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To Study the Bending Length, Drape & Crease Recovery Properties on Functional Finish Cloths

Awadhesh Kumar Choudhary[1], Satish Kumar[2], Abhimanyu Chhapola[3], Hardeep Singh[4], Harish Kumar[5], Neeraj Saini[6], Ramratan[7]
[1]Associate Professor, [2-6] Research Scholar, [7]Assistant Professor
[1-6] Department of Textile Technology, Dr. B R Ambedkar National Institute of Technology, Jalandhar, Punjab, India
[7]School of Design, Mody University of Science and Technology, Lakshmangarh, India

ABSTRACT
The handle or hand of the fabric is one of the most important characteristics of textiles for determining fabric quality. The handling attribute of a fabric, which describes how the fabric behaves while in contact with the skin, has an impact on how wearable the fabric is. The impact of fabric functional finishes on handling and crease characteristics is highly helpful for evaluating the performance of the garment. On cotton woven fabric, several functional finishes are applied, and their effects on the drape and bending, as well as the crease recovery capabilities of the fabric, are studied. The bending modulus, flexural rigidity, and bending length decrease with fragrance, stains release, dirt release, soft, antistatic, stain release, wrinkle-free, and soft - wrinkle-free finishes. The crease recovery as well as the stain release + wrinkle free and flame-retardant finish has increased. While the soil release, stiff, water repellent finish shows a decrease in crease recovery. For the soft, wrinkle-free, and soft + wrinkle-free finishes, a slight variation in crease recovery is seen. It has been noted that cotton textiles' drapability coefficient has increased, whereas the drapability coefficient of stiff, flame-retardant, water-repellent, and soil-release materials has significantly decreased.

Keyword: Woven Cloths, Bending length, Crease & Drape performance

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I. Introduction

Any dry or wet processing operation performed on the grey fabric is referred to as "finishing" in a more general sense. This includes singeing, cropping, desizing, mercerization, bleaching, dyeing, printing, and the final finishing [1]. But when viewed specifically, finishing refers to the processing steps intended to improve the fabric's aesthetic and practical qualities. For the domestic or international market, fabric finishing is of utmost importance. Finishing is a crucial stage in the manufacture of technical textiles, which have a sizable market today and significant future growth potential [2].

Fabrics are polished to improve their appeal, usefulness, and to add specific desirable features. The majority of fibres used in clothing lack beneficial qualities such high moisture recovery, static and pilling resistance, and stability in hot alkaline washings [3–4]. Cotton fibres have issues with dimensional stability and poor crease recovery. While having advantageous qualities like high strength, high elasticity, and thermosetting character, synthetic fibres also have disadvantages like low moisture regain, a propensity for pilling, and static buildup. Finishing treatments are applied to the fibres in order to reduce their drawbacks while preserving as much of their valuable features as feasible. Chemical finishing can be added to cellulosic fabrics and cellulosic-rich polyester blend fabrics. Chemicals are used to produce the required fabric property, according to its definition [5].

A solution or emulsion of the active chemical in water is referred to as a chemical finish. Finishes can be either durable or non-durable, depending on whether they are needed for short-term purposes or whether the completed textile is normally not washed or dry cleaned, such as with some technical fabrics [6]. Durable finishes withstand repeated launderings or dry cleanings without losing their effectiveness.

Although these finishes aim to enhance functional qualities, they may have a negative impact on some beneficial mechanical qualities like fabric bending characteristics. One of the most crucial characteristics of fabrics is their ability to

bend, which is especially true when they are likely to be exposed to outside elements for an extended period of time [7-8]. The use of finishes to enhance the handle qualities of fabrics is prioritised in the majority of practical situations. The flexibility of textile materials, however, is the key characteristic that sets them apart from other types of structures and enables them to be employed in a wide range of applications with exceptionally low bending rigidity, such as clothing [9–10]. Different textile end uses call for varying degrees of bending stiffness. Water repellent, stiff, wrinkle-free, aroma-resistant, flame-retardant, antistatic, antipilling, and combinations of stain release-wrinkle-free, water repellent-wrinkle-free, soft-wrinkle-free, and water repellent-flame retardant are some of the finishes applied to fabrics [11–12]. The research paper describes an experimental inquiry on the handling characteristics of the dyed, completed, and washed stages.

