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Simulation of the pile loop for terry woven fabrics

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Simulation of the pile loop for terry woven fabrics

E Oner[1], G Durur[2] and B Sirin[2]

[1]Usak University, Textile Engineering Department, Usak, Turkey

[2]Pamukkale University, Textile Engineering Department, Denizli, Turkey

eren.oner@usak.edu.tr

Abstract. The purpose of this study is to propose a method to simulate the yarn loop formation for terry woven towels taking into account the movements in the weaving process. In accordance with this purpose, the structural properties of 27 type systematically produced terry woven fabrics, which had three different pile warp count, three different weft setting and three different pile ratio, were analyzed before and after pile formation. The changing of pile form was observed on the jaw moving platform, and pile formation steps in the terry weaving process were simulated.
Keywords: Terry woven, terry towel, terry loop formation, simulation.

1. Introduction

Terry fabric is an important part of textile products which holds a major place in daily life with different end-use purposes. Terry fabrics are constructed with loop pile on one or both sides of the surface, and they can be produced by both weaving and knitting techniques. Terry weaving process is the first invented method and still holds the major share [1]. During terry weaving process, the pile yarns are under tension as a result of movements and deformations. Thus the decisions about terry woven fabric structure and properties should be made before the production.

Modelling and simulating of terry woven fabrics provide significantly facilitation for decision of the appropriate structure and shorten the development process. For this reason many researchers have focused on the designing and modelling of the terry woven fabric in recent years [2-6]. However, the researchers generally used grey or finished fabric for the model development and tried to simulate fabric behavior. In this study, it is aimed to simulate the behavior of the realistic pile loop taking into account production process of terry weaving loom and formation steps of pile loop by measuring the dimensions of the pile threads unraveled from finished terry towels.

2. Materials and methods

In this study, three identical groups of 27 type terry woven fabrics, which had three different pile warp counts, three different weft settings and three different pile ratios were systematically produced. Ground warp and ground weft yarns of the fabrics were chosen as Ne 20/2 and Ne 16/1 carded cotton, respectively. The fineness of the carded cotton pile warp yarns were chosen as Ne 16/1, Ne 20/1 and Ne 20/2, which are commonly used counts in the market. The basic properties of the loop yarns, which were measured by the Uster Tester 5 according to ASTMD 1425, are given in Table 1.

All fabrics were produced on Vamatex dobby type towel weaving machine using constant setting values. Pile warp counts were chosen as Ne 16/1, Ne 20/1 and Ne 20/2, which are common counts in the market. The weft settings of the fabrics were determined as 15/cm, 18/cm and 21/cm, which represent loose, medium and tight setting levels. The pile ratios (length of pile yarn/centimeter of towel) were adjusted as 43, 52 and 61, which can constitute short, medium and long pile form.

Table 1. Properties of the pile loop yarns used to terry woven towel samples.

Yarn Count (Ne)	Twist Coeff. (α_e)	% U (%)	%CVm (%)	Thin (-50%) /km	Thick (+50%) /km	Neps (+200%) /km	Hairiness (%)
16/1	3.60	10.10	12.86	2.0	70.0	55.0	7.45
20/1	3.80	10.43	13.27	0.4	86.6	140.6	8.80

All of the fabrics were woven with the same weaving design. The design used in the woven terry towel fabrics is shown in Figure 1.

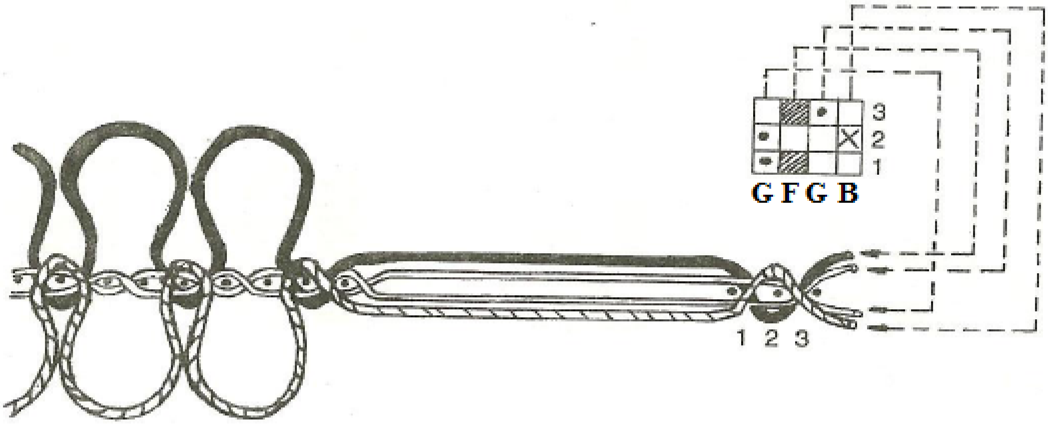

Figure 1. The weaving design used in the samples.
G: Ground warp, F: Face pile warp, B: Back pile warp.

