Investigation and Comparative Evaluation of Fabric Inner Structure Weaved With Different Looms

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Usually several types of looms are used in factories. Wool and semi-wool fabrics are weaved with such looms, where weft yarn insertion is with rapier or projectile, ordinarily. It was noticed that, properties of fabrics with the same setting parameters, but weaved with not identical technological parameters are different. These differences can be seen only from fabric cross-section analysis or differences of stress-strain curves. The microscopical investigations and tensile properties of fabrics were done. The differences can be seen clearly from the initial part of stress-strain curves, which characterizes fabric structure and was confirmed by crimp analysis of 1 m length. Such difference occurs for fabrics with elastic component *lycra* in weft, while without *lycra* fabrics structure are the same. The reason of presented phenomena can be technological and constructional parameters of the looms, which in different looms usually are not the same. The small differences of technological parameters do not influence fabrics without *lycra*, but have the great influence for fabrics with *lycra* because the elastic component of yarn is very sensitive for various effects.

Keywords: fabric cross-section, stress-strain curve, crimp.

1. INTRODUCTION

Woven fabric is a material of sophisticated structure, the features of which are influenced by its structure [1, 2]. There are seven parameters influencing its structure: the raw material of the warp and the weft, the linear density of warp and weft, the warp and weft setting and fabric weave. Different fabric factors estimate seven parameters mentioned above [3, 4]. But the properties of fabric depend not only on 7 main parameters, but also on formation of fabric.

Usually, several types of looms are used in factories. Wool and semi-wool fabrics are weaved with such looms, where weft insertion is with rapier or projectile.

It was noticed that, properties of fabrics with the same setting parameters, but weaved with various loom in various companies are different. When structure of fabric is different the properties are different, too.

Such properties of fabrics as air permeability, strength, elongation, etc. were investigated by many authors. Investigations showed that woven fabric structure influences on fabric properties. To summarise, many studies have been performed on the woven fabric structure influence on different fabric properties [5 – 9].

The constructional parameters of fabric have significant influence on change of mechanical characteristics of warp and weft threads during weaving process. The tensile properties (the breaking force and elongation at break) are of very great importance, though relation with the parameters of woven fabric structure has been found just in a few previous works. According to these investigations, the strength is higher in warp than in weft direction [10 – 14].

The crimp of fabric influences both the weaving technology (set in weft direction leads to additional stress of warp yarns, is solved by the temples) and the fabric properties [15].

The goal of this work was to determine and analyse the differences of fabrics, which were weaved with the same setting parameters, but with different loom (*Vamatex* and *STB* loom), i. e. not identical technological parameters.

2. MATERIALS AND METHODS

Three articles of semi-wool fabrics weaved with rapier *Vamatex* and projectile *STB* looms were chosen for the investigations.

The linear density of warps and wefts is 18 tex × 2 for both articles. The weaves, raw material and densities of warp (P_m) and weft yarns (P_a) data are given in Table 1.

Table 1. Settings of fabrics

Loom	Fabric	Warp yarns		Weft yarns	
		Raw material, %	P_m, dm^{-1}	Raw material, %	P_a, dm^{-1}
Vama-tex	*Rusne*, plain	Wool 45 PES 55	176	Wool 43,3 PES 53 *Lycra* 3.7	200
STB	*Rusne* plain	Wool 45 PES 55	176	Wool 43.3 PES 53 *Lycra* 3.7	200
Vama-tex	*Lauras*, Twill 2/1	Wool 45 PES 55	348	Wool 45 PES 55	210
STB	*Lauras*, Twill 2/1	Wool 45 PES 55	348	Wool 45 PES 55	210
Vamat ex	*Ajax*, Twill 2/1	Wool 45 PES 55	213	Wool 43.3 PES 53 *Lycra* 3.7	240
STB	*Ajax* Twill 2/1	Wool 45 PES 55	213	Wool 43.3 PES 53 *Lycra* 3.7	240

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The same number of heald frames for the same articles (for Lauras and Ajax – 6, for Rusne – 8) was used. The drawing-in straight pass was used.

The measurements of cross-sections were carried out using PC, software *Metric* and the microscope *Ascania* (accuracy of measurements is ±0.001 mm).

The load extension characteristics of fabrics were measured on Zwick/Z005, according LST 13934-1 standard. The extension rate of specimen was 100 mm/min, the pre-load was 2 N, (for Rusne and Ajax) and 5 N (for Lauras) distance between clamps was 200 mm. The stress-strain curves of fabric were obtained when five specimens in every experimental point in weft and warp directions were extended.

3. RESULTS AND DISCUSSIONS

It was noticed, that for fabrics weaved with different loom, but with the same setting parameters their properties sometimes are different. By weaving the same article with two types of looms (*Vamatex* – rapier and *STB* – projectile) the different amount of wefts was used for the same article. According to the consumption rate by weaving with *Vamatex* loom wefts are lacking always, while by weaving with *STB* such appearance is not noticeable.

