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Effect of the Stitch Length on the Breaking Load of Stitches of Sewing Products

A.Djurayev, M.A.Mansurova, G.Sh.Tursunova, M.X. Shirinova

Tashkent institute of Textile and Light Industry

ABSTRACT. The article provides an analysis of existing lines of shuttle and chain stitches. Based on the analysis of the discontinuous characteristics of the stitches and the operating conditions of the garments, a new method of obtaining stitches with varying stitch length is recommended. The results of experimental studies of the deformation-discontinuous characteristics of the lines when sewing materials drape, denim, adras, satin, silk when changing the length of the lines are presented. The principles of using stitches with different stitch lengths are determined, taking into account the operational characteristics of garments.

KEY WORDS*:* sewing machines, material, silk, adras, satin, method, shuttle,stitch, thread.

I.INTRODUCTION

The main type of technological equipment in clothing manufacturing processes is sewing machines. They can be divided into universal machines (grinding), specializing in the type of work performed or on lines and semi-automatic. When using machines, especially special and semi-automatic, the time spent on operation is reduced many times and the quality of the parts being machined is improved. By the method of weaving thread machine stitches are divided into shuttle and chain stitches. Most often, when connecting fabrics, machines with a hook stitch are used, and when connecting parts from knitted fabric, as well as elastic materials, with a chain stitch.[1]

A sequence of stitches form a stitch. Shuttle stitches, and consequently, the lines they form, can be made with two threads — a two-thread line, three threads — a three-thread line, four threads — a four-thread line, etc. Chain stitches are straight through, hidden and obmetochnymi. Chain stitches can also have a different number of threads involved. Chain stitches can be one-, two-, three- and four-thread. When chain stitches are formed, a looper is used instead of the hook. The thread consumption during the formation of chain stitches is greater than with the formation of the hook stitches, but the chain stitches are more elastic and durable.

In the existing ways of producing lowercase shuttle and chain stitches, the length (pitch) of the stitches is constant. In this case, the length of stitches is provided in sewing machines by mechanisms for moving materials, in particular, stepper motors with programmed control [2]. The disadvantage of the existing method of producing stitches with stitches having the same length (step) is the constancy of the breaking load of the stitches along its entire length. It is not possible to increase the strength of stitching in the necessary gaps (zones) line. It is known that a decrease in the length of stitches in a line leads to an increase in the strength of stitching, that is, to an increase in the breaking load of the lines. [3]

Therefore, in order to increase the strength of the stitching of materials, it is considered expedient to reduce the stitching step (stitch length). The consumption of sewing threads for stitches with different types of stitches is presented by the formulas for their calculations. [4]

From the technology of grinding materials in the manufacture of clothing it is known [1] that high strength stitching is required in certain areas, and in certain areas this is not required. Therefore, it is important to obtain lines with variable strength tensile characteristics.

II. METHODOLOGY

The method of obtaining lines with varying strength characteristics.

To obtain high-performance garments, especially with the required strength of seams, it is important to develop a method for producing hook and chain stitches with variable strength in the required areas of stitches. The problem is solved by a method of obtaining lines with variable stitch length in certain areas of the line.

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The method is illustrated in the drawing, where, in Fig. 1 a is a diagram of a double-thread shuttle line of type 301 with a variable pitch of stitches, in fig. 1b is a double-thread chain stitch type 401 with variable length (pitch) stitches.

Sewing materials 1 and 2 upper 3 and lower 4 threads on the proposed method is as follows. In the process of stitching materials 1 and 2 stitches of length t_1 are formed in sewing machines. At the same time, due to a change in the movement of materials 1 and 2, the process of stitching materials 1 and 2 will be further carried out

with a step (length) of stitches t_2, while $t_1<t_2$. Then in the stitch zone with stitches of length t_2, the strength will be greater than in the stitch zone with stitches of length t_1. Changing the step of moving materials 1 and 2 in practical terms will be carried out by a stepper motor moving materials in sewing machines (not shown in Fig. Because of their general popularity).

