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Pleat Effects With Alternative Materials and Finishing Methods

Sedef Acar[1*], Derya Meriç[1], Elif Kurtuldu[1]

Dokuz Eylül University, Faculty of Fine Arts, Textile and Fashion Design Department, 35320, İzmir, Turkey

Corresponding Author: Sedef ACAR, sedef.acar@deu.edu.tr

ABSTRACT

In this study, various pleating methods formed by shrinking and finishing are experienced as an alternative to the pleats formed with weaving method, numerical and visual values of these methods were determined and in the conclusion part, their contributions to new design ideas were analyzed. In the experimental study, the factors such as weaving method, structure, and density were kept at standard values, besides polyurethane-elastomer, wool and cotton yarns that could shrink under different conditions were used as variable groups. As a result, it was observed that the results obtained from the fabrics passing through alternative processes such as the use of elastomer, fulling, and caustic soda application, supported 'the local shrinking on fabrics and clothes' idea.

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KEYWORDS

Pleat, elastane, wool, caustic soda, seamless garment, local shrinking, woven pleat

1. INTRODUCTION

Nowadays, trends that guide fashion in all design areas and also in fabric design require an innovative perspective. In the field of textiles as in the case of all areas of human interest, the widespread and even foreground of design thinking has also influenced the expansion of the boundaries of product functionality. This function includes not only protection and usage but also aesthetic and appearance (1). In accordance with all factors affecting the design, versatile function expectations enable infinite variety in fabric design by merging with technological opportunities and imagination. Yarn, technical, weave, density-tension differences, surface deformations due to weaving, finishing processes, colour, and raw material factors affect not only physical properties of woven fabrics but also their aesthetic properties (2-4). Different yarns and constructions form effects such as puffy, piled, relief, voluminous, shiny, matt-bright, iridescent, shirred, wrinkled, textured, light-dark which give the design factor to the surface appearance (5). Especially, owing to the raw materials' characteristics fabrics could stretch, felt, raise, and be shaped by heat, shrink, be sensitive towards dye, chemicals and enzymes (4). Therefore, the raw material and the yarn has a significant role in the chemical, physical and visual structure of the fabric (1).

Creating three dimensional relief effects are significant in quest of innovation and variety in woven fabrics. This effect could either be achieved with weaving techniques ensure three-dimensional structure or be depended on types of yarn or fiber in the fabric. For example, if the yarn is strictly twisted, the fabric automatically shrinks and the relief effects occur without any intervention. Relief effects based on the dimensional change are obtained by applying appropriate finishing methods according to the raw material. Some of these finishing methods are fulling, chemical, enzyme and heat treatments. Other factors that determine the quality of relief effects that the fabrics to be subjected to finishing are woven with yarns of the same or different raw materials and basic or advanced weave structures.

It is possible to see the relief effects examples on the woven fabrics in the works of textile-fiber artists (6-7), and the mass production fabric designers (8-11) (Figure 1-4).

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Figure 1. 'X-form Series 07', Philippa Brock, 2D-3D Jacquard Woven Textiles Exhibition, Montréal (8).

Figure 2. 'Jellyfish', the polyester fabric design which was endowed with relief effects through thermal processing, Reiko Sudo, Nuno Corp., 1993 (9).

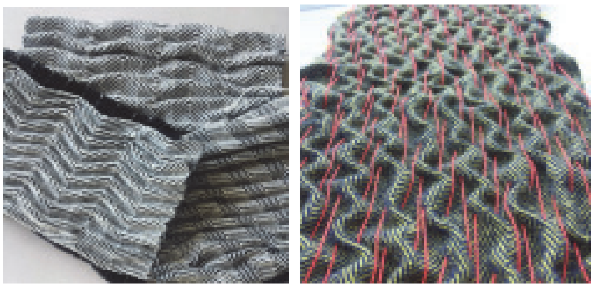


Figure 3. 3D woven fabric designs inspired by optical effective natural structures, Awarded the Incorporation of Weavers Innovation Prize 2015, Amy, Bond (10).

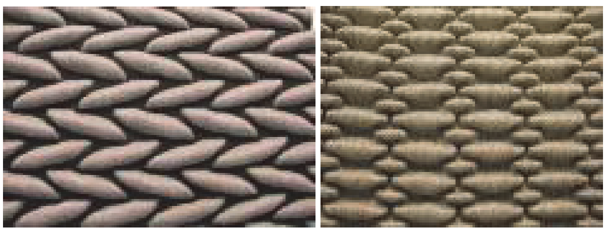


Figure 4. Example studies of unique 3D effects from woven fabric design (11).