Such differences of properties may occur because of unequal inner structure of fabrics. These differences can be seen from the fabric cross-section or stress-strain curves analysis.

In the first stage the microscopical investigations of fabrics cross-section were done (Fig. 1).

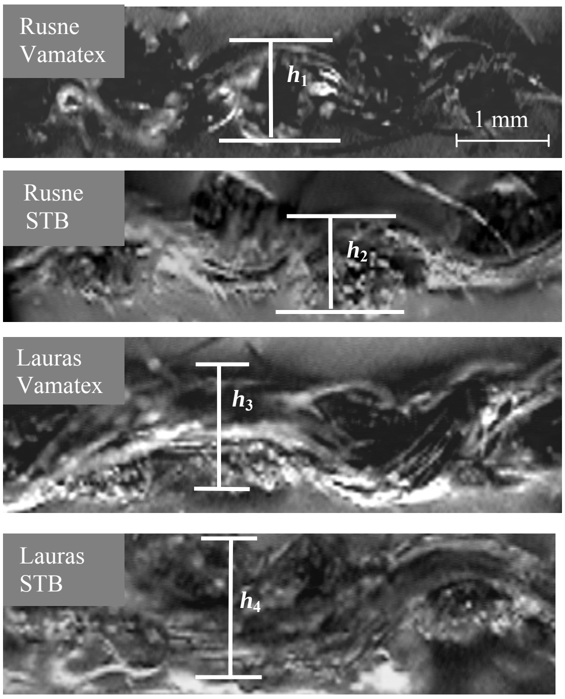

Fig. 1. Cross-section of fabrics in weft

The differences of fabrics can not be gathered from these investigations, because measurements can be done only in very small area of fabric, i. e. it covers only few yarns and only the momentary differences of the staple yarns thickness can be seen. The values of wave height h_1 for Lauras are very close (*STB* – 0.415 mm, *Vamatex* – 0.410 mm), for Rusne (*STB* – 0.360 mm, *Vamatex* – 0.350 mm), too. The coefficient of variation for Lauras is 14 % and for Rusne 21 %. The inadequacies are in within the error limits. So, the statistically certain fabric structure inequalities can not be done according to the microscopic measurements – they can occur of staple yarns linear density inequality in short distances – thin and thick ranges of yarns. Both of fabrics warp and weft cross sections shape is ellipse, and either for fabrics cross-sections weaved with *Vamatex*, or *STB* loom were noticed any differences.

As seen in Figure 1, one of the fabric geometrical parameters, i. e. fabric wave height for both variants of fabrics (weaved with *Vamatex* and *STB* loom) are very close.

For more precise prove of inner fabric structure inequality the experiments of fabric tension were done.

The starting zone OA of curve (Fig. 2) shows a process of forces, which need to overbear the friction, when yarns are straightened. This zone characterizes rather big stiffness. In the zone AB, the yarns of tension system become more straightened and the elements of opposite system crimps more intensively. It is the change of crimp effect.

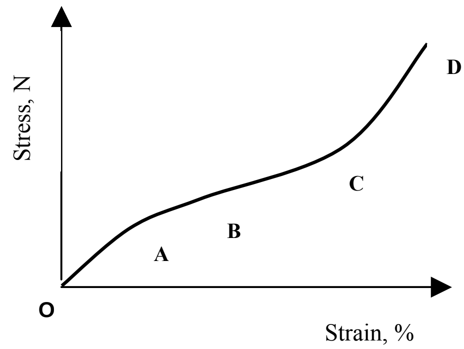

Fig. 2. Typical zones on the stress-strain curve

The forces, which defeat resistance to binding, in the zone BC increases. Further fabric extends only for yarns extension. The tightness of fabric increases more intensively in the zone CD and finally sample breaks.

So, the initial part of stress-strain curve depends on the structure of fabric and the inequality of curves in the initial part shows the inequality of fabric structure.

The 5 cm width strip of fabric, which consists of 88 – 174 yarns was under the sway during tension process. So, the single inequalities of staple yarns influence on the results more slightly than microscopic fabric cross-section measurements. Fabrics weaved with different looms were tensioned in both, warp and weft directions and the results were different.

Analysis of these data showed that character of all stress-strain curves is the same – differs the breaking force size only. In some cases the initial part of stress-strain curve, which depends on fabric structure differs (Fig. 3, 5, 7).

As seen from Figure 3, stress-strain curves of fabrics in weft direction are already different in initial part of tension i. e. the part, which depends on fabric structure. While fabrics are tensioned in warp direction (Fig. 4, 6, 8), the differences in initial part of curve are not so significant as they are tensioned in weft. So, it can be asserted, that structure of fabrics weaved with *Vamatex* and *STB* loom are not identical completely.

