REDUCTION COSTS PRICE OF PRODUCTS ARE PRODUSED FROM HIGH-ELASTIC MATERIALS DUE TO APPLICATION OF RATIONAL METHODS OF DESIGNING CLOTHES

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This article is taken up questions concerning the resource saving in sewing industry due to application of rational methods of designing clothes. New progressive method for the research characteristics of deformation behaviors high-elastic materials, namely the extensibility, residual deformation and cross-contraction is described. Furthermore, the classification of the extensibility groups for high-elastic materials and some worked out recommendations for the designing and manufacturing of tight-fitting clothes are presented. The applying of these method and recommendation allows reducing of materials consumption and simplifies some operation of a designing and manufacturing preproduction.

Key words: materials consumption, high-elastic materials, deformation behavior, design parameters.

The resource-saving is one of the most actual theme in the world recently. The main task of any enterprises in market competition is an increase in profits, which is possible due to reduction of production costs. The production costs include a various kinds of expenses. The share of material expenses in the cost price of garments accounts about 70 %. These one can reduce due to introduction of the high-efficiency equipment and progressive methods of designing clothes.

The high-elastic materials are materials, which consist of from 2 up to 14 % polyurethane fibres in the structure. The inclusion polyurethane fibres in textiles predetermines special properties of the high-elastic materials, including their high degree of an extensibility and the smallest share of residual deformation at average operational loadings. Such specific properties of high-elastic materials influence on process of designing products from them, in particular influence on opportunity of manufacturing tight-fitting clothes with the preservation its high ergonomic properties. In terms of material properties, the reasonable choice of design parameters for tight-fitting clothes allows to reach an optimization between the materials consumption and quality of product. At the same time, the materials research methods play a significant part in achievement of formulated goals.

It is known, that the design parameters of tight-fitting clothes, namely a limit narrowing of details and relative modulus of elongation details, are defined proceeding from characteristic of deformation behaviors of the high-elastic materials. However, at present the basic characteristics, which accountable at definition of the design data are the extensibility and residual deformation of a material. It is necessary to note, a cross-contraction value of the materials at uniaxial tension, which defines a value of relative modulus of elongation details, does not appear in calculations of design data directly.

The edge effect of elementary sample arising during the deformation is the reason why impossible to use standard test methods for simultaneous definition values of the extensibility and the cross-contraction of the high-elastic materials. This effect is due to more significant structure change of material cuts in comparison with an average zone of a sample. Besides definition of the extensibility and residual deformation of high-elastic materials by standard test methods is carried out at uniaxial tension. It does not correspond to the real conditions of deformation high-elastic material when the tight-fitting clothes are being worn on a person body because a biaxial tension of the material is being occurred owing to its fixing on the basic constructive sites and the friction force. Therefore, the existing test methods do not allow to receive the initial information for the scientifically-grounded definition of design data of tight-fitting clothes with necessary degree of accuracy.

For the achievement of the real conditions of deformation high-elastic material when the tight-fitting clothes are being worn and an elimination of the edge effect have an influence upon a measurable value, authors developed a method for definition some characteristics of the extensibility and cross-contraction of the high-elastic materials. This method is based on the standard technique of definition the extensibility of knitted materials at loading less breaking load. Basic distinctive feature of the developed method is the opportunity of fixation of the test-sample lateral cuts for prevention its cross-contraction. This make it possible to provide real conditions of clothes operation at biaxial tension of the high-elastic materials. Special device [1] for the tensile machine was developed by authors for the implementation this method (figures 1, 2).