Liz Williamson, Pauline Verbeek-Cowart (12), Anne Field, Hideko Takahashi, Vicki Masterson, Patricia Parlson and Sedef Acar are some of the designers that perform fulling experiments on this kind of fabrics to form innovative relief effects (Figure 5). While designers like Jean Williams Cacicedo, Mary Jaeger, and Latifa Medjdoub design garments by applying fulling on 100 % wool fabrics, Sedef Acar produces seamless garments by applying local shrinking and fulling method on their surfaces (13) (Figure 6).

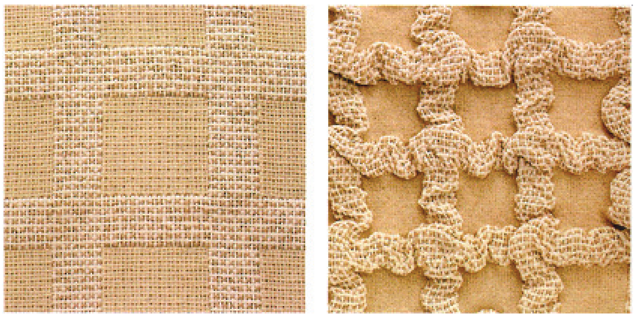


Figure 5. The fabric that has double weaving structure method with wool and rayon yarn woven and fulled by Pauline Verbeek-Cowart (12).

Figure 6. Seamless garment produced by Sedef Acar from relief effected- fabric that was woven with wool and rayon and local fulled (13).

Holly Brackmann's textile design works could be listed in the successful examples of relief effects created by using sodium hydroxide (14). It is also possible to see examples of caustic effects experiments among the various experimental practices of fiber artists like Signe Ran Ebbessen (Figure 7).

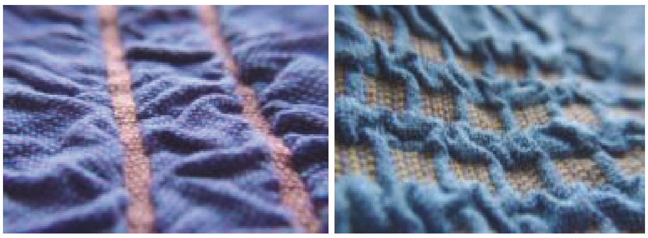


Figure 7. Sodium hydroxide experiment examples from silk and cotton yarned-hand weave fabrics. Vintage series, Signe Rand Ebbesen (14).

1.1. Woven Pleats and Other Pleat Applications

Today, the relief effects are often used to create three-dimensional, innovative designs that based on the complex surface effects. One of the oldest known relief-featured fabric types is the pleated fabric. Having even vertical or horizontal linear relief effect-surfaces are the decisive characteristics of these fabrics. Derived from "plissé" which means doubling in French, pleat is defined as "a process which is performed in order to bring permanent embossing or wrinkle" in Oxford English dictionary (15). Even though as a term, the pleat was first used in French at the end of the 19th century, it dated back to the textiles in Ancient Egypt.

Two of the linen tunics with pleat effect are located in Museo Egizio (Egypt Museum), Turin, Italy (16) (Figure 8).

Figure 8. The linen tunic with pleat effects from the 5th or 6th dynastic period (BC. 2435-2118) (16).

Today, there are many examples of the woven fabrics brought pleat effect. When these examples are analyzed in detail, it is seen that, as in Routte's classification, it's possible to study the pleat given to the fabrics according to their production methods in three groups, *woven, shrinking and the pleats created with finishing process* (17).

1.1.1. Woven Pleats

Woven pleats formed by weaving technique during the production are achieved after intense and hard works (18). Woven pleats are formed by using two sets of warp yarns wrapped around different beams. The yarn forming the surface is tense while the pleat yarn is loose (19) (Figure 9).

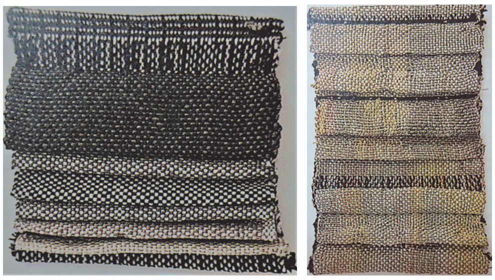


Figure 9. Woven pleat samples (20).