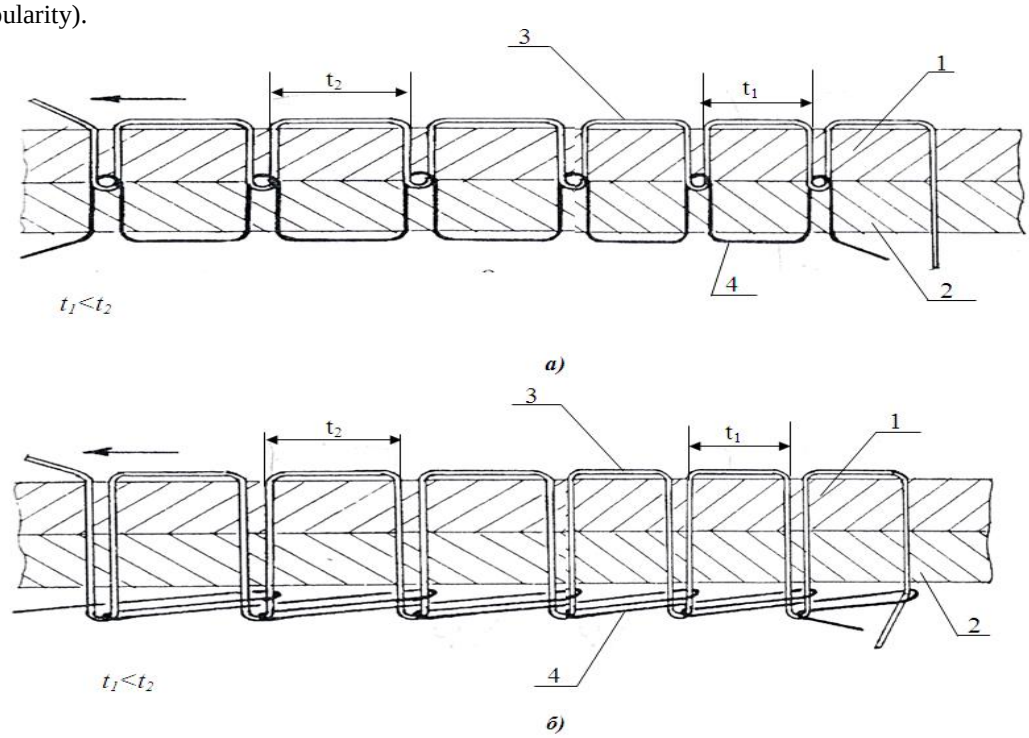

Fig.1. The method of producing stitches from the shuttle and chain stitches

The proposed method of producing stitches with variable length of hooks and chain stitches allows obtaining garments with the required strength and performance characteristics.

Definition of tensile stitch characteristics. In the experiments, the threads “100% Spun Polyester”, No. 40/2 and No. 20S / 2 were used for the upper thread in white, and for the lower thread in red, so that the stitches in the string were different.

The strength of the stitching in the longitudinal direction depends on the strength of the sewing thread [5]. First, we determined the strength and elongation of the sewing thread “100% Spun Polyester”, No. 40/2 and No. 20S / 2 on the STATIMAT-C tensile testing machine. This installation is designed to determine the breaking characteristics (breaking load, breaking elongation) of various threads. The device works with the computer using a special program. The test results printed on the printer in the form of graphs and tables.

In fig. 2 shows the results of the experiment. From the graphs it can be seen that the elongation from the applied load is non-linear. When a tensile force is applied up to 185 cN for yarn No. 40/2 and up to 360 cN for yarn No. 20S / 2, the yarn elongation is close to a linear form and reaches up to 2.45% for yarn No. 40/2, and for yarn No. 20S / 2 3.1%. As the load increases from 185 cN to 255 cN, the intensity of elongation (strain) decreases, and a further increase in load leads to a significant increase in strain. Maximum breaking load (Maximum Force) for thread “100% Spun Polyester”, No. 40/2 is 973.45 cH, total elongation (EAR: 1% Fmax) is 17.24%, and for thread No. 20S / 2 the breaking force 2180 CH, elongation of 19.7%.