II. Material and methods

2.1. Material

JCT Mills Ltd. in Phagwara, India is where the fabrics were purchased. Following, in the order described below, is the processing of the cotton fabrics. There are four groupings formed from all of the fabric samples. It was investigated how fabrics finished with 14 different functional finishes affected their tearing strength and bending characteristics. After laundry, the tearing strength and bending characteristics of practical fabrics were also investigated. The characteristics of a fabric's construction after being coloured, finished, and washed. The numerous stages of dyed fabric production, from the initial grey stage to the finished product. The Osthoff Singe machine (Germany) desizes fabrics. In a continuous pretreatment range (PTR) machine (Benninger AG, Switzerland), desized fabrics are scoured and simultaneously bleached using the recipe provided below. Acetic acid is then used to neutralise the bleached fabrics. Following acetic acid neutralisation, the bleached fabrics are mercerized in Bendimenza (Benninger AG, Switzerland). Following neutralisation with acetic acid, the bleached fabrics are dyed using a combination of dyes in a continuous dyeing range machine (Benninger AG., Switzerland). The coloured fabrics are subsequently treated in a Stenter machine (T. Maniklal) with various functional finishes. The dyed samples are sanforized in a sanforizing machine throughout the continuous process. According to ASTM Standards (D13 1950), finished fabric samples are put through a laundering procedure in a home washing machine with twin tubs using a 0.5 Oft., solution of non-ionic detergent. The complete collection of specimens undergoes seven cycles of washing at a temperature of 45 °C, followed by daytime outdoor drying.

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2.1.1. Recipe for finishing of fabrics

Table 1. Level of concentration and water-repellent finish

S.no.	Water repellent finish	Concentration (gpl)
1.	Phovotex JVA	60
2.	Oleophobol CO	25
3.	Knitex FEL	30
4.	Sapanine KL	10
5.	iso-propyl alcohol	2

6.	Acetic acid	2

Table 2. Stiffness of completion and level of focus

S.no.	**Stiff finish**	**Concentration (gpl)**
1.	Apprantan E M	40
2.	Apprantan MBX	20
3.	Polyethylene	10
4.	Sirix N	1
5.	Acetic acid	2

Table 3. Level of concentration and wrinkle free finish

S.no.	**Wrinkle free finish**	**Concentration (gpl)**
1.	VLF finish	80
2.	MgCl2	20
3.	PE2	15
4.	Ceraperm MW	15
5.	Acetic acid	2

Table 4. Level of concentration and aroma finish

S.no.	**Aroma finish**	**Concentration (gpl)**
1.	Lexroma	15
2.	Cellbinder	5

Table 5. Level of concentration and strain release finish

S.no.	**Stain release finish**	**Concentration (gpl)**
1.	Oleophobol ZSR	60
2.	Ultraphil HSD	20
3.	Iso-propyl alcohol	10
4.	Sapamine KL	20
5.	Acetic acid	1

Table 6. Level of concentration and soil release finish

S.no.	**Soil release finish**	**Concentration (gpl)**
1.	Oleophobol ZSR	60
2.	Ultraphil HSD	40
3.	Knitex FEL	30
4.	MgC12	10
5.	Acetic acid	1

Table 7. Level of concentration and chemical softening finish

S.no.	**Chemical softening finish**	**Concentration (gpl)**
1.	Recosoft	10
2.	Ceraperm MW	8
3.	Ceranine	1
4.	Acetic acid	2

Table 8. Level of concentration and flame-retardant finish

S.no.	**Flame retardant finish**	**Concentration (gpl)**
1.	Pyrovatex CP	400
2.	Alcoprint PFL	30
3.	Knitex FEL	50
4.	Ultraphil DCW	40
5.	Sapamine KL	40