1.1.2. Shrinking Pleats

Shrinking pleats and the pleats created with finishing process offer alternate production approaches to the woven pleats that requires a hard and intense production method. Yarn or/and fiber type are important in creating shrinking pleat effects. With the help of the characteristics of the yarn, the just-woven fabric can be able to have pleat effects without finishing process. It is common to use high twisted yarns or elastane yarns for shrinking pleats (21) (Figure 10).

Figure 10. Pleat effects on a high twist cotton-wool yarned-fabric (21).

Polyurethane-elastomer yarns that have shrinkage property are thermoplastic yarns that can recover its original shape. When they are woven at a stable tension together with non-elastic yarns, relief and pleat effects are created by bringing out a volume in the fabrics without finishing processes. Another property of fabrics woven with yarns is that they could stretch but also recovery its original shape shortly after the force is removed.

Polyurethane-elastomer yarns have an important role in relief and pleat effects creation depending on yarn and fiber type. The first elastic yarn Lastex which was produced from an artificial material was invented in 1930 and it was introduced as Perlon U (22) by the Du Pont Company in the USA in 1958, as Lycra in 1962 again in the USA, as Spandex (Fiber-K) in Asia and as Elasthan in Germany (23). They are consisting of two parts; soft and hard (7) and able to stretch up to 800 % (23).

1.1.3. The Pleats Created With Finishing Processes

The pleats created with finishing processes are formed by applying various finishing processes to the fabrics designed by using different yarns together in weaving having fibers with different chemical and physical features. These fabric structures, not having a shrinking characteristic unless being exposed to an effect, are enable to form relief structures and pleat effects to this factor by showing a shrinking respond when being exposed to suitable finishing process.

The pleats and relief structures created with finishing processes by created by the effects formed by using shape memory materials in textile structures, fulling the wool structures, applying thermal processes to the thermoplastic-featured yarns, applying sodium hydroxide (caustic soda) to the cotton yarned-structures enable to form relief effects and so the pleat surfaces.

Felting caused by the expanding of the flakes on the wool fibers with heat and humidity and their interlocking to each other because of pressure is the oldest known shrinking method. The most known traditional texture created by spreading the wool fibers and felting them is wet felt. Shrinking experiments are also applied by producing textile structures that have wool fibred-yarns and then exposing them to fulling. This kind of felting processes applied to woolen fabrics is called fulling method.

A visual richness is formed by creating three-dimensional ruffles on the fabric by weaving wool yarns together with yarns from other raw materials with various weaving techniques and then fulling them. When the wool parts of the fabric shrink by fulling, it causes raisings and falling in other parts and this creates three-dimensional views (24).

Caustic-featured substances are generally used during the finishing process of the fabric structures that consist of regenerated fibers like viscose and rayon and in the mercerization-based experiments in cotton fibers (25-27). Besides, there are examples of three-dimensional and relief effects forming with various local printing studies in accordance with the shrinking characteristic caused by caustic solutions. Seersuckers are one of the examples of these relief effects. It's applied by printing sodium hydroxide (caustic soda) on linen or cotton woven fabrics which are flat and fine. Applied chemical causes shrinking and puckering in processed parts (28).

In addition to these applications, Issey Miyake, one of the Japanese designers globalized in the 1970s and after, presented one of the most innovative examples in this area with extraordinary apparel forms (29). Having used pleat effects based on folding and heat processes in his previous works, Miyake presented pleat effects in his SS/16 collection by application of a new baking method with thermochromic colorant (29) (Figure 11-12).

2. MATERIAL AND METHOD

Shrinked pleat and the pleats created with finishing process have a potential to exhibit alternative production approaches to *woven pleats* that known as labor-intensive manufacturing method.

In this study were examined the pleat effects of yarn properties that take part in shrinked pleat and the pleats created with finishing process. Accordingly, the yarns that give a shrinkage reaction under the various conditions are composed to experimental group of this study. Shrinkage performance experiments have been made with these yarns and performed weaving implementations. The visual effects formed in weaving were tried to be based on measurable results by obtaining measurable values and visual values based on senses are evaluating together.

For applications with the purpose of providing this, a two-stage process was implemented as 'yarn experiments' and 'weaving applications'.