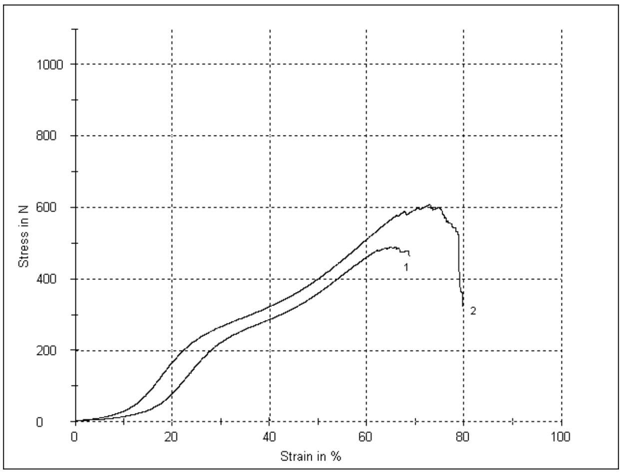

Fig. 3. Fabric Rusne in weft: 1 – Vamatex, 2 – STB

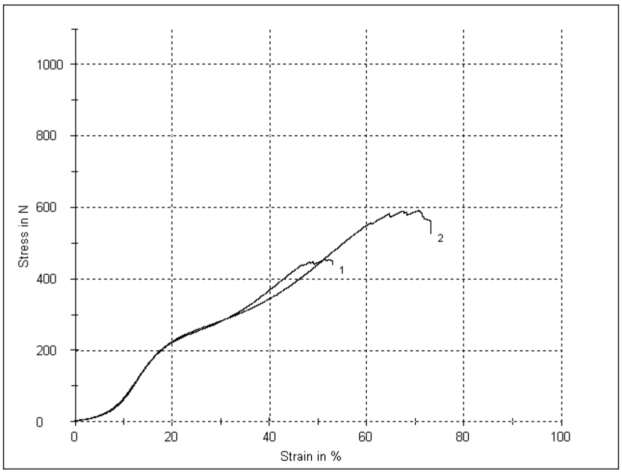

Fig. 4. Fabric Rusne in warp: 1 – Vamatex, 2 – STB

The analogical investigations were done for another fabrics – Ajax and Lauras, too (Figs. 5 – 8).

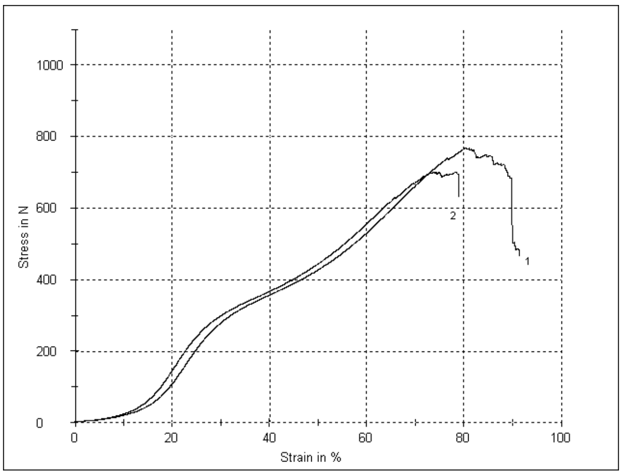

Fig. 5. Fabric Ajax in weft: 1- Vamatex, 2- STB

As seen from Figures 5 and 8, the differences between stress-strain curves in initial part of tension are not so significant as for fabric Rusne. But it can be seen that for fabric Ajax, weaved with *Vamatex* loom, initial part of curve (in weft) is more flat than for analogical fabric weaved with *STB* loom.

While the average curves of Lauras are very similar, though very small difference can be seen in the initial part of stress-strain curves in weft. The stress-strain curve for fabric weaved with STB loom is more flat, than with *Vamatex* loom (see Fig. 7).