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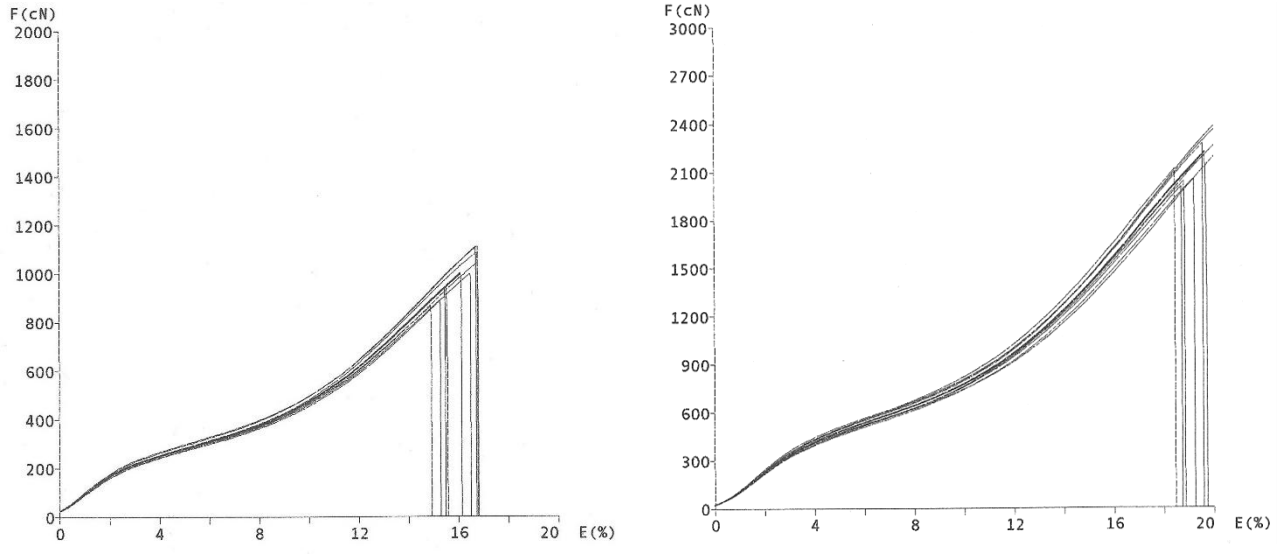
For filaments and fabrics, the stress-strain dependence is unambiguously subject to Hooke's law [6]. According to this work, under cyclic modes of thread movement (load-unloading), the stress-strain characteristic has a non-linear character with a certain plastic deformation.

In fig. 3. The obtained graphical dependences of the change in the value of the discontinuous efforts of the double-thread chain lines as a function of the change in their lengths are given. From the graphs it can be seen that the breaking of the elastic chain double-stitch line (for knitted material) occurs with a breaking strength of 205 N with a line length of 2.0 mm, and for the existing version of the double-threading chain stitch under equal conditions, the breaking strength is 33 N.

Dependencies have the same character for the two other variants of stitched materials. It should be noted that increasing the stitch length to 3.0 mm can significantly reduce the breaking force for the recommended double-thread chain stitch. This is due to the fact that with an increase in the length of the line, the stock of the thread in the line significantly decreases and the strength of the gap is spent on breaking the threads of the line, not of the materials (see Fig. 3, curves 1 ÷ 4). Therefore, it is necessary to stitch more elastic materials with a shorter length of double thread chain stitches, and less elastic materials with a longer length of chain stitches [7, 8].

It should be noted that the maximum load on the sample when the seam is stretched in the transverse direction for the shuttle stitch is 250-320 N when stapled with cotton and 380-440 N with silk; double-thread chain strings withstand loads 2.3 times higher than those indicated [9,10]. Deformation - discontinuous characteristics of the shuttle lines with different stitch lengths were carried out by sewing together drape and denim materials. In fig. 4 shows the characteristics of stitching denim material.

The tensile load of the shuttle stitch with a size of 2 mm when stitching denim materials is 322.6 N, and with a stitch length of 4 mm; -156.1 N. At the same time, the change in elongation is insignificant, equal to 5%. The actual proportionally reduced breaking load of the hook lines with increasing stitch length. Figure 5 shows the discontinuous characteristics of the shuttle lines when sewing drapery materials.



