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Smart Digital Thickness Test Method® For Knitting Clothes

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Abstract

The present invention relates to fabric testing apparatus. In November 2011 the 1st electronic version of a digital thickness test method apparatus tutorial of thickness test method for velvets and knitting fabrics was released in the Kaferelsheikh University, Egypt. Functioning in a multitask mode of pressure. Its contents corresponds to the discipline "calculation and designing of the machines in light Industry", for fabrics to measure their thickness, with specific of force collaboration on velvets and knitting fabrics, were developed for 3D loops " weft" and harness on thickness, quantification of digital clothes, and using of them in many different applications such as simulation digital® in textiles and apparel industry.

Keywords: Electronic version; Digital thickness; Velvets; Knitting fabrics

Introduction

Fabrics are designed to fit different projected demands in order to be suitable for their end use. For a fabric constructor it is essential that the relationships between the constructional parameters of fabrics and their individual properties [1]. The prediction of the mechanical behavior of the fabrics using analytical methods is restricted by the complexity of the fabric structures, the anisotropic properties of the yarns, their high deformability and also the contact phenomena. For these reasons the use of finite elements analysis becomes continuously wider for the modelling of fabrics' structures. The modelling, of course, requires the knowledge of mechanical properties of the yarn and the geometrical characteristics of the fabric [2]. We consider orthotropic structure properties of the yarn with three level of pile modules [3]. Thickness of velvets and knitting fabrics is one of the basic physical properties of textile materials. In certain industrial applications, the thickness of knitting fabrics may require rigid control within specified limits. Bulk and warmth properties of textile materials are often estimated from their thickness of knitting fabrics values, and thickness of velvets and knitting fabrics is also useful in measuring some performance characteristics, such as before and after abrasion and shrinkage. The thickness value of velvets and knitting fabrics is most textile materials will vary considerably depending on the pressure and torsion applied to the specimen at the time the thickness measurement is taken. In all cases, the apparent thickness of knitting fabrics varies inversely with the pressure applied. For this reason, it is essential that the pressure be specified when discussing or listing any thickness value. When using this test method for measuring the thickness of textile materials, this test method is used in its entirety when no test method for measuring thickness of knitting fabrics is available for the specific material to be tested or unless otherwise specified in a material specification or contract order. The repeated modification in the fabric design procedure introduces the problem of the prediction of the fabric properties before its production in order to reduce the design period duration [4]. Thickness of knitting fabrics is an important property that decides the gracefulness of any garment as it is related to aesthetics and appearance of garments, and is importance for designing and development of garments and selection of appropriate fabric for intended garment formulated geometrical models consisting of known curves, for measurements that have been carried out on a series of knitted based on pressure and torsion with the existing geometrical models of knitted structures is in some cases the insufficient accuracy of the predicted dimensions or their difficulty to be used for the generation of the 3-dimentional representation of the plain weft velvets and knitted

fabric structure. The behaviour investigations of knitted fabrics and with embroidery materials, while the shapes of Thickness, during their extraction through a rush have shown that this type of textile material's testing is closer to their performance compared to standard specimen tension tests in uniaxial direction. The prime example of this is tension deformation of bias specimen, i.e. It is evident that in such a case the behaviour of a bias specimen is concerned only with a shear deformation and does not have much similarities with the deformation of specimen in main directions. Objectives of smart digital thickness test method for velvets and knitting fabrics measurement is invention to meet the requirements of knitting fabrics with other equivalent standards and customer specific written practice for training and certification in this method of non-destructive testing personnel. After completion of smart digital thickness test method for measurement course you will get in depth knowledge of smart digital thickness Testing principles of the geometrical characteristics of a single jersey knitted fabric structure supporting the maximum possible accuracy, of plain weft velvets and knitted fabric structure, transducers, equipment and application of smart digital testing techniques to test various product forms. During this digital thickness test method for knitting fabrics measurement give us examination in general theory, specification and practical. In the digital thickness test method for knitting fabrics high-frequency plain weft velvets and knitted fabric structure transmitted into a material to detect the imperfections or to locate changes in material properties. The most commonly used digital thickness test method for knitting fabrics is from internal imperfect ions or from the part's geometrical surfaces.