In the first stage of the study, the properties of the yarns showing shrinking properties of the experimental group were investigated under the heading of 'Yarn shrinking experiments' and samples were examined. Preliminary tests were performed for shrinking performance values of yarns to measure the shrinking performance of these yarns before weaving process. The performance values related with shrinking directly of the yarns to be used in weaving applications are presented in the tables (Table 2-4). It should be noted that Table 2, 3, and 4 reveal independent values because of each raw material type has different characteristics due to different shrinking reactions.

Under the heading of 'Weaving experiments and results' weaving applications were performed with experimental group and control group that have standard values.

Weaving experiments were carried out on a hand weaving loom with 40 cm width. In the study, it has been found sufficient making only one application from each one for the purpose of observing the effects of different types of yarns on the pleats in the weaving.

The experimental groups were included in woven structures as extra weft yarns and the ratio of these weft yarns connecting to structure is 20:4 (16 weft loose / 4 plain weave), (Figure 13). The reason for making long weft looses is that these looses correspond to the tensed warp looses in the regular pleat weaves weaving with double-beam in woven pleats (32) (Figure 14).

Figure 11. The pleat effected-clothes Miyake created by using baking method (30).
https://www.dezeen.com/2016/01/08/spring-summer-2016-fashion-collection-issey-miyake/ 01.01.2018

Figure 12. Details of the new pleat effects from Issey Miyake (31).
https://www.fastcodesign.com/3055520/issey-miyakes-new-technique-for-perfect-pleats-bake-them-in-the-oven 01.01.2018

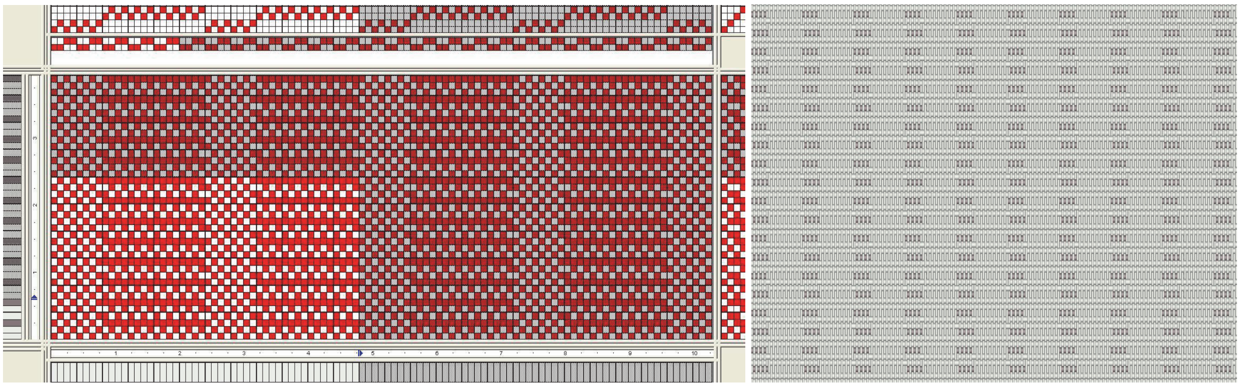
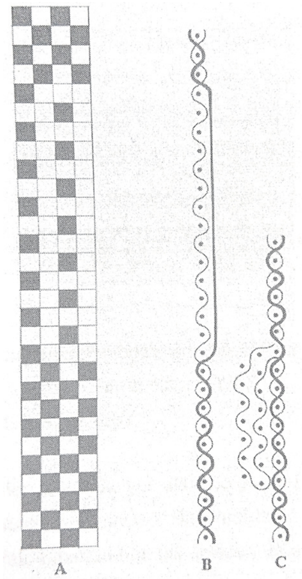


Figure 13. Weaving structure reports of the applications and simulation preview.



Resim 14. Woven pleat sample weaving with double-beam application (32).

All elements except the experimental group are standard. 33 tex regular twisted polyester warps and ground wefts on same value, reed plan, drafting plan, weaving structure reports and lifting plan are standard. Furthermore, the experimental groups were included in woven structures as extra weft yarns ratio of standard weft yarns which have not the shrinking feature is 2:1. The experimental group yarns have shrinking features by its nature or due to having *different raw material, yarn types or fineness* they can be shrunk by various finishing methods. These yarns are classified under three groups:

1. Polyurethane-elastomer yarns
2. Wool yarns
3. Cotton yarns

In the experiments, by using two different yarns in each three different raw material groups, six different woven fabric were created (Table 1).