6.	Iso-propyl alcohol	15
7.	Phosphoric acid	25

Table 9. Level of concentration and stain release wrinkle free finish

S.no.	**Stain release - wrinkle free finish**	**Concentration (gpl)**
1.	Oleophobol ZSR	60
2.	Ultraphil HSD	20
3.	Sapamine KL	20
4.	Iso-propyl alcohol	10
5.	Oleophobol ZSR	60
6.	Ultraphil HSD	20
7.	Sapamine KL	20
8.	Iso-propyl alcohol	10
9.	Acetic acid	1
10.	Knitex FEL	40
11.	MgC12	13
12.	Megasoft Jet	10
13.	Acetic acid	1

Table 10. Level of concentration and water repellent wrinkle free finish

S.no.	**Water repellent - wrinkle free finish**	**Concentration (gpl)**
1.	Oleophobol CO	50
2.	Megasoft Jet	10
3.	Knitex FEL	30
4.	MgCl2	10
5.	Hydrophobol XAN	10
6.	Iso-propyl alcohol	10
7.	Acetic acid	1

Table 11. Level of concentration and wrinkle free- soft finish

S.no.	**Wrinkle free - soft finish**	**Concentration (gpl)**
1.	Finish VLF	40
2.	MgC12	8
3.	PE2	15
4.	Ceranine MW	15

Table 12. Level of concentration and flame retardant - water repellent finish

S.no.	**Flame retardant - water repellent finish**	**Concentration (gpl)**
	First step	
1.	Pyrovatex C P	400
2.	alcoprint PFL	30
3.	Knitex FEL	50
4.	Ultraphil DCW	40
5.	Sapamine K L	40
6.	Iso-propyl alcohol	15
7.	Phosphoric acid	25
	Second step	
8.	Phovotex JVA	60
9.	Oleophobol CO	30

10.	Knitex FEL	30
11.	Sapamine KL	10
12.	Iso-propyl alcohol	10
13.	Acetic acid	2
14.	Hydrophobol XAN	15

2.2. Methods

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2.2.1. Measurement of bending length

Samples are tested using the Shirley stiffness tester. In order to calculate the fabric's bending length, flexural rigidity, and bending modulus, a rectangular fabric strip measuring 25 cm by 2.5 cm is mounted on a horizontal platform in such a way that it overhangs like a cantilever and bends dovtimarth, 1 he overhangs length, l, and the angle * made by the free end of the fabric with the horizontal.

The length of a cloth when it bends under its own weight to a specific degree is known as the "bending length," or "C," of a fabric. C= I x f (*)

F (*) = [cos*/8tan*]1/3

Flexural rigidity, G is a measure of stiffness associated with handle.

$G=W^2 *C^3 *10$ 3mg/cm

here. W^2= cloth weight in grams per square centimeters

Flexural modulus. The term "intrinsic stiffness" refers to q. When comparing the stiffness of fabrics with various thicknesses, this value is used. = 1(12 6 1 0^{-4}) I g^2 kg $ical^2$

Where. g^2 = cloth thickness in cms

2.2.2. Crease Recovery: A fabric's look does not generally change for the better when it creases while being worn. The type of fibre used in a fabric's manufacturing has the biggest impact on how resistant it is to creasing.

Cellulosic textiles, such as cotton, viscose, and linen, have very poor resistance to creasing compared to wool and silk.

2.2.2.1. Shirley Crease Recovery test:

The instrument consists of a circular dial which carries the clamp for holding specimen

Procedure

- A knife edge and an index line for calculating the recovery angle are located directly beneath the dial's centre.
- The dial has an engraving of the instrument's scale.
- Using a template, a specimen measuring 2 inches long by 1 inch broad is cut from the fabric. Folding it in half, setting it between two glass plates, and adding 2 kg of weight causes it to carefully wrinkle.
- The specimen is transported to the fabric clamp on the device and given time to recover from the crease once the weight is removed after one minute.
- In order to maintain the specimen's free edge in alignment with the knife edge while it recovers, the instrument's dial is spun.
- The recovery angle in degrees is read from the engraved scale at the conclusion of the allotted recovery time, which is typically one minute.
- To suit certain cases, the load, creasing time, and recuperation time may be changed.