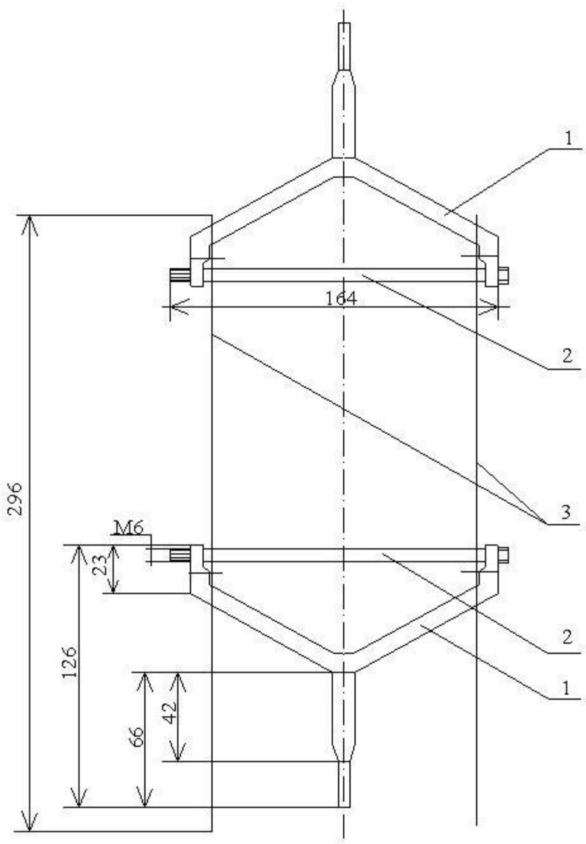


Figure 1 - The drawing of special device for research deformation behaviors of the high-elastic materials

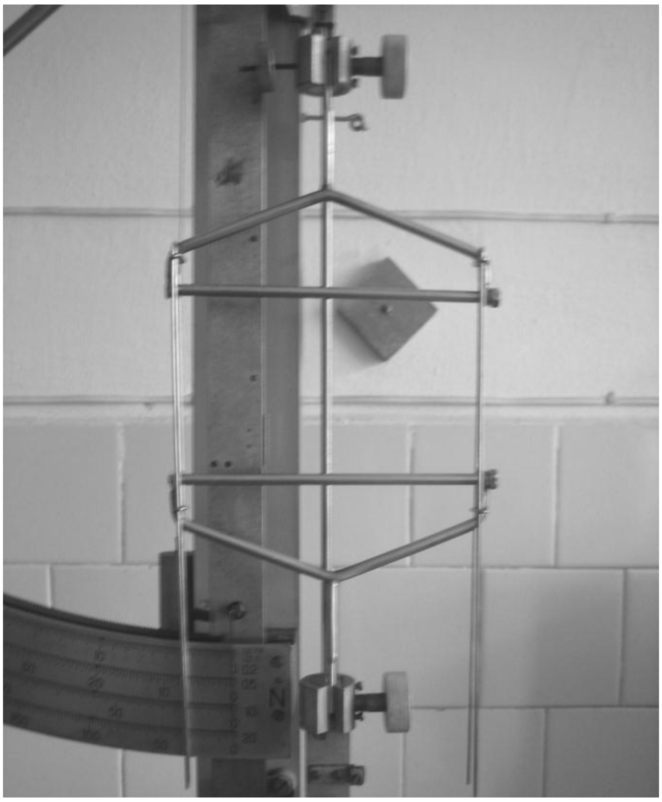
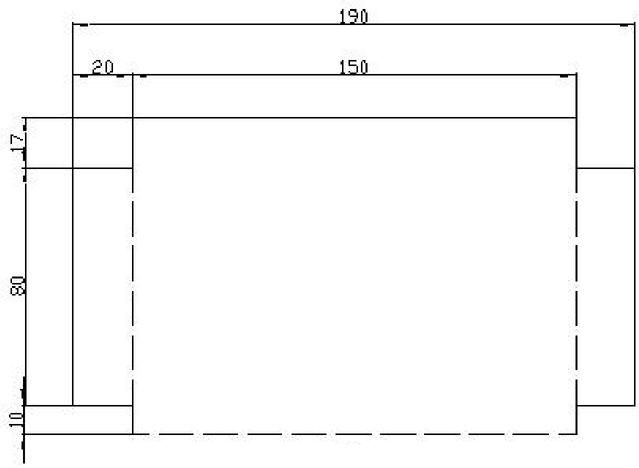


Figure 2. - Appearance of special device for research deformation behaviors of the high-elastic materials

The special device (see fig. 1) consists of two steel frameworks-clips - 1 with a demountable top as coupling bolts – 2. There are special technological apertures - 4 on the lateral parts of both frameworks. The fixtures – 3 are passed through special technological apertures – 4 and clamp width of elementary test-sample. The width of ring test-sample is 150 ± 1 mm. It is three times more in comparison with a standard technique. The circuit of cutting and preparation the test sample for definition of the extensibility and residual deformation is represented according to figure 3. Direct carrying out of tests and calculation of the extensibility, elasticity and residual deformation is made according to a standard technique.