In order to examine pile formation stages, the jaw moving platform with millimeter ground were designed (Figure 2). The pile threads were unraveled from each of towel sample and they were investigated with millimetric jaws according to before and after pile formation analysis of the fabrics.

Figure 2. Designed jaw moving platform with millimeter ground fabrics used in the study.

The unraveled pile threads were conditioned in a conditioning room at standard atmospheric conditions (20 ± 2°C, 65 ± 2% relative humidity) for 24 h according to ASTM D1776-08e1. The images obtained under microscope were processed in the Ms Visio with x and y origins.

3. Results and discussion

The pile ratios, settings, ground and pile yarn lengths before pile formation, as well as ground length in the final state of pile of the each of fabric were measured. The results of the measurements are presented in Table 2.

Table 2. Measurement results of the terry woven fabrics.

Pile Warp Count (Ne)	Pile Ratio	Weft Setting (threads/cm)	Pile Height (mm)	Ground Length (mm)
16/1	43	15	8.6	2.00
		18	7.2	1.67
		21	6.1	1.43
	52	15	10.4	2.00
		18	8.7	1.67
		21	7.4	1.43
	61	15	12.2	2.00
		18	10.2	1.67
		21	8.7	1.43
20/1	43	15	8.6	2.00
		18	7.2	1.67
		21	6.1	1.43
	52	15	10.4	2.00
		18	8.7	1.67
		21	7.4	1.43
	61	15	12.2	2.00
		18	10.2	1.67
		21	8.7	1.43
20/2	43	15	8.6	2.00
		18	7.2	1.67
		21	6.1	1.43
	52	15	10.4	2.00
		18	8.7	1.67
		21	7.4	1.43
	61	15	12.2	2.00
		18	10.2	1.67
		21	8.7	1.43

The pile formed due to the ground length in the final state of pile were examined and recorded under the microscope step by step with the help of the designed platform, as shown in Figure 3. As seen in the images, the pile formation is occurred in seven steps with regard to ground lengths of the terry woven fabrics. The images were obtained under the microscope and the x and y coordinates were determined. For seven pile formation steps shown in Figure 3, the coordinate points were determined on x and y axes. The pile threads unraveled from towel fabrics were moved with the help of the millimetric jaw moving platform, and mean values of the coordinate points were calculated for each of 27 terry woven fabrics.

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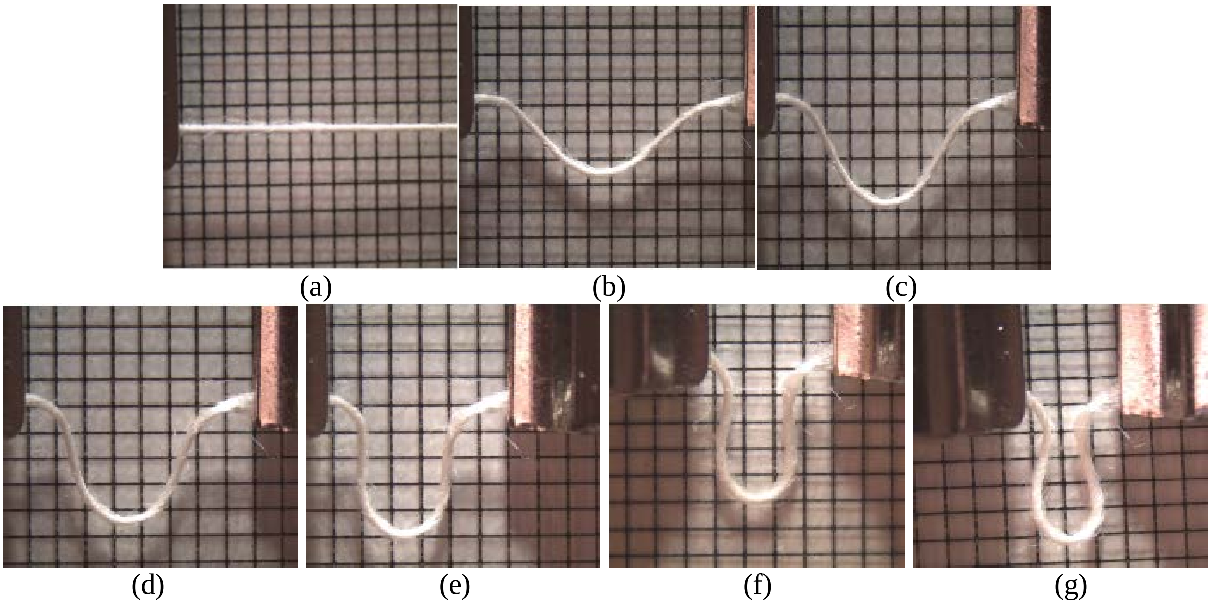