2.2.3. Drape tester

It is a fabric's capacity to create pleating folds when distorted by its own weight.

A fabric's drapeability is influenced by a number of variables, including stiffness, flexural rigidity, weight, thickness, etc. One of the key elements in defining a fabric's drape quality is its stiffness, which is a property of the fabric hand. For example, soft fabric will ripple closer to the body than stiff fabric will. The geometrical characteristics of the cloth determine the stiffness of the fabric itself.

Pprocedure

A fabric's degree of deformation when allowed to hang under its own weight is measured using a drape metre. It is a subjective performance trait of cloth that significantly enhances its aesthetic attractiveness. It is a complicated quality that can deform by both bending and shearing. One technique for assessing drape involves placing a sample of the fabric in the shape of a circle piece over a circular support, with an annular segment protruding over the support to show how the warp and weft weave features combine to generate an elegant fold. To determine the drape co-efficient, the horizontal area covered by the shadow cast by the fabric's overhang is measured and contrasted with its actual area.

III. Result and discussion

Finish's impact on cloth bending behaviour

The bending characteristics of fabrics can be impacted by the various functional finishes. An inherent quality of the material that results from flexural rigidity is the bending modulus. On the other side, bending length is used to calculate

flexural stiffness values. Fabric handle is related to fabric flexural rigidity, but fabric drying quality is determined by bending length. The impact of finishing treatment on bending modulus has been explored in the next section, followed by discussions of the impact on flexural rigidity and bending length. Figures 1 to 3 show the bending characteristics of dyed, finished, and washed fabrics.

Finish's impact on bending modulus

Figure show that the bending modulus increases for finishes that are water repellent, stiff, wrinkle-free, flame retardant, water repellent-flame retardant, and water repellent-flame retardant, whereas bending modulus decreases for all other finishes. While soft finishes significantly reduce bending modulus, stiff finishes significantly increase them. Water repellent finishing chemicals polymerize and create a hard, brittle surface film on the fibre material, which can be the cause of the increase in fabric stiffness in the case of a water repellent finish. The use of high molecular weight film forming polymers and cross-linked stiffening agents that coat fibre assemblies, on the other hand, results in stiff finish, which increases the bending stiffness. Due to the surface coating, the constituent yarn stiffens. The degree of adhesion will be greater in the points where the yarns cross over. Although in wrinkle-free finishes the fabric's rigidity typically increases due to resin penetration into the yarn and cross-linking, it is observed that the use of textile softeners, which lubricate the surface of the fibres, slightly alters the bending modulus. Furthermore, it has been found that fabrics with flame retardant compositions have a stiffer hand. The handle, drape, and look of fabric can be negatively impacted by high application levels of flame retardants. When a finish is soft, lubricants and softeners are used to provide a smooth surface, which lowers the bending modulus.