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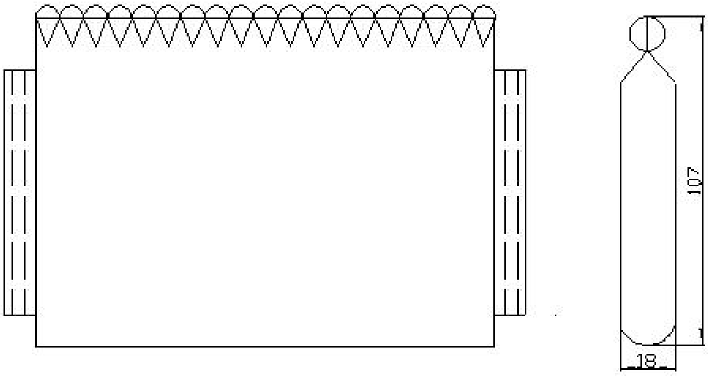
a)



б)

Figure 3 - The circuit of cutting (a) and preparation the test sample (б) for definition of the extensibility and residual deformation

The method for determination of the cross-contraction value presupposes using special device described above without fixing lateral cuts of the test-sample. The measurement of the cross-contraction is carried out in an average part of test sample in the marked horizontal axial line within the range of its working zone. The marking working zone of the test sample for definition of the cross-contraction value is represented on figure 4.

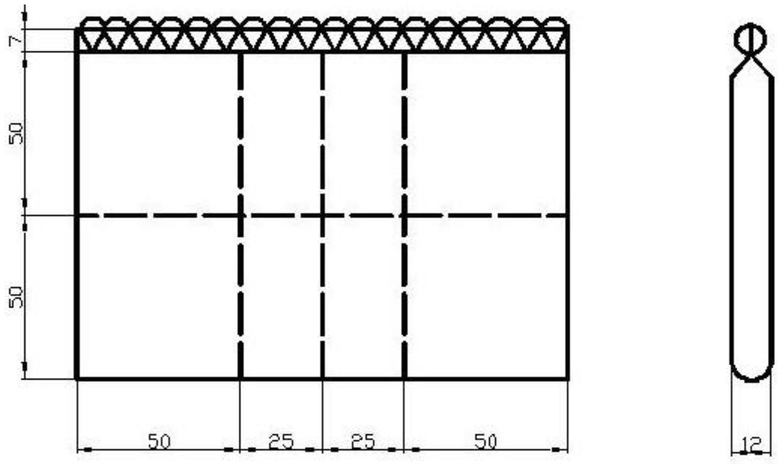


Figure 4 - The Circuit of marking working zone of the test sample for definition of the cross-contraction value.

The formula for calculation of the relative cross-contraction value ε_{cc} , % is

$$\varepsilon_{c.c.} = (B_0 - B_1) \cdot 100 / B_0 , \qquad (1)$$

Where B_o - initial width of the working zone test sample, mm;

B_1 - width of the working zone sample in the marked horizontal axial line after cross reduction test, mm.

The values of the extensibility, residual deformation and cross-contraction for more than 50 high-elastic materials were determined with using developed method for the research in deformation behaviors. There are different percent of polyurethane fibres (from 3 % up to 10 %) in the structure of test specimens. The characteristic some investigated samples and test results are given in Table 1.

Table 1 - Characteristic some investigated samples and test results

Num-ber of sam-ple	Method of manufacture and weave	Fibrous composit ion	surface density, g/m^2	Characteristic of deformation behaviors		
				extensi bility, %	residual deforma tion, %	Relative cross-contra-ction, %
1	Weft knitted, smooth surface	polyester polyure-thane	205	49,4	1,4	15,8
2	Weft knitted, jacquard	polyester polyure-thane	253	47,6	1,5	2,0
3	Weft knitted, smooth surface	Polyester polyure-thane	136	26,1	1,4	4,0

4	Weft knitted, smooth surface	wool, polyure-thane	327	67,0	1,7	33,6
5	Weft knitted, rib stitch 1x1	viscose, acetate, polyure-thane	131	70,1	1,6	1,2
6	Weft knitted, smooth surface	polyacryl onitrile, polyure-thane	244	69,0	1,9	4,4
7	Weft knitted, smooth surface	cotton, polyure-thane	204	30,8	1,0	2,0
8	Warp knitted, composite surface	polyester polyure-thane	214	30,0	1,3	4,4
9	Warp knitted, composite surface	polyester polyure-thane	113	12,4*	0,1*	7,6
10	Warp knitted, composite surface	polyester polyure-thane	124	31,2*	1,0*	2,0

Note:

1. * - values of the extensibility and residual deformation were resulted along wale as maximal.