Experimental Work

Invention relates to fabric testing apparatus, for a test of velvets and thickness of fabric testing digital apparatus, the general circles apparatus view and principal scheme of circles are presented in Figure 1. The principal scheme of ElNashar-digital Thickness-tester device left curcle for organize and speed control and right curcule for control of

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Figure 1: The principal scheme of ElNashar-digital thickness-test method (left circle) for organization and speed control in (a), and right circle for control of displacement measurement in (b).

Figure 2: Principal scheme of ElNashar-digital thickness-test method (a) and its general view (b).

displacement measurement in Figure 2a and 2b. This test method is considered satisfactory for acceptance testing of commercial shipments since current estimates of between-laboratory precision are acceptable, and this test method is used extensively in the trade for acceptance testing. The invention relates to fabric testing apparatus, for a digital thickness test method for knitting fabrics .

Results and Discussions

In a standard of standard specimen diameter less than that of the fabric, the centers of fabric and the plate being coincident. Above the plate is a translucent screen on which is positioned a fabric annulus having an inner diameter equal to that of the plate and an outer diameter equal to that of the fabric. The center of annulus is coincident with the fabric. The plate (and hence that of the fabric). Light is shone upwardly from beneath the fabric so that its digital counter is projected through the translucent screen onto the paper annulus. A line is then hand drawn onto the annulus around the digital counter of the outer edge of the fabric circle. Next, the annulus is cut around the line. The remaining inner portion of the annulus represents the extend to which the fabric projects laterally beyond the circular plate, This inner portion of the annulus weighed and this weight is used in the calculation of the durability coefficient.

Figure 3 illustrates the principal timer scheme of ElNashar-digital thickness-test working with 0.001 second. And view the principal force gage to 40000 gram, principal scheme of servo motor 24 VDC 4000 RPM of ElNashar-digital thickness-test. It is well know that various tests are carried out on fabrics to measure their thickness properties, e.g., generally these tests are conducted digital using somewhat time consuming procedures. The measurement of thickness may be cited as an example, this test method covers the determination of knitted fabric structure, loop, velvet and herness thickness of finished multi-pressure loop yarn floor covering using a thickness measuring instrument having a stationary surface (platen), a circular pressure foot under specified force, and capable of being moved vertically above the platen.

This practice covers the conditioning and testing of textiles in those instances where such conditioning is specified in a test method. Because prior exposure of textiles to high or low humidity may affect the equilibrium moisture pick-up, a procedure also is given for preconditioning the material when specified. The equipments to be used in the conditioning and testing of textiles shall include conditioning room or chamber, psychrometer ventilated by aspiration, preconditioning cabinet, room, or suitable container, balance, and multiple shelf conditioning rack. The conditioning room or chamber shall consist of equipment for maintaining the standard atmosphere for testing textiles throughout the room or chamber within the tolerances given and including facilities for circulating air over all surfaces of the exposed sample or specimen and equipment for recording the temperature and relative humidity of the air in the conditioning room or chamber. Samples or specimens requiring preconditioning shall be brought to a relatively low moisture content in a specified atmosphere. Samples or specimens requiring conditioning shall be brought to moisture equilibrium for testing in the standard atmosphere for testing

textiles, or when required. This test method is useful in quality and cost control during the manufacture of knitted fabric structure and loop yarn floor covering. Both appearance and performance can be affected by changes in the tuft height. This test method covers the determination of tuft height using a grooved specimen holder. It applies to cut-loop and loop-loop floor covering after adhesive backing has been applied to bond the loop yarn to the backing fabric as the standard for all measurements.

