INDIRECT DETERMINATION OF THE LOAD INTENSITY PARAMETERS ACTING ON THREADS DURING KNITTING BY MEANS OF TESTING STRUCTURE CHANGES IN SPECIAL PREPARED YARN

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Abstract

Intensive loading of yarn processed by knitting influences the efficiency of the process and the quality of the knitted fabrics which are manufactured. It is frequently necessary to determine their value and eliminate the negative effect if such a necessity arises. In this work we propose an indirect method for measuring and testing loads and load changes acting on the yarn during the knitting process. By means of this method it is possible to see which parts of the stitch structure are the most loaded, and thus predict the consequences of these loads on the yarn structure. Special knitted thread-bands are used, which are photographed at the moment of knitting or scanned after the unknitting of the knitted fabric. The structure of these bands easily imprints 'copies' of the value and the type of loads.

Key words:

Yarn stress, load, knitted fabrics, load intensity measuring methods, indirect determination

Introduction

The yarn which forms the stitches is under the impact of complex spatial loads, connected with the necessity of yarn passing through the stitch forming organs and through the old half loop [1]. The yarn is submitted to complex stretching, rumpling and bending loads. On the basis of these loads, the fundamental requirements for the knitting yarns are defined. They must have high mechanical strength, high flexibility, and sufficient elasticity of deformation. The selected yarn, which must meet these requirements, should be made of equalised long staple fibres, and with a comparatively low torsion coefficient [2]. This leads to a considerable increase in the costs of these yarns.

On the other hand, the characteristics of the different types of loads which impact on the yarn during the time of knitting depend on the type of the knitted structure. For more complex knittings, for example miss (float) and tuck stitches, relief ridges, cables etc., the strains on the fibres during the knitting process are high and have a specific character. Sometimes they have such high values that they worsen the knitted structure and the strength of yarn, which finally leads to worsening of the qualities of finished knittings.

The determination of the type and intensity of these loads in the process of knitting is extremely difficult. The use of special precise laboratory devices for measurement and of complex mathematical apparatuses for calculation is necessary. On the other hand, the results of such research methods can be used to better examine the effects which occur over knitting and to check for opportunities which would allow for determination of strain in yarns at lower requirements and low costs respectively.

Various authors have tried to directly measure the stretching of yarn in the space between the needles where the process of knitting occurs, and on this basis have created different hypotheses and mathematical models for the type of stretching in the area of knitting directly between the knitting needles [3,4]. Considering that yarn in the process of knitting is not stationary but moves, we may assume that the results received and models are only an approximation and do not always correspond to reality [3]. By means of using the above-mentioned measuring methods, many such efforts have been made, but the results achieved are not satisfactory.

Test method

In this work, an indirect measuring method is proposed for examination of loads and its changes which occur in the yarn over the process of knitting. Thanks to this method, it is possible to see which part of the stitch structure is the most loaded, and so predict the consequences of these loads on the yarn structure. In the proposed method, the different samples of knitted fabrics are knitted from special yarns: bands with the form of tubular weft-knitted uninterrupted finger type bands (Figure 1). Usually, the periphery of the spiral ring is formed by several (from 5 to 15) stitches, and they have a diameter of only a few mm (from 1 to 6 mm). The bands are made from yarns of different types with low yarn count, by knitting with the use of specially designed knitting machines.

Figure 1. Form of the yarn-band before knitting

The process of stretching these bands corresponds to the process of longitudinal stretching (on the y-axis) of the plain knitted fabric [5]. In Figure 2a a stitch image of plain-knit right-side knitting is demonstrated in a balanced state, and in Figure 2b at maximum stretching on length (per stitch rows). In the second case, the width of the stitches reaches the minimum value (A_{min}). During longitudinal stretching, the height of the stitch B_i and the width A_i changed, initially because of the elasticity of the fibres, and after that due to the change of the knitted fabric's structure, and to the passing of a part of the fibre from the needle and sinker loop areas to the areas of legs (see Figure 2) [6,7]. These changes in the basic parameters of the plain-knit right-side stitch structure occurring in longitudinal stretching are fundamental to the proposed method.

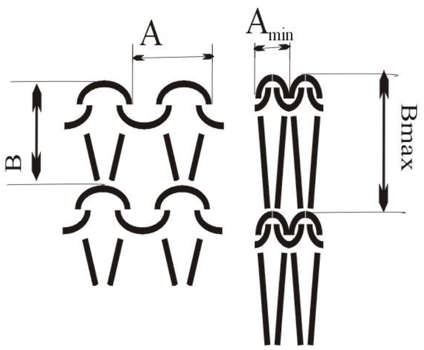

Figure 2. Stitch image of plain knit right-side knitting: a) in balanced state, b) at maximal stretching on length (per stitch rows)

During the process of knitting, the knitted band is stretched across, as the stitches in it are stretched along stitch rows (longitudinally). In that case, the width H_1 depends on the width A_i of the stitches in it. Under the force of the different intensity of stretching, the width H_i is also changed. Obviously, between the intensity of stretching F_i and the band width, a dependency of the type

$$F_i = f(1/H_i)$$

exists. Thanks to this dependency, it is possible to define the stress which acted on the stitch by means of measuring the band width at a certain length which is related to a certain moment. On the other hand, the value of A_i defines the intensity of the effort (stress). The intensity of stretching is larger by as much as the band width is shorter. Therefore, if such experimental settings were created, the yarn photocopied at separate moments of the knitting process, and the band width measured, the value of the pressure on the stitch in these moments would be defined. We can see which parts of the stitch are put under maximum strain, and correspondingly take precautions for its deduction.