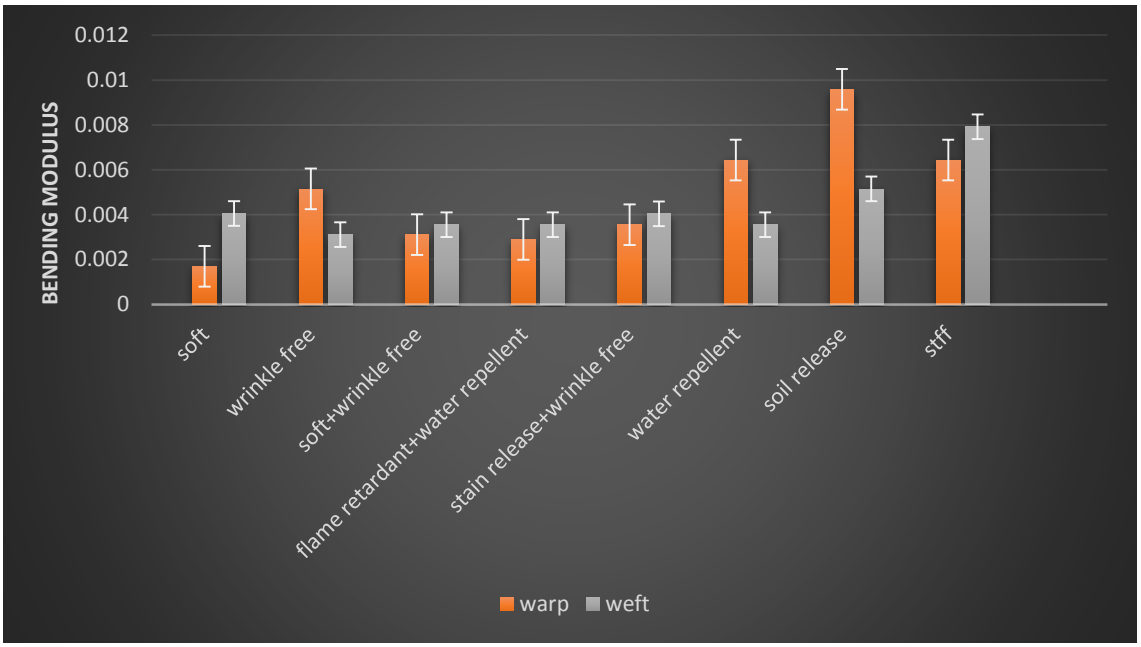

Figure 1. Bending modulus properties for the woven fabrics

Effect of weft/warp direction

In cotton fabrics, warp-wise bending modulus changes are seen to be greater than weft-wise bending modulus changes. The reason for this is that the warp is more dense than the weft.

Finish's impact on flexural stiffness

Figure 5 shows that for cotton fabrics, the stiff and flame-retardant finishes increase the flexural rigidity, whereas the aroma, soil release, stain release, soft, stain release - wrinkle free, and soft - wrinkle free finishes decrease the flexural rigidity. In the case of a water wrinkle-free finish, a slight modification in flexural rigidity is seen. With water repellent, wrinkle-free, water-repellent-wrinkle-free, and water-repellent-flame-retardant finishes, a slight change in flexural rigidity is seen. The bending modulus and thickness of the fabric have an impact on flexural stiffness. It is scheduled to end. It is a result of the fabric's altered thickness following the finish application. The flexural stiffness increases as the bending modulus and cloth thickness both rises. However, a reduction in flexural rigidity may result from a reduction in bending modulus.

