

## EXAMINING THE CAPABILITY AND CHARACTERISTICS OF TWILL WEAVE FABRIC WITH DIFFERENT WEAVING MANUFACTURING

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### Abstract

This examination was carried out to advance the fabric structure for the array regarding the capability and properties of fabric woven on a sword carry-less weaving machine by utilizing twofold yarn with twill weave patterns. Add up to seven unique sorts of weaves viz. plain, 2/2 matt, twist rib, 3/1 twill, herringbone twill, satin, and crepe were concentrated to research the solace and different properties. Cotton yarn was utilized as a part of the twist for all weaves. Cotton, polyester/cotton, and bed-look polyester yarn was utilized as a part of the weft to research the impact of weft material on fabric properties. Completing therapeutics like burning, desizing, mercerizing, fading and pitch completing were done on the fabric. All the fabric examples in the dark and in a completed state were tried in standard climatic conditions for capability attributes. Subsequent to testing acquired outcomes were dissected utilizing Minitab factual programming. It was discovered that a list of interlacements assumes an imperative part in changing fabric properties. Completed plain weave fabric with P/C mixed weft will offer ideal execution regarding the durability and serviceability of the array.

**Keywords:** Capability, Twill Weave, therapeutics, and Polyester/Cotton mixed.

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### Introduction

Fabrics are a vital piece of human life. The essential part of the attire is to frame a layer or layers of obstructions that ensure the body against unacceptable physical conditions. This insurance of the body satisfies a number of capacities, such as keeping up the correct warm condition to the body, which is basic for its survival, and keeping the body from being harmed by scraped spots, radiation, wind, power, concoction, and

microbiological substances. Nassi (2012) stated that, elements of attire unmistakably demonstrate that it assumes a critical part at the interface between the human body and it is encompassing in deciding the subjective impression of the solace status of a wearer. Today, clothing fabrics are relied upon to meet all prerequisites identified with comfort, and medicinal services and handle simple care properties, and in addition execution. This has driven analysts to grow new

materials to furnish fashioners with cutting-edge devices for their particular plans. The present pattern in the industry is towards enhanced wear comfort. Various reports have demonstrated that the greater part of the questions gotten by the technologist from the purchasers are connected somehow, to the solace parts of the substrates and thus normal intentions are traveling toward assist enhancements.

According to Anderson (2007), numerous specialists are growing new crude materials that improve the capability of fabric. Woven textiles are intended to meet the necessities of their end users. Their quality, thickness, extensibility, porosity, and durability can be differed and rely on the weave utilized, the string dispersing, that is the number of strings per centimeter, and the crude materials, structure (fiber or staple), direct thickness and curve components of the twist and weft yarns. From woven fabrics, higher qualities, and more prominent strength can be gotten than from whatever other fabric structure utilizing interweave yarns. Structures can likewise fluctuate to create fabrics with broadly extraordinary properties in the twist and weft headings. The property of any fabric created relies on the constituent strands of

material, yarns, and the fabric structure and how every one of these variables collaborates with each other. A definitive point of any clothing fabric is to fulfill the wearer and make him feel great (Hulle 2014). Consequently, with regard to the above, it is worth examining the solace properties of various woven fabrics. This investigation focuses on the various comfort, and characteristics of different woven structures, woven using double yarn with twill weave patterns, and a shuttleless weaving machine. A total of 7 different types of weaves viz. plain, 2/2 matt, warp rib, 3/1 twill, herringbone twill, satin, and crepe were studied to investigate the comfort and other properties. Cotton yarn was used in warp for all the effects of weft material on fabric properties. Finishing treatments like singeing, de-sizing, mercerizing, bleaching, and resin finishing were carried out on the fabric. All the fabric specimens in grey as well as in finished condition were tested in standard atmospheric conditions for properties like crease recovery, abrasion resistance, and tearing strength. After the testing was obtained, results were analyzed using Minitab statistical software.

## Materials

### Warp and Weft Yarns

100% cotton yarn was used as warp for all the fabric specimens and the same yarn was used as one of the weft. 100% cotton (same yarn that was used in warp), 80:20 blended cotton/polyester, and 120 denier cot look polyester multifilament yarn was used in the weft. Raymond Zambaiti LTD. Kagal provided 100% cotton and P/C blended yarn and cot-look polyester yarn was procured from Reliance, Ichalkaranji. All weft yarns were selected such that their linear density is nearly equal. Characteristics of these yarns were tabulated in Table 1.