Table.1. Technical information of the fabric samples

<table>
<tr><td rowspan="10">STANDARDS</td><td>Technique</td><td colspan="3">Extra weft structure</td></tr>
<tr><td>Reed number and change</td><td colspan="3">80/2</td></tr>
<tr><td>Warp yarn</td><td colspan="3">33 tex twisted polyester yarn</td></tr>
<tr><td>Weft yarn</td><td colspan="3">33 tex twisted polyester yarn</td></tr>
<tr><td>Warp density</td><td colspan="3">16 cm^{-1}</td></tr>
<tr><td>Total weft density
(Ground + Extra weft)</td><td colspan="3">9 cm^{-1}</td></tr>
<tr><td>Ground weft / Extra weft ratio</td><td colspan="3">2:1</td></tr>
<tr><td>Weaving structure</td><td colspan="3">Edge: 2/2 warp ribs
Ground: plain weave</td></tr>
<tr><td>Fabric width on the loom</td><td colspan="3">19.75 cm</td></tr>
<tr><td>Fabric length</td><td colspan="3">10 cm</td></tr>
<tr><td rowspan="6">VARIABLES</td><td rowspan="6">Extra weft yarn groups</td><td rowspan="2">Elasto mer</td><td>Experiment 1</td><td>Experiment 2</td></tr>
<tr><td>9 Tex polyurethane-lycra + polyester multifilament</td><td>20 Tex polyurethane-lycra + dyed twisted yarn</td></tr>
<tr><td rowspan="2">Wool</td><td>Experiment 1</td><td>Experiment 2</td></tr>
<tr><td>100 Tex raw wool
(20 micron fiber content)</td><td>50 Tex dyed wool
(17 micron fibre content)</td></tr>
<tr><td rowspan="2">Cotton</td><td>Experiment 1</td><td>Experiment 2</td></tr>
<tr><td>25 Tex raw cotton</td><td>22 Tex dyed cotton</td></tr>
</table>

3. RESULTS AND DISCUSSION

3.1. Yarn Shrinkage Experiments and Results

The polyurethane-elastomer is a material that stretches when applied force. Besides; wool felted with humidity, temperature and pressure; and cotton reacted to the application of caustic are fibers that have shrinkage property. These three group of materials have been determined for use in applications and preliminary data on the specific shrinkage performances of three different raw materials yarn groups were obtained before the applications.

3.1.1. Results of Polyurethane-elastomer Yarn Shrinkage Experiments

In the experimental study, 9 Tex-polyurethane-lycra + polyester multifilament and 20 Tex-polyurethane - lycra + twisted dyed yarns were used weaving of two different sample. Thus, the effect of different yarn types and fineness are observed for yarns having same raw materials. The tensile strength of these yarns was tested by the INSTRON testing machine and it has been determined that these yarns respectively have 13% and 4% straining rate. It was observed that the yarn which is streched in the rate of 100% didn't exceed ultimate strength point (Table 2). Therefore, it was decided that the polyurethane elastomer weft thread yarn is streched in the rate of 100% during the weaving applications.

3.1.2. Results of Wool Yarn Shrinkage Experiments

In the experimental study, 100 Tex wool yarn having 20 micron fibers, and 50 Tex dyed-wool yarn having 17 micron fibers were used. Thus, it was possible to observe the shrinkage behaviour of the raw and dyed yarns with different fiber fineness and yarn count. The time of the maximum shrinking on the fabrics, brought by using these yarns in the weaving as extra weft yarns, was measured (Table 3).

3.1.3. Results of Cotton Yarn Shrinkage Experiments

In the experiment, fabrics woven by using cotton fibers as the extra weft yarn are applied to finishing process with a caustic soda solution. Caustic goes by chemical name NaOH which means sodium hydroxide is widely used in textile finishing process (33) (Table 4). During the experimental study, in addition to create relief effects creation of pleat appearances by using caustic soda solution was observed. First of all, it was decided to use 25 tex raw cotton and 22 tex dyed cotton yarn in two different applications to observe the reaction that the cotton yarns of different properties will give to the caustic soda solution.

Before weaving, 100 cm long of yarn for each kind of yarns was measured and subjected to the caustic soda application to determine the shrinkage degree of raw cotton extra wefts and to observe the degree of chemical and physical impact of the solution to the ground polyester warps and wefts. It was found that cotton yarns form optimum strength and shrinking rate with a 60 sec / 30° baume scale while it was observed that polyester yarns do not change in caustic soda (Table 4).