This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. This practice is intended for use in determining the sample size required to estimate, with specified precision, a measure of quality of a lot or process. The practice applies when quality is expressed as either the lot average for a given property, or as the lot fraction not conforming to prescribed standards. The pressure of a characteristic may often be taken as an indication of the quality of a material. If so, an estimate of the average value of that characteristic or of the fraction of the observed values that do not conform to a specification for that characteristic becomes a measure of quality with respect to that characteristic. This practice is intended for use in determining the sample size required to estimate, with specified precision, such a measure of the quality of a lot or process either as an average value or as a fraction not conforming to a specified value. This practice covers simple methods for calculating how many units to include in a random sample in order to estimate with a specified precision, a measure of quality for all the units of a lot of material, or produced by a process. This practice will clearly indicate the sample size required to estimate the average value of some property or the fraction of nonconforming items produced by a production

Figure 3: Principal timer scheme of ElNashar-digital thickness-test method force gage.
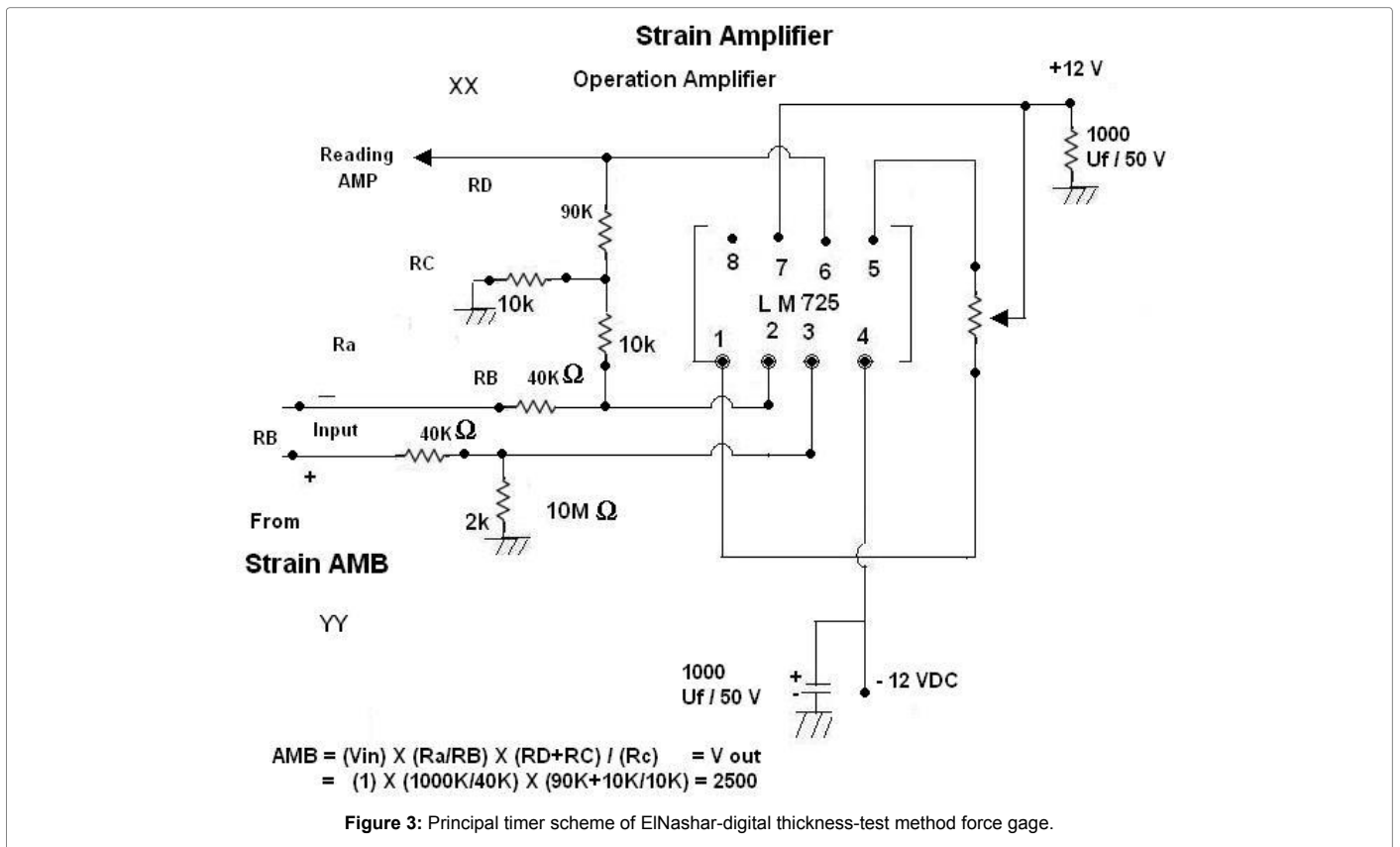
process during the time interval covered by the random sample. If the process is not in a state of statistical control, the result will not have predictive value for immediate (future) production. The practice treats the common situation where the sampling units can be considered to exhibit a single (overall) source of variability; it does not treat multi-Pressure sources of variability.

