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Influence of Fabric External Friction Force and Certain Parameters of a Sewing Machine Upon Stitch Length

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In the process of stitch formation sewing garment is affected by various friction forces. Magnitude of these forces decides the slip of sewing garment with respect to a tooth plate and move from inertia later on. In this case the sewing garment is affected by external friction force, which depends not only on the properties of sewing garment, but on the magnitude of pressing force, type of pressing foot and on the sewing speed as well. The article discusses the influence of pressing foot design, pressing force and sewing speed upon the stitch length. Experiment were performed using the universal pressing foot with even metal base, the pressing foot with teflon base and the pressing foot to which two rotation plastic rings are attached. The paper analyses three fabrics with different setting, thickness and raw materials. For experiments "Gütermann" sewing threads No. 120, 100 % of PES were used. Rotation speed of the main shaft of the sewing machine was selected 600, 1600 and 2600 min^{-1}. The special device for the determination of the external friction force was created. There was determinated that the highest (80 N) external friction force was received performing experiments with the pressing foot having even metal base and lowest friction force (20 N) was determinated with the pressing foot having rotation rings. Dependences of stitch length shows that different friction forces cause the variation of the stitch length in range of 10 – 20 %. The tendency of variation of the stitch length is more clear when the sewing speed is highest.

Keywords: stitch length, external friction force, pressing force, pressing foot, rotation speed of the main shaft

INTRODUCTION

For the quality of stitch formation and for the accuracy of this knot position, influence has the elasticity of connecting details and pressure of a pressing foot upon an upper and lower planes of a package of details [1]. Without reference to the change of sewing garment thickness, the number of layers to be sewn, fabric external friction, and sewing conditions such as sewing speed, stable stitch length and igh quality seam are a relevant problem [2]. Taking into account these factors pressing force of sewing garment becomes different and, consequently, it may lead to the possible change of stitch formation conditions. Thus, low quality seam with unstable stitch lengths is obtained. In order to avoid that pressing foot are offered, which irrespective of sewing garment properties and sewing conditions would ensure stable stitch formation conditions.

The highest influence upon movement of a lower layer with respect to an upper layer has the design of a pressing foot. In the case of flat metal pressing foot lower layer moves much more with respect to an upper layer, which features a higher friction ratio. A foot with built-in rollers decreases shrinkage of a lower layer. Such pressing foot is used for materials with high friction ratio. Pressing foot with rollers or rotating rings improve movement of the details to be sewn at the moment of stitch formation [3 – 5].

Thus, seam quality is affected by friction force generated by pressing foot. Different ways for decreasing this force are used. The base of foot is produced from the materials with a low friction ratio; the design is changed by using rollers

The article discusses the influence of different pressing foot, pressing force and rotation speed of the main shaft upon the stitch length.

EXPERIMENTAL

The sewing technological regimes depend on the properties and parameters of the fabrics. In this way seam quality indicator, i.e. stitch length is impacted as well. The paper analyses three fabrics with different setting and thickness as presented in Table 1. Influence of these suit fabrics upon the quality of threads and stitch length was studied.

Table 1. Parameters of the fabrics analysed

Fabric	Raw material	Weave	Thick-ness, mm	Set, 1/dm	
				warp	weft
1	100 % PES	Combi-ned	0.56	746	346
2	100 % PES	Plain	0.56	180	218
3	72 % VI, 26 % PA, 2 % EA	Twill	0.48	420	246

For the experiments "Gütermann" sewing machine and sewing threads No. 120, 100 % of PES were used.

Scheme of a device for measuring fabric external friction force is provided in Fig. 1. Specimen 1 is pressed by pressing foot 3 of sewing machine 2. Fastening rope 4

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by one end attached to specimen 1 further passes guiding pulleys 5 and by another end is fixed to the lower clamp of tensile testing machine 6. By tensile testing machine 6 the specimen 1 is pulled from under pressing foot 3. By adjustment screw 7 pressing force of the foot upon specimen is changed in the range of 25, 45, 65 and 85 N, correspondingly. Registering instrument is used for recording a variation law of fabric external friction. Then pressing foot 3 is replaced and the experiment is repeated again by changing the magnitude of pressing force and recording the variation of fabric external friction force.