Figure 3. The loop pile formation steps.

The pile formation stages were simulated according to specified coordinates, as shown in Figure 4. As shown in the simulation, as the distance between the two jaws decreases, the height of the pile increases. As the jaws movement continues, the pile height remains constant after a certain point, and the tail section of the pile is formed.

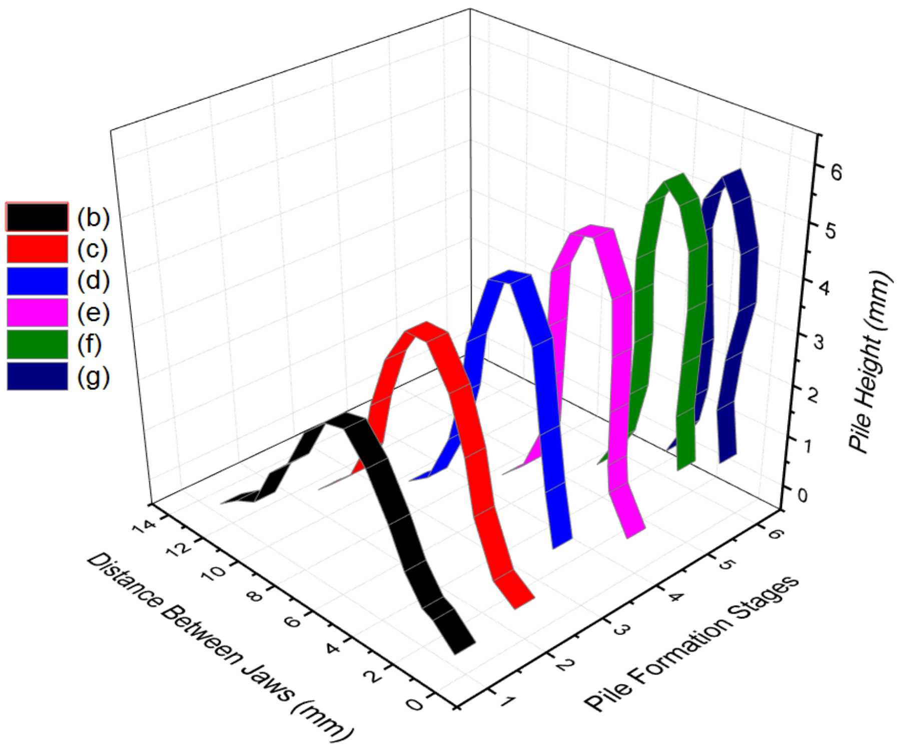

Figure 4. The simulation of the pile formation.

4. Conclusion

In this study, the simulation of terry pile formation stages has been developed on the basis of actual weaving process with respect to systematically produced terry woven samples. With this simulation method developed for the part of the research, pile formation is observed and recorded under microscope from the stretched state of pile thread to the pile form is obtained. The obtained forms are placed on the x and y coordinates, and pile formation graph is drawn. When the pile formation graph is examined, it is seen that the top part of the pile, where is the peak point, is formed according to the bending resistance of the yarn. After that, the lower folds of the pile are formed based on the force generated from jaws movement. This finding is important in terms of describing the pile formation in terry weaving, and this state may be related to the physical properties of the pile yarn.

Therefore, it will be useful to examine the effect of physical properties of the pile yarn on the pile formation with using this simulation. Besides, to investigate the relationships between pile yarn physical and mechanical properties and terry weaving process parameters comprehensively will be helpful for further studies.

It is known that, the manufacturing calculations of the terry woven fabric are made by trial empirical methods in the industry, in general. In this case, a lot of production, time and workforce waste occur. With this simulation method, desired pile form after weaving can be analyzed and planed on the computer, and the terry woven manufacturing calculations can be predicted before production.

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