. Knitted fabric stiffness in the wale and course directions was measured. From the statistical analysis it was found that both knit structure and machine gauge have a significant effect on the knitted fabric stiffness in the wale and course directions at significant level 0.01.

It is observed that machine gauge has a positive effect on the knitted fabric stiffness in the wale and course directions. An increasing trend is detected confirming that as the machine gauge increases the stiffness of fabrics knitted from different knit structures also increases. In the case of course direction, fabrics knitted from single jersey have higher stiffness followed by those knitted from rib and interlock structures respectively.

2.2 Air permeability:

The plot of air permeability against the machine gauge at different weft knitted structures was illustrated in figure 7. The statistical analysis of the effects of the independent parameters on the knitted fabrics air permeability was listed in table 6. From this table it is noticed that knitted fabric structure and machine gauge has a significant influence on the air permeability. From figure 7 a decreasing trend was detected confirming that as the machine gauge increased the air permeability of the knitted fabrics decreased significantly. Increasing machine gauge from 22 to 30 leads to a reduction of the air permeability by 29, 26 and 14% for single jersey, rib and interlock knitted fabrics structures. It is also apparent that at lower machine gauge, the weft knitted fabrics of structure rib 1×1 has higher air permeability, while interlock knitted fabric structure showed the highest air permeability at higher machine gauge [13].

2.3 Bending Behaviour:

To understand the behavior of knitted fabrics under bending and shear deformation is very important, since their functional properties are closely related to their mechanical properties, such as bending, shear and tensile. For example, the drape properties of fabrics are affected by both bending and shear properties. Drape is the aesthetic property of the fabrics. It is defined as deformation of the fabric produced by gravity when one part of the fabric is directly supported. An increase in bending and shear parameters, such as bending and shear rigidity, hysteresis of bending and shear, result in a decrease in the drape structure of the fabric, something undesirable in most cases (Gaucher and King, 1983). Another example of the importance of the bending and shear characteristics of fabrics involves their handle properties. Handle is the sum total sensations of the physical and mechanical properties of fabric when it is handled by touching, flexing by the fingers, smoothing, etc. In most cases, lower bending and shear parameters and lower roughness for knitted fabrics are necessary for the best handle (Chen *et al.,* 1992). Many examples exist showing the relationship between a fabric's functional properties and its bending and shear properties.

The bending behavior of woven fabrics was first studied by Pierce (1930). Hamilton and Postle (1974) analyzed the bending characteristics of plain knit fabrics. They assumed that each wale in the fabric behaved as a pair of double helices. Stewart and Postle (1974) analyzed the effect of felting on the bending and shear properties of wool knitted fabric. Gibson and Postle (1978) compared the bending and shear properties of woven and knitted fabrics. Alimaa *et al.* (2000) constructed a straight parallel yarns model in which the knitted structure is assumed to consist of a series of straight yarns to explain the bending behavior of several basic knit fabrics. To date, most studies have shown that fabrics' bending and shear rigidity parameters increase with increases in relaxation, (i.e. with wash &

dry treatment)(Hamilton and Postle, 1974; Stewart and Postle,1974; Hamilton and Postle, 1976; Gibson and Postle, 1978).

3. CONCLUSION

The overall effect of change in the fabric structure on mechanical and surface properties of the fabric is quite prominent which in turn have influence on fabric handle and other comfort related properties of the fabric. Twill weave makes the fabric flexible for bending and shearing, improves extensibility and compressibility, reduces hysteresis effect and increases smoothness of the surface. The increase in smoothness, fullness and softness of twill weave fabrics in turn enhances the Total Hand Value of the fabric. Hence, fabric construction can be altered to offset the undesirable handle characteristics by selecting a weave that permits greater yarn mobility.

Increase in yarn twist, yarn fineness and more open structure of the fabric improved air permeability. It can thus be deciphered that air permeability will depend on the yarn or fabric structural parameters which will influence the shape and area of channels permitting airflow in fabrics. Thermal insulation or thermal resistance can be said to depend uniquely on factors that influence fabric thickness. The surface features of the fabric have a greater influence on warm/cool feeling than the fabric structure. A rough fabric surface reduces the area of contact appreciably, while a smoother surface increases the area of contact and the heat flow, thereby creating a cooler feeling. It was noted that Total Wear Comfort Index gives a better understanding of the suitability of a fabric for a given end use as it includes both thermophysiological and tactile parameters combined into a single index.

The statistical analysis proved that physical properties of the weft knitted fabrics have been affected significantly by the independent variables, namely knitting machine gauge and knitted fabric structures. The following conclusion can be drawn:

- Dimension stability of knitted fabrics was characterized by fabric shrinkage in the wale and course direction. It was noted that machine gauge has a negative impact on the fabric shrinkage in both direction. It is also shown that in the wale direction the fabrics knitted from interlock structure showed higher shrinkage whereas single jersey fabrics gave lower fabric shrinkage. In the case of course direction, the fabric shrinkage has found to have the following order: Single jersey > Rib > Interlock.

-As the machine gauge increases the bursting strength of the knitted fabrics increases. The bursting strength of the knitted fabrics was found to have the following order: Single jersey > Rib > Interlock.

- Stiffness of the knitted fabrics was measured in the wale and course direction. The statistical analysis showed that stiffness of the knitted fabrics was significantly affected by the machine gauge and fabric structures. It was found that machine gauge has a positive impact on the knitted fabric stiffness in the both direction. In the case of course direction, fabrics knitted from single jersey have higher stiffness followed by those knitted from rib and interlock structures respectively. Whereas in the wale direction, fabrics knitted from interlock structures was found to have higher stiffness followed by those knitted from rib and single jersey respectively.

- For air permeability, an increasing trend was detecting assuring that as the knitting machine gauge increases the air permeability decreases. It was found that rib structure was more permeable than other structures at lower machine gauge, while in the case of higher machine gauge, interlock structures showed higher air permeability than the other ones.

Most studies in the literature have shown that the progress of relaxation (wash & dry treatment) leads to a decrease in bending and shear rigidity parameters, due to a decrease in frictional forces between fibers and between yarns. However, it has been noted that the progress of relaxation (wash & dry treatment) resulted in an increase in bending and shear rigidity parameters. This may be due to the fact that the wash & dry treatment increases the fabric density (number of loops per unit area or fabric weight), leading to an increase in inter fiber and yarn pressure.

Of course, an increase in inter fiber and yarn pressure can cause an increase in fabric bending and shear parameters. The wash &

dry treatment can also lead to an increase in bending and shear parameters due to fibrillation damage to the yarn. Thus, we cannot conclude with any certainty that the wash & dry treatment decreases the bending and shear parameters. This is dependent on which effect of relaxation is the predominant effect on the fabric. The second effect, i.e. an increase in bending and shear parameters due to an increase in inter fiber and yarn pressure was predominant. There is a general trend that an increase in the tightness factor leads to an increase in bending and shear parameters. Bending and shear parameters in the course direction are greater than those in the wale direction. Statistical analyses showed that the results are also significant statistically, i.e., both tightness factor and relaxation treatment, direction of deformation have significant effect on the bending parameters and shear parameters of knitted fabrics (B, 2HB, G, 2HG5) [14].

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