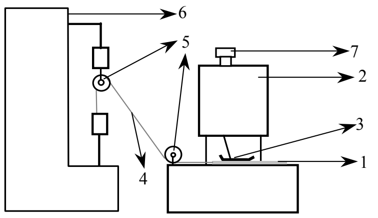
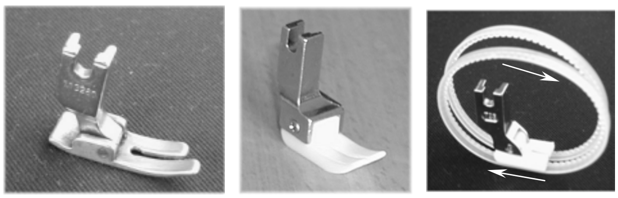


Fig. 1. Scheme of the device for measuring external friction force: 1 – specimen, 2 – sewing machine, 3 – pressing foot, 4 – specimen fastening rope, 5 – guiding pulleys, 6 – tensile testing machine with a registering instrument, 7 – adjustment screw of pressing force

Pressing foots used for this research are illustrated in Fig. 2.



a b c

Fig. 2. Pressing foot used for this research: a) pressing foot with even metal base, b) pressing foot with teflon base, c) pressing foot with teflon base, to which two rotating plastic rings are attached

Experiments were performed using the universal pressing foot with even metal base (Fig. 2 a). Later experiments were repeated using the pressing foot with teflon base (Fig. 2 b). Besides, for this research the pressing foot with teflon base, to which two rings rotating in the process of sewing and intended for decreasing fabric external friction force were used (Fig. 2 c).

After determining external friction forces of fabric in warp, in weft and bias directions at different pressing foot and different pressing forces, specimens were sewn. Sewing was performed by a universal sewing machine from UNICORN company. In the sewing process the magnitude of foot pressing force upon specimen as well as rotation speed of the main shaft was changed. Pressing force upon the specimen was changed in the same way as performing the tensile test 25, 45, 65 and 85 N; the rotation speed of the main shaft was selected 600, 1600 and 2600 min^{-1}.

RESULTS

First of all external friction force F_{fr} of the fabrics analysed was determined by changing the magnitude of pressing force P. As the results obtained show (Fig. 3), in all cases of fabrics and directions analysed increase of pressing force P, fabric external friction force F_{fr} increases as well.