In a standard of standard specimen diameter less than that of the fabric, the centre of fabric and the plate are coincident. Above the plate is a translucent screen on which is positioned a fabric annulus having an inner diameter equal to that of the plate and an outer diameter equal to that of the fabric. The centre of annulus is coincident with the fabric. Light is shone upwardly from beneath the fabric so that its digital counter is projected through the translucent screen onto the paper annulus. A line is then hand drawn onto the annulus around the digital counter of the outer edge of the fabric circle. Next, the annulus is cut around the line. The remaining inner portion of the annulus represents the extend to which the fabric projects laterally beyond the circular plate, i.e., a measure of the durability of the fabric. This inner portion of the annulus is weighed and this weight is used in the calculation of the durability coefficient. Clearly this is a laborious, error-prone operation. Furthermore, certain of the tests require more than one sample of the fabric. An example of this is the bending stiffness test which is carried out by measuring the length of the rectangular specimen of material which will bend under its own weight to a predetermined angle. For any one fabric, this test must be repeated several times with specimens of material each cut along principal directions. It is an object of the present invention to mitigate the above-mentioned disadvantages. According to the present invention there is a turntable on which the fabric may be positioned, at least one sensing means for making a continuous measurement of the fabric during rotation of the turntable, and computing means for calculating the property of the fabric from such measurement.

Pressure and torsion of yarn cross-section

Pressure is a stress and torsion of velvets and a single jersey fabric. It is a scalar of course-spacing, the wale-spacing given the thickness of single jersey fabric by the pressure on yarn cross-section of the force per unit area. with initial restricted contact area between them, it is the force per unit area exerted by the change of momentum of the molecules impinging on the surface. a change in the direction of motion requires a resultant force. The impact of a loop formation on a fabric surface is an elastic impact so that its pressure on yarn cross-section and torsion energy are conserved. However, because its direction of motion course-spacing , wale-spacing changes on impact, a resultant torsion force must have been exerted by the fabric surface on a single jersey fabric. Conversely, an equal but opposite force was exerted by the course-spacing on the fabric surface. If we consider a very small area of the surface of the fabric ,then the force exerted by the a single jersey fabric will vary sharply with time. When we consider the forces acting on a torsion, for example, the lift force is proportional to the average pressure difference acting over the lower and upper surface of the wing. This pressure difference is caused by the fact that the average velocity over the upper surface of the fabric is somewhat greater than the average velocity over the lower surface . The pressure differences are usually small, but wings have a large surface area so that the total lift force can be very large. For low mach number flow, the pressure difference and the lift force are proportional to the difference in the dynamic pressures between the upper and lower surfaces.

Theory of thickness measurement

It was assumed that in the case of idealized (isotropic) test material of fabrics at the initial stages of extraction process, the outer contour of the specimen force and obtains the shape, which reminds the curve down rush. It was defined that in the case when the experimental and calculated number of fabrics density practically coincides for most of the materials, complex criterion is defined on the basis of polar diagram in which eight parameters are laid in a strict order. This order in clockwise direction is always the same. Thus, criterion depth of rush enables to compare different fabrics according to their total counters reader evaluations.