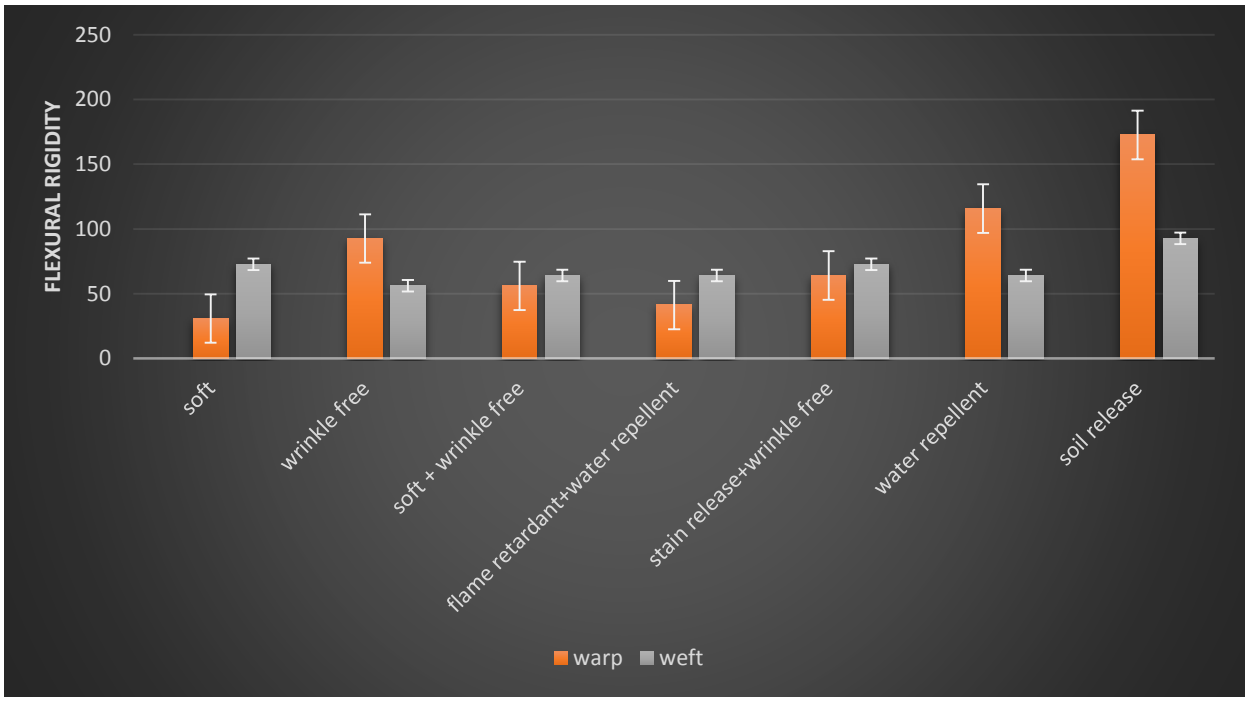

Figure 2. Flexural rigidity properties for the woven fabrics

Finish's impact on bending length

Figure 3 shows that the bending length decreases for finishes with scent, stain release, soil release, softness, stain release, wrinkle free, and soft + wrinkle free characteristics. An increase in bending length is shown when the finish is water resistant, stiff, wrinkle-free, flame retardant, and water repellent-flame retardant. Fabric weight and flexural rigidity have an impact on bending length. The bending length decreases as cloth weight (in grammes per square cm) increases during finishing. The relative movement of the yarns results in high inter-yarn friction, which shortens the bending length. If flexural rigidity increases while the weight changes just slightly, the length of the bend may also lengthen.