## Methods

## Chemicals

Chemicals like Alpha amylase enzyme, wetting agent, sequestering agent, and deformer were used for the de-sizing of fabric. NaOH was used for mercerization. H<sub>2</sub>O<sub>2</sub>, peroxide stabilizer, and soda ash were used for the bleaching process and Saralink ULF Resin, Acetic Acid, Extra soft Silicon softener, Expocil CEL Antislipping agent, Macl<sub>2</sub>, Sarasoft EP Tear improver, and JET-B Wetting agent were used for finishing treatment of fabric. Raymond Zambaiti LTD. Kagal provided all these chemicals.

S/no	Yarn Characteristics	Cotton	Cotton/Polyester	Polyester
1.	Count (Ne)	42.14	42.3	44.29(120D)
2.	Tensile Strength (g/tex)	16.82	24.65	26.37
3.	Elongation (%)	3.45	7.57	14.95
4.	Hairiness Index	3.1	4.54	-
5.	Unevenness (U%)	7.63	10.82	-
6.	Twist per Inch	27.2	22.3	-

**Table 1:** Characteristics of Yarn

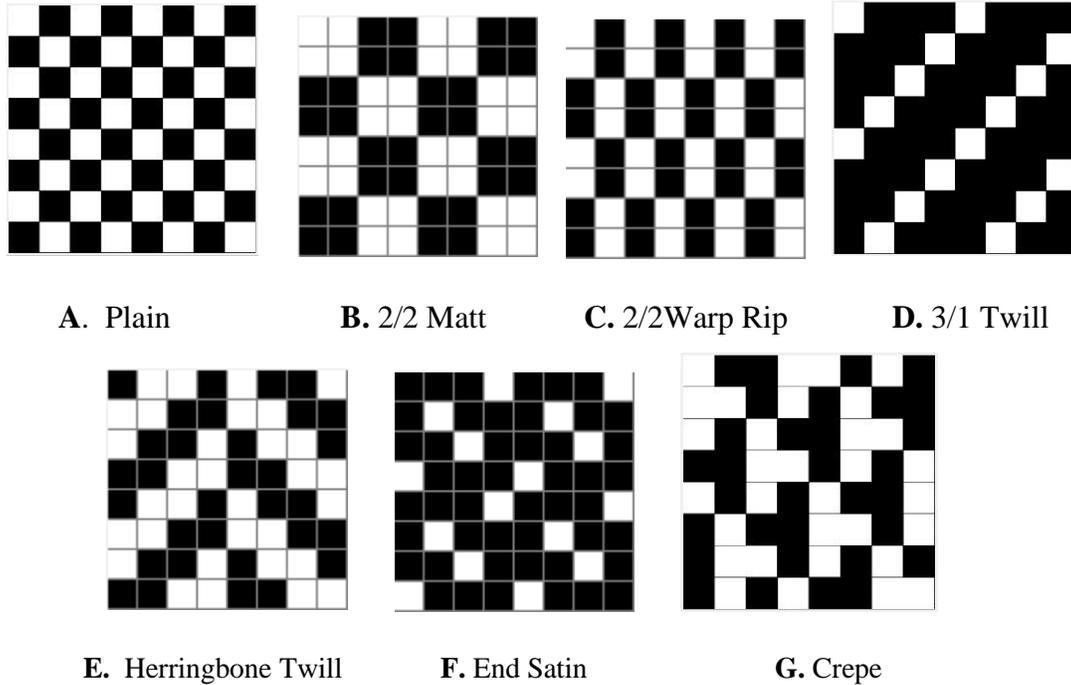
As mentioned earlier 100% Raymond Zambaiti LTD. Kagal provided cotton and P/C

weaves. Cotton, polyester/cotton, and cot-look polyester yarn were used in the weft to investigate blended yarn and cot-look polyester yarn was procured from Reliance, Ichalkaranji. All these yarns were double yarns. After procurement, all yarns were tested for different properties such as linear density (count), single yarn strength, hairiness, unevenness, and level of twist. After testing, fabric with double yarn in warp and weft and ends/picks having a 2:1 set ratio was manufactured on a shuttle-less weaving machine with different weaves. The gray fabric was processed and finished. Testing of gray as well as finished fabric was carried out to find out different fabric properties.