Optimization of the main parameters diameter of upper pleat and the force of the device is based referring to the specimen's jamming conditions in the rounded rush and between the limiting plates. pressure measurement N/cm², maximum force, reseat force, diameter of rush, diameter of road, time, depth of rush, and fabric thickness are defined. The dangerous zone in which the specimen can be jammed during its extraction locates at the outer contour of the pads rush. The jamming phenomenon is related with the thickness and the radius of the specimen. In ElNashar-digital method-Tester device the size of the specimen is similar to those used in other devices of the same type, i.e., h=0.3 cm. (for heavy fabrics), h=0.5 cm. for medium fabrics, h=0.4 cm. for light fabrics, which allow to observe and to capture the variations of specimen's shape during the extraction. The rating is given by the three digital counters processing based system for thickness in the specimens. Scale which is used in the subjective assessment of fabric thickness varied from 1 to 3.5 cm. in order of their superiority (Figure 4).

Basic of the geometrical plain weft knitted fabric structure model

Basic parameters of a plain weft knitted fabric structure are: loop width Ωr, loop height Δr, loop length ℓpi,

$$\ell pi = \pi \Delta r - \Omega r \tag{1}$$

Where ℓ is loop length (mm), Ωr is loop width (mm), Δr is loop height (mm)

$$p_1 = 2d\, p_i + d_2 \tag{2}$$
$$p = 4d\, p_i + 3d_2 \tag{3}$$

Where: p1, space between wefts of loop fasted , P:widths repeat.

Figure 4: ElNashar Digital Thickness Test Method.

And d_{p_i}: is plain weft knitted fabric structure, yarn thickness [mm]. The loop length is influenced by the yarn input tension, plain weft knitted fabric structure take-down tension, velocity, materials friction in the plain weft knitted zone, yarn structure and properties, yarn linear density, etc. The weft knitted vertical density W:is defined by the plain weft structure density and the yarn input tension; it changes only slightly with the change of the yarn input tension for conventional yarns for elasticized. The vertical density of the plain structure changes with depth change. The loop length increases and simultaneously the vertical density is reduced. Theoretically, a plain weft knitted fabric structure changes continually and perpetually tends to attain more stable state than the previous one. The changes are also influenced by the factors like temperature, relative humidity, pressure of materials etc. As the changes are not visible anymore the state is comply with the order. The relaxation shrinking can easily be monitored through the changes of the vertical and horizontal density and the mass per unit area repeated. Three variants of cumulative parameter of a plain weft velvets and knitted fabric structure were introduced, considered to be balanced. The determination of the shrinking is very Important when planning the materials quantity of the fabric to be plain weft knitted fabric structure to the main structural parameters of a plain weft knitted fabric structure are: the head of loop-spacing (P): widths repeat. The plain weft knitted fabric structure vertical density (w) and the thickness of the plain weft knitted fabric structure, yarn (d_{p_i}). The rest of the geometrical parameters required for the complete description of the structure derive analytically from them. The estimation of the geometrical parameters has been based on the assumption of the ideal cotton yarn of towel fabrics. Thus the yarns are represented as homogenous cylinders of constant diameter for plain weft knitted fabric structure and ground, with initial restricted contact area between them. We consider initially the independent parameters c, W, d1=d2= d_{p_i}, P2, P1, P, and in addition the: distance t as it is noticed in Figure 5a geometrical model without pressure plain weft knitted fabric structure, and Figure 5b low pressure, so in Figure 6a geometrical model with medium pressure plain weft knitted fabric structure, and (b) high pressure, it means the pressure of plain weft knitted fabric structures& loop status. The fabrics wear made from weft produced at twist factor 1.8 for weft with we consider initially the independent parameters c, W, d1=d2= d_{p_i}, P$_2$, P$_1$, P and in addition the: distance t as it is noticed in Figure 5a and 5b, geometrical model of medium pressure of plain weft knitted fabric structure. Where: dPI=diameter of plain weft knitted fabric structures, cross section: dPI=0.02036 cm. W, d1=d2= d_{p_i}, P$_2$, P$_1$, P and in addition the: distance t as it is noticed in Figure 6a and 6b geometrical model of higher pressure of plain weft knitted fabric structure.