The analysis of research results revealed the extensibility of high-elastic materials changes in considerable range - from 10 % up to 70 %. This is the reason for the big variety in structure parameters of high-elastic materials. Generally, the extensibility and residual deformation warp knitted materials are a little bit lower than weft knitted ones. In addition, warp knitted materials have the maximal extensibility both along course (sample № 8) and along wale (samples № 9 and № 10). Weft knitted materials have the maximal extensibility along course only. To sum up, when garment is cut from weft knitted materials should to put an end of detail along wale and when garment is cut from warp knitted materials should to put an end of detail along a direction showing the smaller extensibility.

The values of residual deformation almost all investigated materials do not exceed 2 %. Consequently, it allows leave out these values of residual deformation for garment designing.

The values of relative cross-contraction change in rather wide range - from 1,2 % up to 33,6 %. The explicit dependence between values of the extensibility and relative cross-contraction is not revealed. High-elastic materials, which have close values of the extensibility, can reveal a various values of cross-contraction. For instance, the sample № 4 has 67 % of the extensibility and maximal value of cross-contraction - 33,6 %. The sample № 5 has 70,1% - the extensibility and 1,2% - cross-contraction.

Authors offer to evaluate a basic limit of narrowing details $K_{έ}$, % and relative modulus of elongation details L, % by formulas:

$$K_{\varepsilon} = \frac{\varepsilon}{\varepsilon + 100} \cdot 100 , \qquad (2)$$

$$L = \frac{\varepsilon_{n.c.}}{100 - \varepsilon_{n.c.}} \cdot 100 , \qquad (3)$$

Where έ – the extensibility of materials, %;

$έ_{п с}$ – the relative cross-contraction of materials, %

Basic limits narrowing and relative modulus of elongation details for all investigated high-elastic materials were calculated by formulas (2) and (3). Using the findings a cylindrical prototype models had been produced from investigated materials. The analysis of samples in the equilibrium and deformed conditions showed a high level of conformity its sizes. It proves an opportunity of application the offered technique. The models of a jersey were produced from some investigated high-elastic materials and fitting it on a dummy confirmed efficiency of the developed technique too.

With using method of definition design parameters one can to evaluate the basic limit narrowing of details for any high-elastic materials. Take account of inter-dimensional interval established for knitted clothes and a recommended range of sizes for tight-fitting clothes the classification of the extensibility groups for high-elastic materials was concluded and additionally, recommended basic limits of narrowing details from high-elastic materials was established (table 2).

Table 2 – The classification of the extensibility groups for high-elastic materials and recommended basic limit of narrowing details

The extensibility group	The value of extensibility $\acute{\varepsilon}$, %	Recommended basic limit of narrowing details $K_{\acute{\varepsilon}}$, %
I	up to 20	12 – 14
II	21 – 35	20 – 22
III	36 – 45	27 – 29
IV	46 – 60	34 – 36
V	over 60	40

The established basic limits of narrowing details from high-elastic materials can be applied without restrictions when tight-fitting clothes are designed from smooth dense materials.

The analysis of appearance test of models, which produced from high-elastic materials IV and V groups of the extensibility with a coarse surface, sparse construction and fast-printed has shown that value of the basic limit of narrowing details should be corrected for the reduction and should not exceed 30 %.

Conclusions

The developed method for the research of deformation behavior high-elastic materials allows to approach test conditions to the real conditions of deformation high-elastic material when the tight-fitting clothes are being worn on a person body and consequently, provides determination of the initial information for accurate calculation of the necessary design data for tight-fitting clothes.

The offered classification of the extensibility groups for high-elastic materials and the worked out recommendations for the designing and manufacturing of tight-fitting clothes from such cloth substantially simplify a designing and manufacturing preproduction, favour the reduction of materials consumption and release of high quality clothes.

References

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