According to the 60 sec / 30° baume scale test results presented in Table 5, it was decided to use the 1st and 2nd yarn sample in two different weaving experiment. These yarns were used as extra wefts in weavings and were applied to caustic soda application for the same time and with the same baume scale.

Table 2. Elastic properties of polyurethane-elastomer textured yarns

	Yarn no / type	Straining ratio	Stretching ratio in weft insertion during weaving
1	9 Tex-polyurethane-lycra + polyester multifilament	13%	100 %
2	20 Tex- polyurethane -lycra + dyed twisted yarn	4%	100 %

Table 3. Final shrinking rates under the stable bath, temperature, force

	Yarn no / type	Water-soap bath ratio	Water temperature	Approximate force gap	Final shrinking time	Yarn shrinking rate
1	100 Tex/20 micron fibre raw wool	1 Liter/10 gr	80 degree	1-5 kg	8 min	52 %
2	50 Tex/17 micron fibre dyed wool	1 Liter/10 gr	80 degree	1-5 kg	5 min	64%

Tablo 4. Caustic soda solution test results to 100 cm. long raw cotton yarns in 3 different time and 3 different baume scale

Baume scale/ time	Control group	30° Baume	35°Baume	40°Baume
60 sn.	100 cm	91,1 cm*	93,3 cm	91,2 cm
120 sn.	100 cm	92,5 cm	91,2 cm	91,7 cm
180 sn.	100 cm	95,0 cm	92,2 cm	91,7 cm

*Selected time / baume scale.

Table 5. Yarn shrinking rates after applying caustic soda with a 60 sec / 30° baume scale to the 50 cm-length five cotton yarns

	Cotton yarn samples	Yarn length before the experiment	Length after the caustic soda with a 60 sec / 30°baume scale	Shrinking ratio of yarns
1*	25 Tex raw cotton	50 cm	43,9 cm	12,2 %
2*	22 Tex grey-dyed cotton	50 cm	41,2 cm	17,6 %
3	36 Tex blue-dyed cotton	50 cm	43,6 cm	12,8 %
4	26 Tex dark blue-dyed cotton	50 cm	41,3 cm	17,4 %
5	45 Tex coal colour-dyed cotton	50 cm	41,9 cm	16,2 %

* Selected cotton yarns.

3.2. Weaving Shrinkage Experiments and Results

The tensile tests of the three different raw material group yarns were measured and then used in weavings with extra weft structure. Two different performance measurements were made from each of the polyurethane-elastomer and wool yarn groups. Differently, in the cotton yarn group, 5 different yarns were tested for performance and 2 yarns were selected for weaving. Thus, a weave sample was made for each yarn and six different samples were woven. The aim of the work is to compare the pleat effects with each sample provided by six different yarns types independently of one another therefore no repeat was done. The sample fabrics were produced on the hand-woven loom and because of this; a manual weft insertion method was used instead of a constant weft insertion mechanism. Straining ratio in weft insertion was determined by measuring the width of the fabric samples after taking from the loom. These values are presented in detail below (Figure 16-19).

3.2.1. Results of Polyurethane Elastomer Yarn Weaving Shrinkage Experiments

In the first woven sample with polyurethane-elastomer yarn, 9 Tex polyurethane- lycra + polyester multifilament white yarn was used by stretching at a rate of 100 % in weft insertion. No processing was applied after removing from the loom. Fabric gets a three-dimensional form by shrinking at a 47 % rate after get rid of tension on the loom. Thanks to the shrinking process formed by elastic property of the yarns, linear pleat effects in regular intervals were obtained (Figure 14).

In the second woven sample with polyurethane-elastomer yarn, 20 Tex polyurethane-lycra + twisted dyed yarn was used by stretching at a rate of 100 % in weft insertion. No processing was applied after removing from the loom. After getting rid of tension on the loom, the fabric got a three-dimensional form by shrinking at a 31 % rate. Thanks to the shrinking process formed by elastic property of the yarns, linear pleat effects in regular intervals were obtained (Figure 15).

Differences between the two samples are types, fineness and thickness of the polyurethane–elastomer yarns used in experiment 1 and 2, so they created differences at shrinking ratios on fabrics by having different elasticities.