$$\ell pi = \pi\Delta r - \Omega r \tag{4}$$

Where ℓ is loop length (mm), Ω_r is loop width (mm), Δ_r is loop height (mm)

$$p_1 = 2d\,p_i + d_2 \tag{5}$$

$$p = 4d\,p_i + 3d_2 \tag{6}$$

Calculation of single jersey fabric loop length (L)

Due to the symmetry of the unit cell the loop length of the plain weft knitted fabric structure is received by the equation 7. Yarn crimp ratio cross-section change is not neglected it may be assumed, that greater angel of contact will be connected with more important change of yarn cross-section from circular into approximately elliptical.

$$c_{Pi} = \frac{\pi(d_1 + d_2)}{180\sqrt{d_1^2 + 2d_1 d_2}} + (\pi\Delta r - \Omega r)\cos^{-1}\frac{d_1}{d_1 + d_2} - 1 \tag{7}$$

Development of digital counters processing system

The thickness properties can be measured by digital counters processing system. Canny edge direction technique is used for the measurement of durability in fabric. And edge is a property attached to an individual force for depth and is calculated from the digital counter function behavior having magnitude of the gradient and direction. The direction of depth should be oriented perpendicular to the edge. This direction in not known in advance. However, a robust estimate of it based on the smoothed gradient direction is available. If the digital counters is the normal to the edge is estimated as due to the symmetry of the unit cell the length of the plain weft knitted fabric structure is received by the equation (8).

$$T_c = N_{Fs^2}\left(\frac{\pi(d_1 + h_1)}{180\sqrt{d_1^2 + 2d_1 d_2}}\right) + N_{RS^2}(\pi\Delta r - \Omega r)\cos^{-1}\frac{cd_1}{(d_1 + d_2)} - 1 \tag{8}$$

Basic parameters of a loop woven fabric are: loop width Ω_r, loop height Δ_r, loop length ℓpi,

$$\ell pi = \pi\Delta r - \Omega r \tag{9}$$

Where: d1: diameter of horizontal yarn, d2: diameter of vertical yarn, N_{Fs^2}: maximum force, N_{Rs^2}: force after rest, ℓ is loop length (mm), Ω_r is loop width (mm), Δ_r is loop height (mm), R: distance pleate circumference ,r: distance of road circumference, T$_1$: time for depth in rush,T$_2$: time of reset in rush, h: depth of loop, T$_C$: thickness of fabrics, C: total of loop.
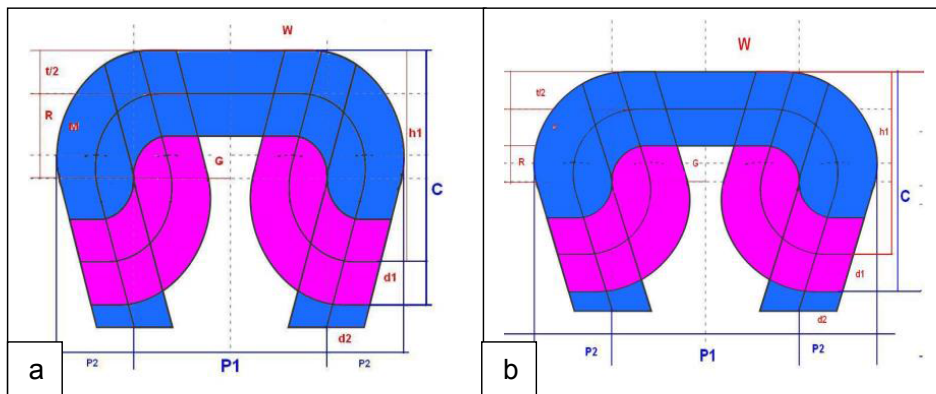