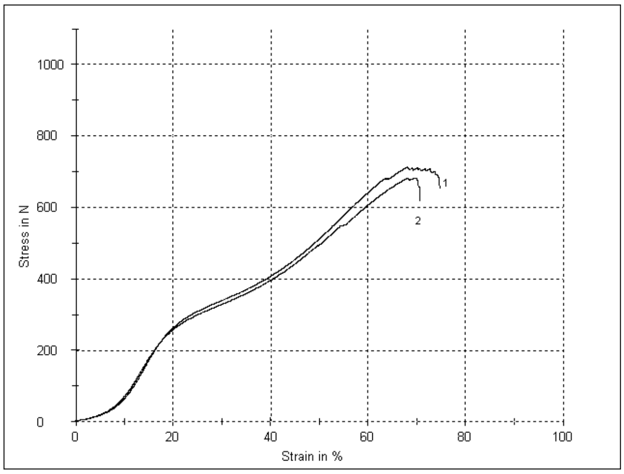

Fig. 6. Fabric Ajax in warp: 1 – Vamatex, 2 – STB

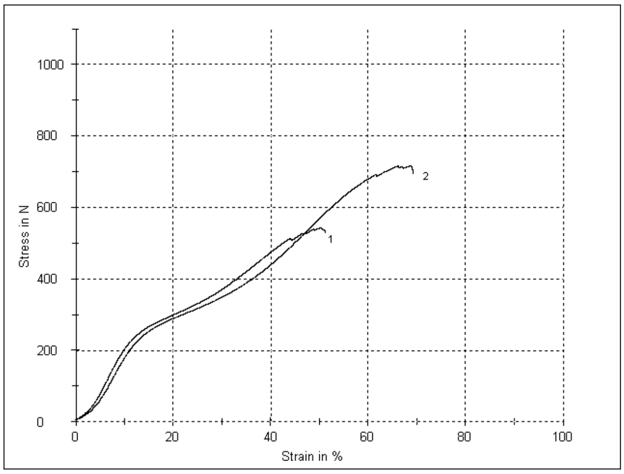

Fig. 7. Fabric Lauras in weft: 1 – Vamatex, 2 – STB

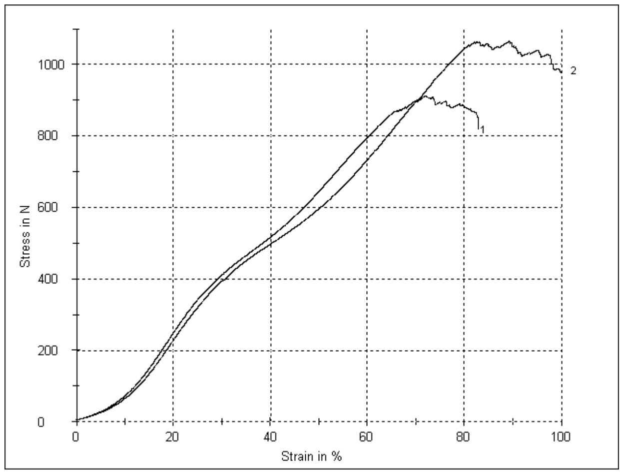

Fig. 8. Fabric Lauras in warp: 1 – Vamatex, 2 – STB

The results are rather uneven – for fabrics Rusne and Ajax, weaved with *Vamatex* loom, crimp of weft yarns is higher than they are weaved with *STB* loom, while crimp of wefts of fabric Lauras is the same (see Figure 9).

The values of yarns crimp depend on the yarns straightening on the ruler, i. e. they depend on the person, who performs the measurements. To guide these measurements, when differences of results are so small, crimp of weft yarns was measured not in 10 cm (according to the standards), but in 1 meter of fabric. In this way the differences are higher and different crimps patently are seen. These results confirm the higher consumption of weft yarns by weaving with *Vamatex* loom.

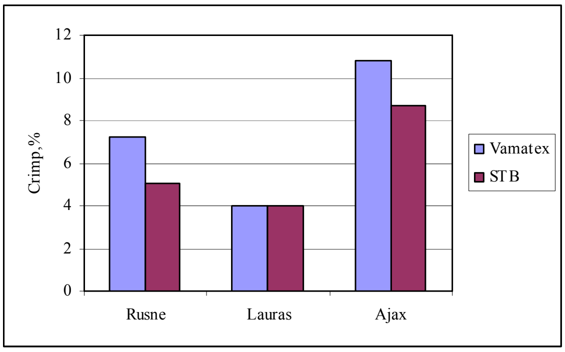

Fig. 9. Crimp of fabrics

Such difference may occur because of unequal raw material of weft yarns. Weft yarns of Rusne and Ajax are with *lycra*, while wefts of fabric Lauras are without *lycra*.

It is well known that such technological and constructional parameters as position of back rest, heald levelling advance, geometry of shed, weft and warp yarns stress in general meaning, may influence on fabric structure [5, 6, 9]. Also it is known that yarns with polyurethane component (*lycra* is polyurethane fibre) are very sensitive for various technological parameters [16]. All of that confirm our obtained results – differences occur only for fabrics with elastic component.

CONCLUSIONS

The inner structure is different for fabrics weaved with the same setting, but with different technological parameters. These differences can be seen clearly from initial part of stress-strain curves, which characterizes fabric structure.

The crimp of fabrics weaved with rapier loom when they are with *lycra* is higher than for fabrics without *lycra* and weaved with projectile loom. In this case the consumption of weft yarns will be higher, too.

Such differences of inner fabric structure may occur, because of different technological parameters of equipments.

To produce fabrics with equal structure they must be weaved in the same conditions and with the same looms.

Acknowledgments

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