3.2.2. Results of Wool Yarn Weaving Shrinkage Experiments

In the first woven sample with wool yarn, 100 Tex raw wool (20 microns fibre) yarn was used. The width of the fabric, which was 19.75 cm on the loom, decreased to 18.50 cm after being removed from the loom and contracted in the ratio of 6.3%. Shrinkage rates as a result of felting are measured after taking the sample from the loom. After being removed from the loom, the fabric was exposed to fulling during 8 minutes and it reached maximum shrinking. Shrinking at a rate of 48 % gave a three-dimensional form to the fabric. With the effect of the fulling process formed by the felting of the wool yarn, non-linear pleat effects in irregular intervals were obtained (Figure 16).

In the second woven sample with wool yarn, 50 Tex dyed wool (17 microns fibre) yarn was used. The width of the fabric, which was 19.75 cm on the loom, decreased to 18.60 cm after being removed from the loom and contracted in the ratio of 5.8 %. Shrinkage rates as a result of felting are measured after taking the sample from the loom. After being removed from the loom, the fabric was exposed to fulling during 5 minutes and it reached maximum shrinking. Shrinking at a rate of 59 % gave a three-dimensional form to the fabric. Non- linear pleat effects in irregular intervals were obtained after the effect of the fulling process formed by the felting of the wool yarn (Figure 17).

Differences between the two samples are types, fineness and thickness of the yarns and the differences between the microns of the fibers contained in the yarns used in experiment 1 and 2, so they created differences at shrinking ratios on fabrics by fulling.

3.2.3. Results of Cotton Yarn Weaving Shrinkage Experiments

In the first woven sample with cotton yarn, 25 Tex raw cotton yarn was used. The width of the fabric, which was 19.75 cm on the loom, decreased to 18.40 cm after being removed from the loom and contracted in the ratio of 6.8%. Shrinkage rates as a result of caustic soda application are measured after taking the sample from the loom. After being removed from the loom, the fabric was kept in 30° baume scale caustic soda solution for 60 seconds and left to natural air-dying after being washed. Shrinking at a rate of 12 % gave a three-dimensional form to the fabric. Thanks to the finishing method applications by using caustic soda solution, linear pleat effects in regular intervals were obtained (Figure 18).

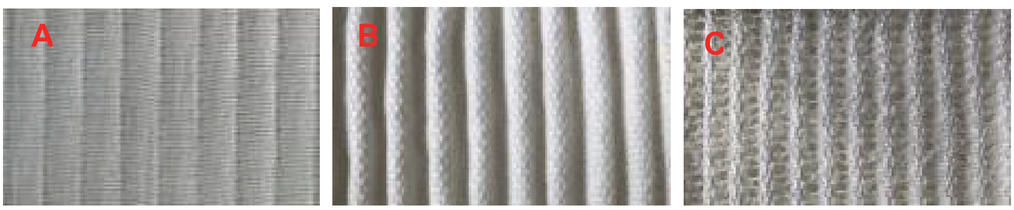


Figure 14. A) Appearance on the loom, B) Appearance after the relaxation of fabric (FRONT), C) Appearance after the relaxation of fabric (BACK)

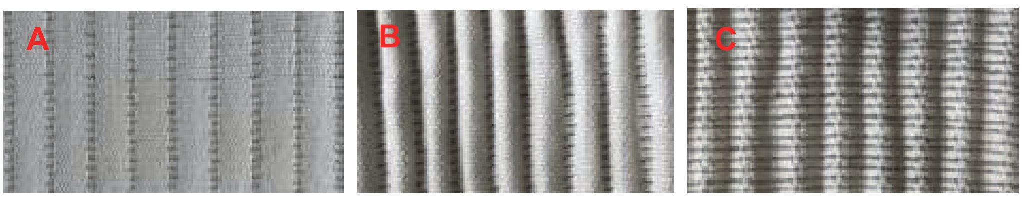


Figure 15. A) Appearance on the loom, B) Appearance after the relaxation of fabric (FRONT), C) Appearance after the relaxation of fabric (BACK)

Figure 16. A) Appearance on before the fulling process, B) Appearance on after the fulling process (FRONT), C) Appearance on after the fulling process (BACK)