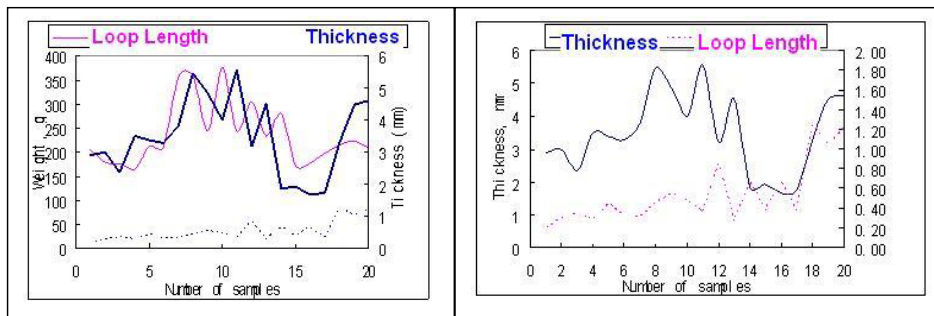**Figure 5:** Structure weft knitted fabrics(a) as normal at left, (b) with light pressure.

Figure 6: Relationship between thickness and loop length.
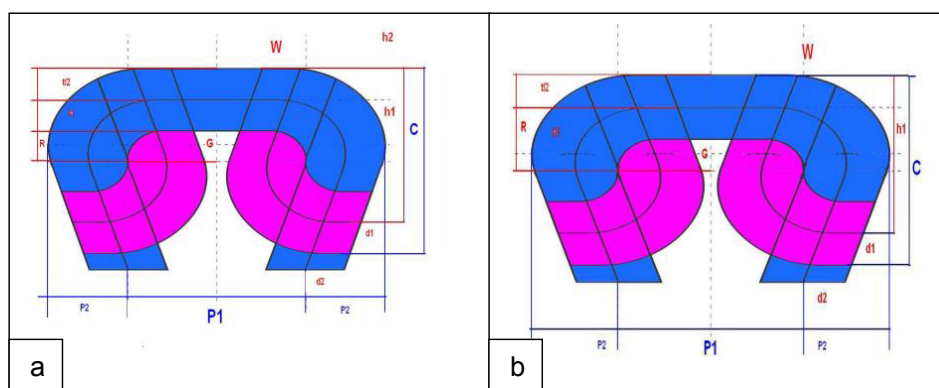

Figure 7: Structure weft knitted fabrics(a) as medium of pressure at left, (b) with heavy pressure.

Evaluation of the geometrical model

For detection of geometric characteristics of structure of the plain weft knitted fabric structure of cotton, polyester, viscose rayon, blended (polyester/cotton), for weft and the of cotton (the same fabric as used for measuring of bending rigidity and hysteresis, under bending load, the method of direct research of inner structure of fabric was used. It was done with help of analysis of soft of fabric samples, introduced in the individual parameters of single jersey fabric were measured the evaluation of the geometrical model is based initially on the comparison of the experimentally defined plain weft knitted fabric structure loop length of a given fabric to the respective calculated by the geometrical model for the same main parameters (c,w,D). The main structural parameters of a fabric can be defined after a microscopic observation and the plain weft knitted fabric structure loop length can be measured using the crimp tester contains the main parameters, the measured plain weft knitted fabric structure loop lengths and the geometrically calculated plain weft knitted fabric structure loop lengths for eight randomly selected fabrics. The error between the calculated plain weft knitted fabric structure loop length and the measured one is considered as the indication the measured one is considered as the indication of the accuracy of the geometrical model.

Evaluation of the geometrical model

For detection of geometric thickness characteristics of weft knitted fabrics, the same fabric as used for measuring of bending rigidity and hysteresis, under distortion, the method of direct research of inner structure of fabric was used. It was done with help of analysis softness of fabric samples, introduced in the individual parameters of the

thickness of fabric were measured. The evaluation of the geometrical model is based initially on the comparison of the experimentally defined thickness of a given fabric to the respective calculated by the geometrical model for the same main parameters single jersey fabric. The main structural parameters of a fabric can be defined after a microscopic observation and the thickness can be measured using the new tester. The main parameters, the measured fabrics thickness, and the geometrically calculated thickness for twenty randomly selected fabrics. The error between the calculated thickness of fabrics and the measured one is considered as the indication of the accuracy of the geometrical model. A flow chart indicating the different steps involved in processing thickness fabric by digital counters are shown in Figure 4. Canny edge detection of replica digital counters are shown in Figure 5 in order to determine the agreement among the digital counters thickness and weight, the coefficient of concordance [5]. The difference between them is essential. the shapes of knitted materials transform into ovals, while the shapes of fabrics–into the shape of four-leaved clover. Intermediate shapes between mentioned are obtained for fused textile systems for woven and knitted fabrics.