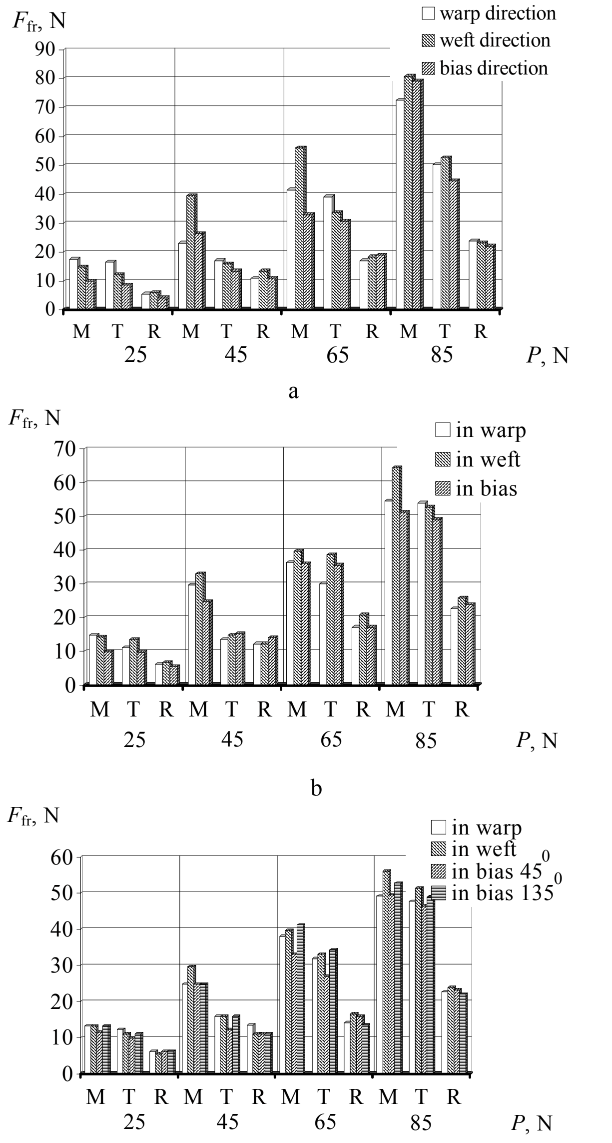


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Fig. 3. Dependence of the external friction force F_{fr} on the pressing foot and pressing force P upon the needle plate: a – fabric 1, b – fabric 2, c – fabric 3. M – pressing foot with even metal base, T – pressing foot with teflon base, R – pressing foot with rotating rings

This fact is relevant for all pressing foot. In addition, the data received demonstrate that using different pressing foot, different external friction force F_{fr} is obtained. In all cases the highest external friction force F_{fr} was received performing experiments with a pressing foot having even metal base. For instance, the increase of pressing force P from 25 up to 85 N increases the external friction force F_{fr} in different fabric directions on the average: from 14 to 78 N – for fabric 1, from 13 to 57 N – for fabric 2, and from 17 to 52 N – for fabric 3.

Lower external friction force F_{fr} is received in the case of the pressing foot with teflon base. During the investigation of fabric 1, when pressing force P is equal to 25 N, the external friction force F_{fr} on the average is equal to 12.5 N. When pressing force P is increased up to 85 N, external friction force F_{fr} in all fabric directions on the average is equal to 50 N. Similar results are obtained in the rest two fabrics along the directions analysed as well: in all cases the external friction force F_{fr} determined by the foot with teflon base is lower comparing to that obtained by the foot with even metal base (Fig. 3).

The lowest external friction force F_{fr} was determined performing experiments by the pressing foot with rotating rings. In this case the fabric 1, when pressing force P is 25 N, external friction force F_{fr} on the average reaches only 5.3 N. The increases of the pressing force P up to 85 N facilitates the external friction force F_{fr} on the average equal to 23 N (Fig. 3).

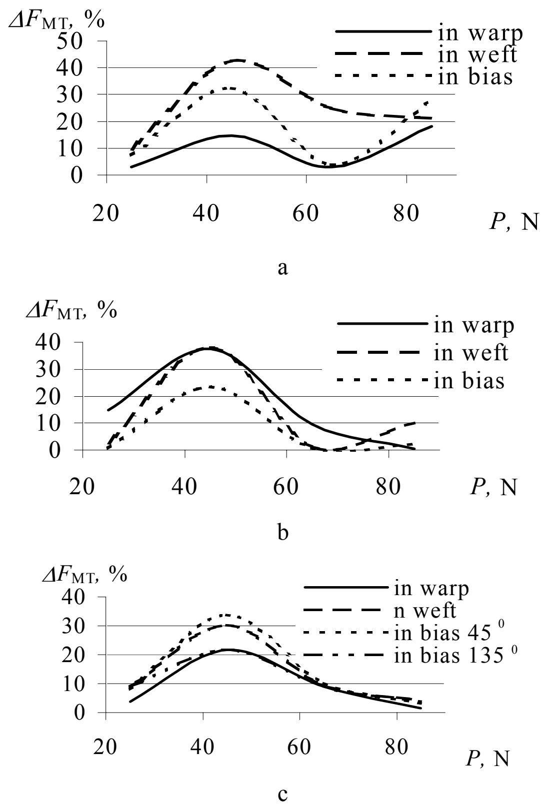


Fig. 4. Change of fabric external friction force ΔF_{MT} at the different pressing force P: a – fabric 1, b – fabric 2, c – fabric 3

Similar results are obtained analysing other fabrics as well: the external friction force F_{fr} using the foot with rotating rings is lower comparing to the analogous cases when the foot with teflon base or the foot with even metal base is used.