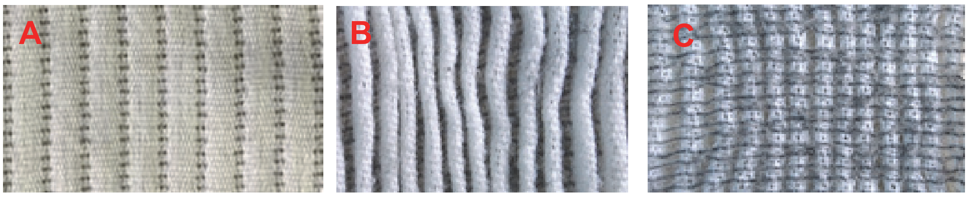


Figure 17. A) Appearance on before the fulling process, B) Appearance on after the fulling process (FRONT), C) Appearance on after the fulling process (BACK)

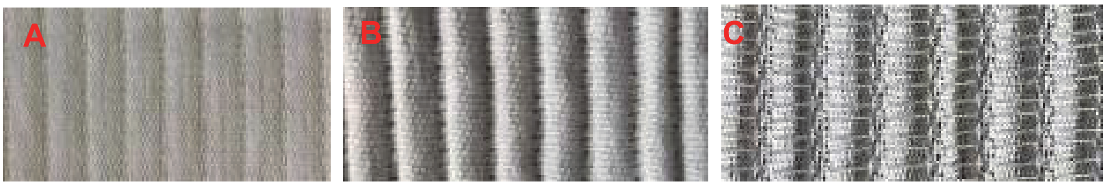


Figure 18. A) Appearance before caustic soda application, B) Appearance after caustic soda application (FRONT), C) Appearance after caustic soda application (BACK)

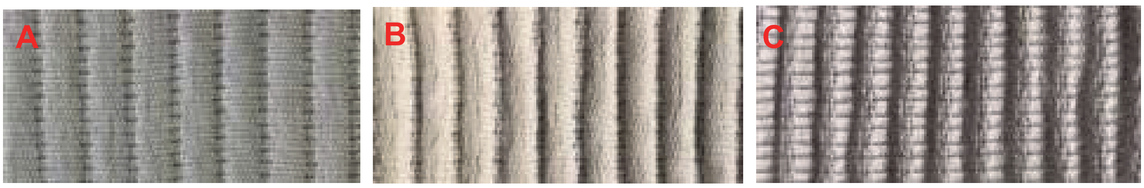


Figure 19. A) Appearance before caustic soda application, B) Appearance after caustic soda application (FRONT), C) Appearance after caustic soda application (BACK)

In the second woven sample with cotton yarn, 22 Tex dyed cotton yarn was used. The width of the fabric, which was 19.75 cm on the loom, decreased to 18.50 cm after being removed from the loom and contracted in the ratio of 6.3%. Shrinkage rates as a result of caustic soda application are measured after taking the sample from the loom. After being removed from the loom, the fabric was kept in 30° baume scale caustic soda solution for 60 seconds and left to natural air-dying after being washed. Shrinking at a rate of 17 % gave to the fabric. Linear pleat effects in regular intervals were obtained thanks to the finishing method applications by using caustic soda solution. (Figure 19).

Differences between the two samples are types, fineness and thickness of the cotton yarns used in experiment 1 and 2, so they created differences in shrinking ratios on fabrics.

4. CONCLUSION

In this study, it was aimed to create pleat effects with shrinking and finishing methods as an alternate to the pleat effects made by weaving method and to analyze the findings. Shrinking rates of the different types and raw materials yarns are significant to create these alternate pleat effects. Polyurethane-elastomer, wool and cotton yarns that show shrinking characteristics were determined as variables in the study. Each of the three yarn groups was treated as extra weft yarns in the weaving. All of the ground warps and wefts, reed plan, drafting plan, weaving structure reports and lifting plan are standard for each weaving sample to control the experimental study.

Quantitative and visual results of the study, based on creating pleat effects with shrinking and finishing methods, were explained in detail in the Results and Discussions part.

Consequently, to obtain weaving methods require quite a long time and labor force, so the alternative pleating methods have significant potentials in terms of production and design. Stretching when applied force of the pleat fabrics produced with polyurethane-elastomer fibres, being able to create local pleats by applying shrinking only on the desired parts to create pleat effects with fulling or caustic soda, being able to create pleats in different directions on the same fabric by employing extra weft and extra warp methods together could be count as the advantages that couldn't be acquired with weaving pleats. All these benefits enable to develop innovative design and production methods on textile and seamless garment designs.

In addition to all these results, it is found out that shrinking rates of wool and cotton yarns experienced before weaving processes are higher than the yarns used in woven structure as an extra weft. And it is thought that these shrunken yarns in fabrics caused to carry all fabric structure.

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