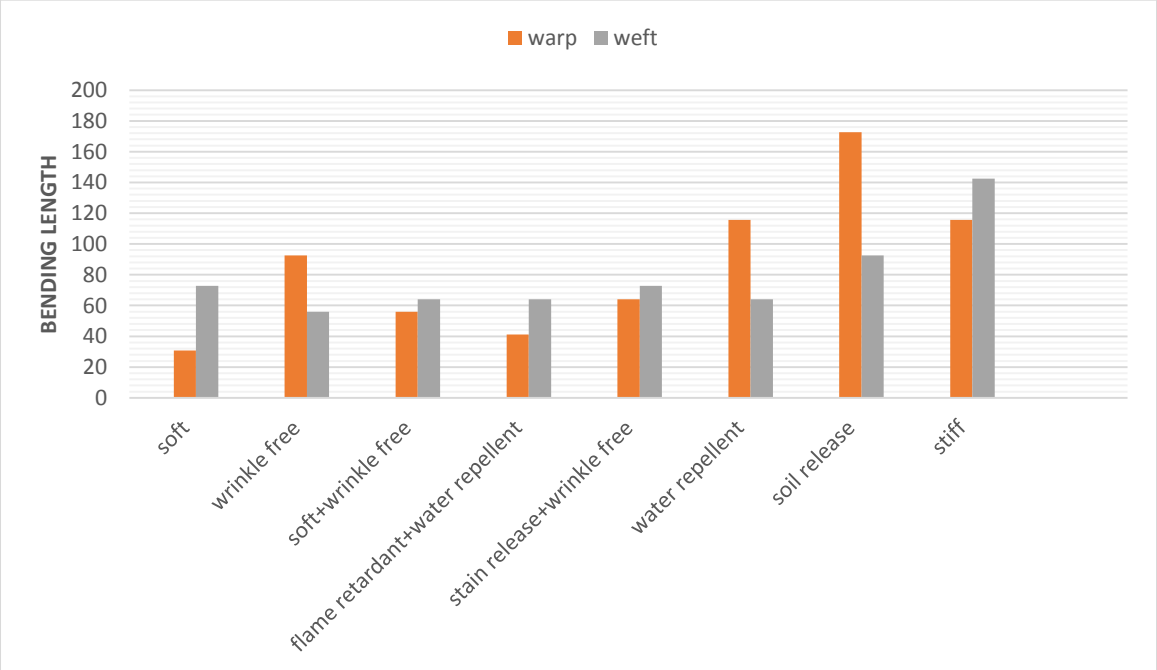

Figure 3. Bending length properties for the woven fabrics

Effect on Drapability
Performance finishing

Figure 4 show that for cotton fabrics with stiff and flame retardant, water repellent, and soil release finishes, the drapability coefficient increases, whereas soft, soft + wrinkle free, wrinkle free + stain release finishes show a decrease in the drapability coefficient. In the event of a wrinkle-free finish, a slight modification in the drapability coefficient is seen. Fabric bending modulus and thickness have an impact on drapability coefficient. It is scheduled to end. It is a result of the fabric's altered thickness following the finish application. The drapability coefficient decreases with increasing bending modulus and fabric thickness. However, a rise in drapability coefficient may result from a decline in bending modulus.