In the case of restrained extraction when rounded specimen for knitted fabrics are pulled through the rush of the pad an interesting transformation of specimens shape are taking part. These changes become significant when outer contour of specimen approaches the rush of the pad, i.e., approaches the value of thickness for knitted fabrics, the analysis of specimens projections at different stages of deformation have shown that geometrical shapes of fabrics can be mathematically approximated with sufficient accuracy using the expressions of shortened epicycloids. While the shapes of thickness of
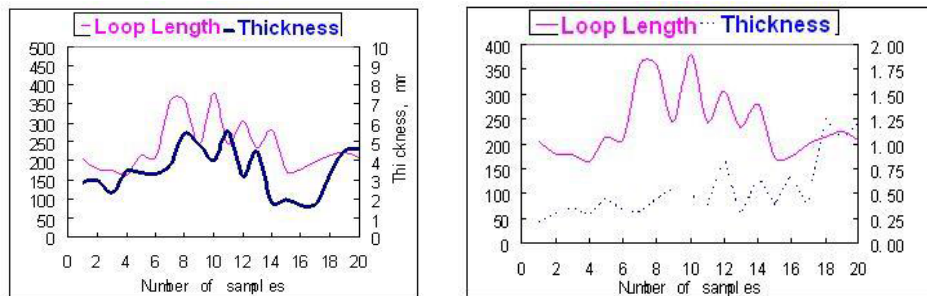
Figure 8: Rrelationship between thickness and loop length.

knitted fabrics are using the expressions of Cassini ovals and shortened epicycloids. The results of distance measurements from specimen's contour to its centre (in the captured views of real knitted fabrics and within Figures 6-8 showed close relationship with the above mentioned models and that parameters can approximate the outer contour of knitted specimen with sufficient accuracy.

Conclusion

The behaviour investigations of knitted fabrics, while the shapes of thickness, during their extraction through a rush have shown that this type of textile material's testing is closer to their performance compared to standard specimen tension tests in direction. The prime example of this is tension deformation of bias specimen, i.e., it is evident that in such a case the behavior of a specimen is concerned only with a shear deformation and does not have much similarities with the deformation of specimen in main directions. Correlation between the thickness, weight and thickness extraction through a rounded rush is established. During the extraction of a disc shaped specimen through a rush all the directions of the material affect each other and the obtained deformation distribution is different. Though the extraction through a rounded rush belongs to the group of pressure measurement N/cm^2, testing methods, still certain similarities between the specimen and disc shaped specimen exist. Firstly the directions of minimal and maximal deformations remain the same, secondly certain similarities between polar diagrams of these two testing, ElNashar-digital thickness test method exist. Also in the case of knitted fabrics reduction with bend point in wale direction, while in the case of knitted fabrics, the minimal value of displacement is obtained at the angle of 45º, as it can be seen from captured digital counter as presented in Figure 5 and theoretical models shown in Figure 8. Thirdly; coefficient of anisotropy for fifth

knitted materials, determined experimentally by pressure measurement N/cm^2, tension test at low values of external loading is closely related with calculated parameter, defined on the basis of specimens extraction through a rush results and applying the model of shortened epicycloids. The later especially suits for knitted fabrics, as shown in Figures 5 and 6. It can be seen from this figures that parameters weight and thickness are related by liner relationship. hence, the dependency exists between the pressure of material anisotropy thickness defined by pressure measurement N/cm^2, testing and the parameter determined during restrained extraction of a specimen through a rush at the similar conditions of loading intensity. The presented results show that ElNashar-digital thickness tester method is technically simple and methodologically reliable instrumental device suitable to control hand properties of textile materials.

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