а) «100% SpunPolyester», №40/2 **б) Polyester № 20s/2**

Fig. 2. Patterns of change in strength and elongation of the sewing thread

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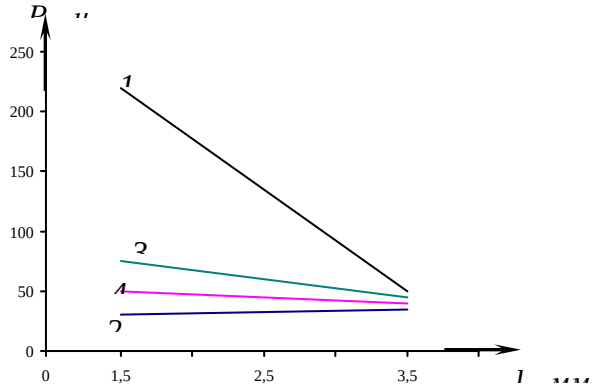

1,2-for material "B", 3,4-for material "T", 1,3-with elastic double-thread chain stitches, 2.4-for existing variants of chain stitches. Fig. 3. Patterns of change in breaking strength due to an increase in the length of double thread chain stitches.

Analysis of the graphic discontinuous characteristics of the shuttle lines when sewing drapery materials shows that with increasing stitch length from 2.0 to 4.0 mm, the breaking load decreases on average from (315 ÷ 325) cN to (140 ÷ 170) cN, that is, actually a decrease A breaking load also occurs with an increase in the length of the shuttle stitches. Therefore, depending on the loads during the operation of garments, sewing the drape and denim materials it is advisable to proportionally change the length of the shuttle stitches along the perimeter of the stitching.

Stitching adras, satin and silk with variable stitch lengths in stitches is important, taking into account the operational characteristics of the products.

III. EXPERIMENTAL RESULTS

The table presents the characteristics of materials adras, satins and silk.

Table 1

Characteristics of the investigated tissues

The cloth	Articul	Fibrous composition		The number of threads per 10 sm		Surface density, g/m^2	Interweaving
		the foundation	weft	the foundation	weft		
Adras	65144	cotton	viscose	300	180	140	Linen
Atlas	32590	silk	acetate	520	260	110	Satin
Silk	52010	capron	capron	560	80	80	Satin

The strength of thread stitches made from natural fabrics adras, satins, silk was investigated.

They varied: the supply of fabric in the range of 2.3.4 mm, the average values of tensile loads of the thread stitches on the base and on the weft of the studied tissues are given in Table 2

Table 2

Explosive load of seams, N

Fabric feed, mm	Emulsion consumption per 1 cm of tissue, g / sm2	Adras		Atlas		Silk	
		the foundation	weft	the foundation	weft	the foundation	weft
2	0,1 0,2	66 61,5	39,9 35,5	49,5 52	32 24,1	45,2 40	36,0 38,2

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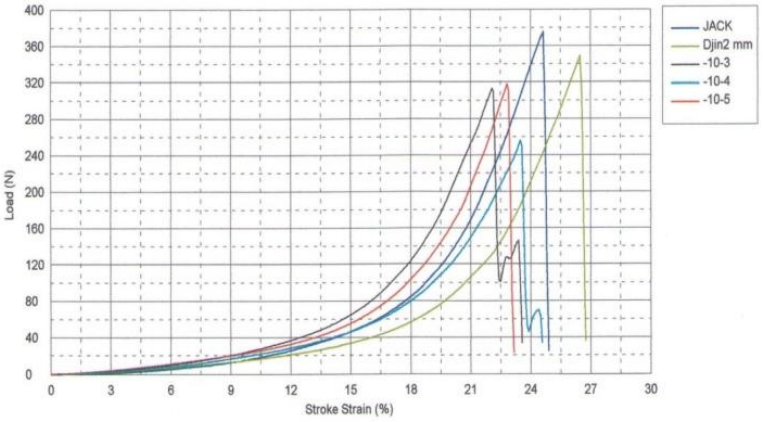
	0,3 0,4	62,5 63,0	38,3 37,2	53,2 56,1	26,2 31	47,8 51,7	39,6 42,2
3	0,1 0,2 0,3 0,4	55,0 60,0 61,5 59,5	30,0 34,0 37,1 39,5	40, 48,5 46 48	21,1 23,4 27,1 31,2	40 47,2 50,3 51,2	26,1 27,9 29,4 31,2
4	0,1 0,2 0,3 0,4	50,0 48,0 54,0 57,0	28,0 31,2 32,4 34,2	38 43 47,5 46	20,1 25,0 27,3 29	38,4 42,5 43,4 42,9	25,0 27,3 29,0 30,1