On the other hand, if the yarn (band) is tested by an already balanced knitting, then after unknitting the sample, conclusions of the type and value of the loads in different areas of the knitted structure can be made (Figure 3). The changes in the structure of the knitted band are examined, which leads to conclusions of the value and the type of the loads (stresses). In Figure 1 we can see the form of the tested yarn (band) before knitting, and in Figure 3 after knitting and unknitting the sample. We can clearly see that various areas of the yarn have different width Hi, which testify that they were under the impact of different loads. The knitted sample obtained for testing the loads during knitting is presented in Figure 4.

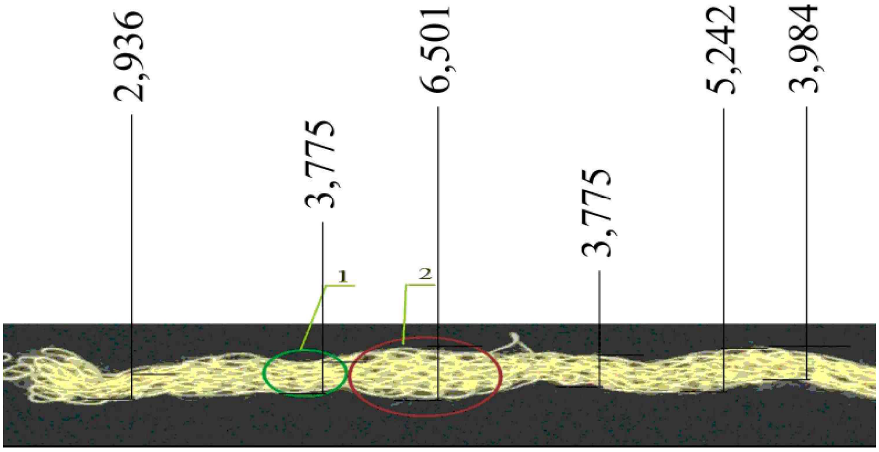

Figure 3. The yarn-band after knitting and unknitting with visible changes of its structure

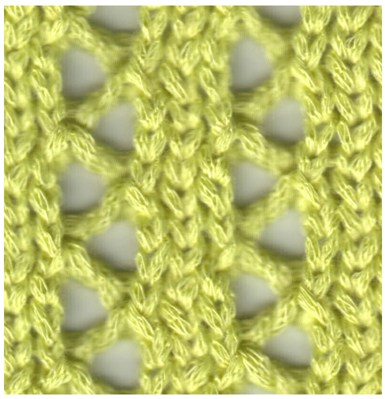

Figure 4. The knitted sample

Analysing Figure 3, it is clearly visible that at position 1 the loads were extremely high and caused the deformation of H_i down to 3.775 mm. This deformation is fundamentally obtained through durable shifting of the fibre of the needle and sinker loops to the legs of the stitch (Figure 2). At position 2, it can be seen that the band width is larger (6.501 mm), which means that the loads were much lower. More detailed and careful examination and research of the yarn form presented in Figure 3 can provide a rich quantity of information regarding the height of loads, as well as for their character at the different points of a defined repeat of yarn. This further corresponds to a definite part of the stitch structure and to the given separate moments of the knitting process. In defined areas, the band is put under triaxial stretching, which can also be tested although more efforts are required.

In Figure 5, the beginning of the separate stitches is marked in advance by a colour pencil before unknitting. In this case the fibre length in the stitch and H_i for concrete areas of the knitting can be defined.

It is possible to measure the band width Hi under different stretching forces, and to define the dependency $F_1 = f(1/H_i)$ exactly by using different software programs.

Freely accessible software was used in the research presented, which allowed the analysed quantities to be measured easily, quickly and correctly, as well as the licensed CorelDRAW and AutoCAD programs.

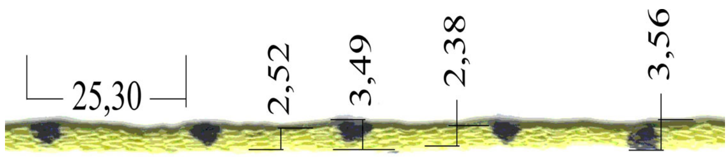

Figure 5. Beginning of separate stitches marked in advance by colour pencil

The method for indirectly measuring the loads in the fibres processed by knitting, presented above, is the subject of deeper research. It is necessary to directly derive dependencies of the formula (1) for different knitting structures, and to experiment with different knitted bands of different classic yarns and different number of stitches, as well as to search for those variants which ensure maximum imprinting of the loads' type and value.

Conclusions

The considerations made in this paper allow us to draw the following conclusions:

* The direct measuring of loads acting on the fibres in the process of knitting is extremely difficult and does not always give correct results.

* Through indirect testing these loads can be numerically defined, and according to the type and to the change of structure of the separate areas of the bands used as yarns, it can be determined to which separate moments of the knitting process the structure changes are related.

* Testing the band (yarn) structure changes can help to determine loads at different moments of the knitting process, and so finally lead to an improvement in quality of the finished knitted fabrics.

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