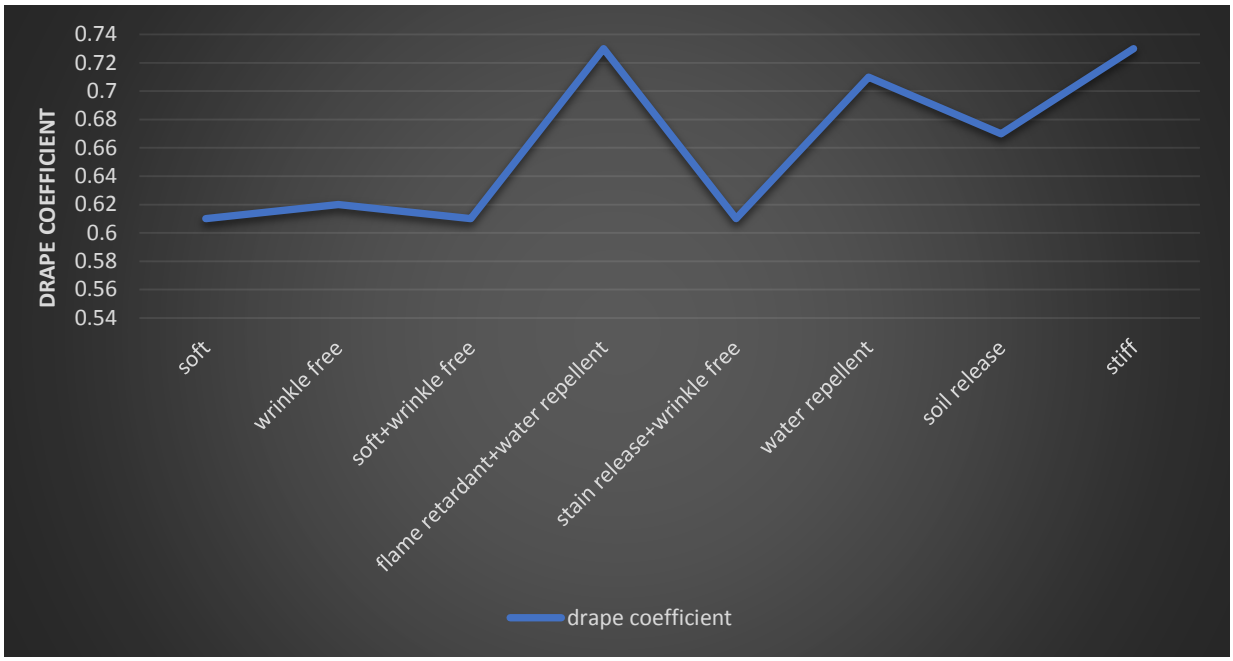

Figure 4. Drape coefficient properties for the woven fabrics

Effect on crease recovery
Performance of finishing

Figure 5 show that there is an increase in crease recovery when cotton fabrics have a stain-release, wrinkle-free, and flame-retardant treatment. whereas soil release, stiff, water repellent finishes show a decrease in the crease recovery. In the case of a soft, wrinkle-free, and soft + wrinkle-free finish, a slight variation in crease recovery is seen.

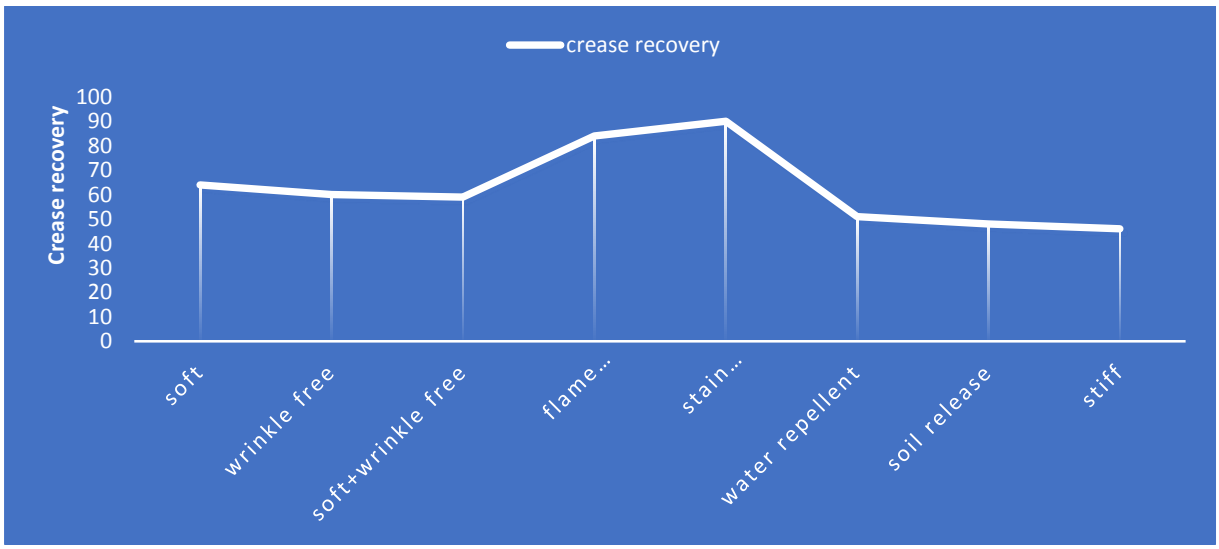

Figure 5. Crease recovery properties for the woven fabrics

IV. Conclusions

One of the most crucial aspects of textiles for evaluating fabric quality is the handle or hand of the fabric. The wearability of a fabric is influenced by the fabric's handling property, which explains how the fabric performs while in contact with the skin. The following results have been reached based on research of the effects of functional finishes on the cloth handle and bending properties:

- That soft fabric is more easily bendable in the warp direction than dirt release finish fabric. While wrinkle-free fabric is easily bendable in the weft direction, stiff finished fabric has the highest bending resistance.
- Drapability: A stiffer fabric has a higher drapability coefficient, and when working with samples, the combination of a stiff fabric and a flame- and water-repellent coating has the highest drapability (i.e., 0.73). Soft finishes have the least amount of draping ability (0.61).
- The maximum (80 to 90 range) crease recovery-crease recovery angle is found when wrinkle free and stain release are combined.
- In general, the findings showed that cloth had excellent drapeability, crease recovery, and bending length qualities.

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