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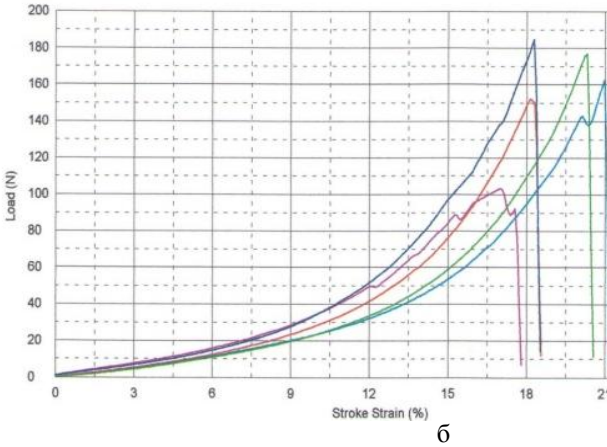

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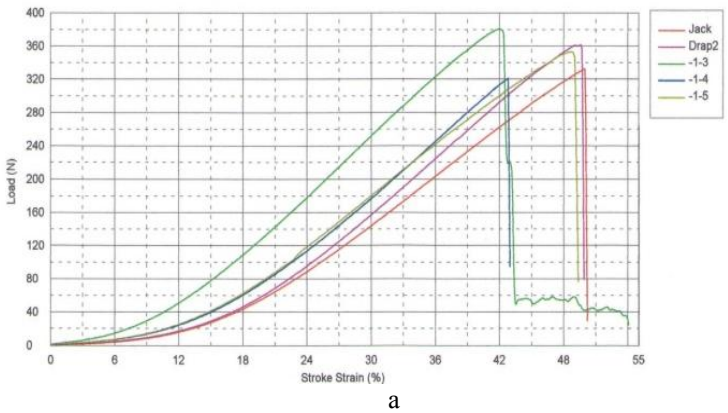
Fig. 4. The breaking load and elongation of the shuttle stitch, the material is denim; a-stitch length 2 mm; in- stitch length 4 mm.



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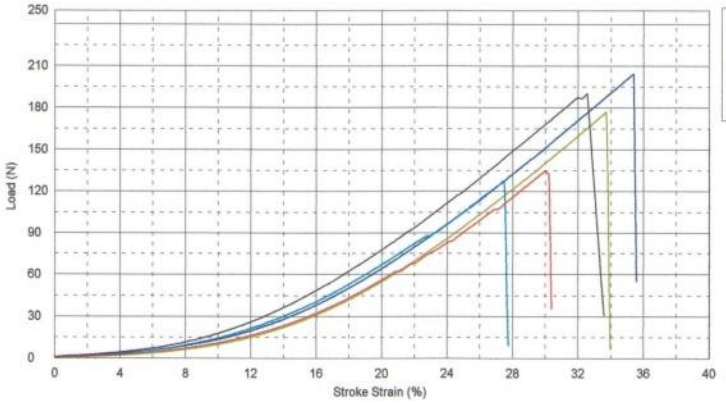

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Fig. 5. Explosive loading and elongation of the lockstitch, material drape: a- stitch length 2 mm; b- stitch length 4 mm.

The analysis of the obtained experimental results shows that the tensile load of the shuttle lines when stitching the material is adras with a stitch jeans of 2.0 mm in an average of 63.2 N along the base and 37.5 N in the

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weft, and with a stitch length of 4.0 mm, respectively, 52.1 H and 33.1 N. For a material, atlas, the tensile strength of the lines on the basis is on average 55.1 N, and for weft 28.9 N with a stitch length of 2.0 mm With a shuttle stitch length of 4.0 m, the breaking loads are 43.9 N and 27.5 N, respectively. For material silk with a stitch length of stitch 2.0 mm 44.0 mm, these forces are respectively 46.9 N and 41.9 N on the base, as well as 38.7 N and 28.2 N on the weft. It should be noted that for the considered materials adras, satin and silk is also recommended stitching with stitches with variable stitch length, taking into account the performance characteristics of garments of these materials.

IV. CONCLUSION AND FUTURE WORK

A method of stitching materials with variable stitch length has been developed. The rupture characteristics of stitch lines for sewing materials like drape, jeans, adras, satin and silk with different stitch lengths are determined. Recommended stitching materials with different stitch lengths in the line, taking into account the operational characteristics of garments.

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