Besides, the changes of ΔF_{MT} and ΔF_{MR} of the fabric external friction force were determined comparing the forces when used the pressing foot with even teflon base and rotating rings to the pressing foot having even metal base:

$$\Delta F_{MT} = \frac{F_M - F_T}{F_M + F_T} 100\%, \quad (1)$$

$$\Delta F_{MR} = \frac{F_M - F_R}{F_M + F_R} 100\%, \quad (2)$$

where F_M is the external friction force when used pressing foot with even metal base, F_T is the external friction force when used pressing foot with even teflon base, F_R is the external friction force when used pressing foot with rotating rings.

As the results presented in (Fig. 4) demonstrate, the change of ΔF_{MT} reaches maximum (~35 – 40 %) in all fabrics when pressing force is equal to 50 N. At the presence of this pressing force the greatest differences between the forces generated by the foot with even metal base and even teflon base are obtained. When the pressing force P is lowest, the highest change of ΔF_{MT} reaches its minimum (10 – 15 %).

The dependence of change of ΔF_{MR} (Fig. 5) shows that in this case it is impossible to distinguish its maximum.

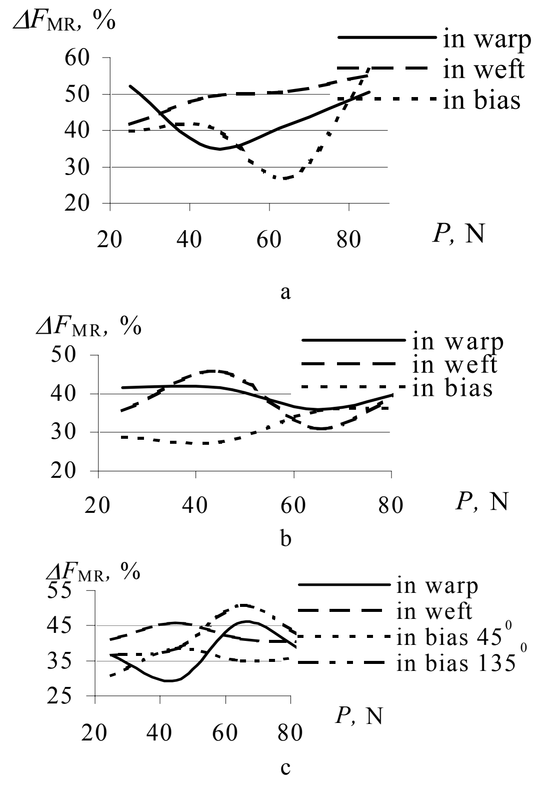
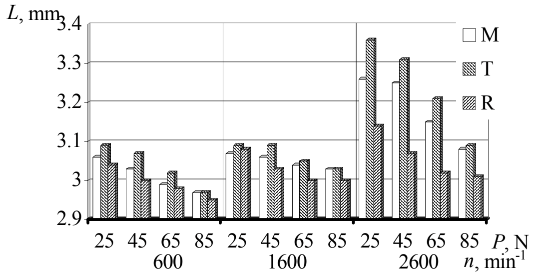


Fig. 5. Change of fabric external friction force ΔF_{MR} at the different pressing force P: a – fabric 1, b – fabric 2, c – fabric 3

In relation of the stitch length L along the seam with rotation speed of the main shaft it was obtained that the stitch length variation law, which is similar to that obtained in the previous investigations: in all cases the increase of the rotation speed of the main shaft leads to the increase of stitch length (Fig. 6). Besides, performing these experiments it was obtained that the increase of the foot pressing force P in all cases decreases stitch length L [6 – 8].

In relation of the stitch length L with fabric external friction force F_{tr} it was determined that the stitch length is impacted by both the magnitude of fabric external friction force and friction type. Between the fabric and the pressing foot having even metal base or even teflon base slip friction exists. As it was already mentioned, in the case of the foot with teflon base the external friction force is lower comparing to that of the pressing foot with metal base. In this case stitch length using the teflon pressing foot is higher comparing to the stitch length obtained using the metal pressing foot (Fig. 6). For instance, when the fabric 1 is investigated in the direction of warp (Fig. 6 a), the stitch length using the teflon pressing foot may be higher in 0.2 mm comparing to the analogous conditions, when the pressing foot with even metal base is used. Increasing rotation speed of the main shaft the difference between stitch lengths foot increases. When rotation speed of the main shaft increases up to 2600 min^{-1} this difference is highest. In addition, it was determined that increasing foot pressing force the stitch length differs only slightly. Similar dependence of the stitch length was received analysing other fabrics as well.



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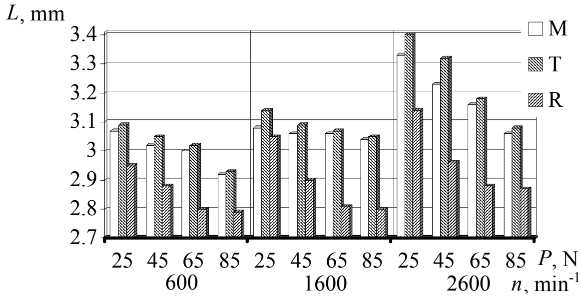

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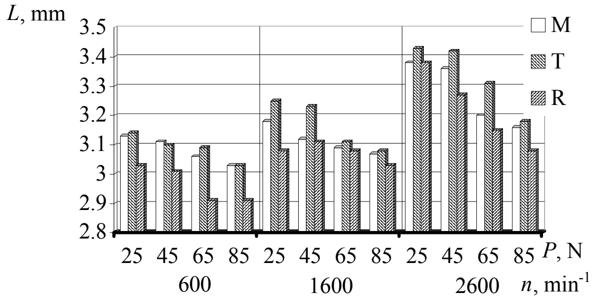

c

Fig. 6. Dependence of stitch length L on pressing force P and rotation speed n of the main shaft in the direction of warp. (Description as indicated in Fig. 3)

Performing experiments with the pressing foot having rotating rings the slip friction between the pressing foot and sewing garment is changed to roll friction partially. In the case, when fabric external friction force is the lowest, the engagement between the fabric sewn and the pressing foot is lowest as well. The stitch obtained with the foot rotating rings is lowest comparing to the stitch length performed by pressing foot with even base.

Thus, in order to obtain high quality sewing garment it is necessary to assess both properties of sewing garment and certain parameters of the sewing machine.

CONCLUSIONS

1. In all fabrics, irrespective of the pressing foot type, increase of pressing force leads to increase of external friction force of fabrics up to 5 times.
2. It was determined that at different types of pressing foot different fabric external friction force is obtained. In all cases the highest external friction force was received performing experiments with the pressing foot having even metal base (up to 80 N). Lower external friction force was established performing experiments with the pressing foot having teflon base (about 50 N). The lowest friction force was determined with the pressing foot having rotating rings (about 20 N).
3. It was determined that in the investigated fabrics, when pressing force is equal to about 50 N, the change of ΔF_{MT} reaches maximum. At this pressing force the greatest difference between the forces generated by pressing foot with even metal base or even teflon base is obtained. When pressing force is lowest or highest fabric external friction force between these different pressing foot differs only slightly (10 – 15 %).
4. Dependences of the stitch length shows that different friction forces causes the variation of the stitch length in range of 10 – 20 %. This tendency of variation of the stitch length is more clear when the sewing speed is highest.

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