### **Fabric Manufacturing**

Weaver's beams were prepared on Suzuki 4 NAS-M6 warping machine running at 800 mpm. After getting weavers beam, fabric samples with double yarn in warp and weft having 2:1 set ratio i.e. 120 ends and 60 picks

were manufactured on the Sliver Vamatex rapier weaving machine. The variable factors were fabric weave and weft yarn. Fabrics with seven different types of weaves were woven on the rapier weaving machine. Weaves include the basic weaves like plain, 3/1 twill, and satin along with their derivatives like 2/2 matt, warp rib, herringbone twill, and crepe. Fig. 1 depicts the different fabric structures, which were woven. The 100% cotton yarn was used in the warp for all the fabric specimens. 100% cotton yarn, 80:20 blended cotton/polyester yarn and cot-look polyester multifilament yarn were used as weft for all the weaves. Each weave was woven using all three types of weft yarns separately. With every possible combination, 21 fabric specimens were manufactured. After manufacturing the fabrics, finishing treatment was given. In brief, the finishing treatment was explained in the following points. All the grey, as well as finished fabric specimens, were characterized for different properties. All the fabric samples were manufactured in M/S Raymond Zambaiti LTD. Kagal.



**Figure 1:** Structural Woven Patterns.  
*Source: Rishante P. S.*

### Fabric Processing

After manufacturing the fabric with all possible combinations. All the manufactured fabric samples were subjected to finishing treatments like singeing, mercerizing, bleaching, and resin finishing. Singeing was done by gas singeing method at 80 m/min with 12 bar flame intensity. After singeing, scouring of fabric was carried out. Scoured and dried samples were mercerized using NaOH under tension and 5-6 hot as well as cold wash was given and fabric rolls were kept rotating to achieve uniform

mercerization. Peroxide bleaching was carried out on mercerized fabric at 85°C for four hours and a resin finish was applied. Resin finishing was carried out by the Pad-Dry-Cure method using a stenter at 60 m/min speed. The finishing temperature was set to 140°C while padding dry-cure. Details of bleaching and finishing were reported.

### Testing

#### Strip Strength

The raveled strip tensile strength test of fabric was carried out according to ASTM D5035-

11 on Instron- 5565. Following a suitable sampling technique, warp and weft strips were cut using the given template. Strings from both sides of the fabric strip were raveled to get a piece of precisely 5 cm in width. At that point, raveled strip was tried on Instron pliable testing machine with 20 cm gage length and at 300 mm/min test speed.

### **Tearing Strength**

The tearing quality of the fabric was tried on a falling pendulum sort Elmendorf tearing quality

analyzer as indicated by ASTM D1424-09 standard test strategy. Constrain required to spread a tear beginning from a cut in a woven fabric was measured by getting a handle on fabric (300×60 mm in measurements) with a mobile clip on one side, and by a settled brace on the opposite side, with the fabric split focused between the two cinches. At that point, as the pendulum was discharged, the example was torn at the part. The tearing power, in grams, was perused specifically off the graduated scale on the pendulum.

### **Abrasion Resistance**

The abrasion resistance of fabric was assessed utilizing Martindale's abrasion resistance analyzer and tried by ASTM

D4966. A round fabric example of 38 mm measurement was rubbed on zero number ordinary clean paper by the multidirectional development of the example holder against the grating surface. Every example was stacked consistently for appropriate rubbing activity. A weight of 9 Kpa was connected to every example.

### **Crease Recovery**

Wrinkle recuperation of fabric was tried on Shirley wrinkle recuperation analyzer as indicated by IS6359. In this test, the examples of measurement 40 mm × 15 mm product collapsed in two, the finishes being held by tweezers. A large portion of the examples were collapsed up close and personal and half of them were consecutive. The examples were then set under a 10 N stack for 5 min. The following 5 minutes example was kept for unwinding (recuperation) in emptied condition for 5 minutes and after that quickly exchanged to the example holder of the measuring instrument. One leg of the example was embedded similar to the stopping board of the example holder and another end was free and permitted to fall under its own particular weight. The instrument was balanced constantly to keep the free appendage of the

example vertical. The wrinkle recuperation point was measured, by perusing the scale when the free appendage was vertical. The higher the wrinkle recuperation point higher will be the wrinkle recuperation of the fabric.

## **Result and Discussion**

### **Tensile Properties**

The tensile behavior of woven fabrics is known to be influenced by their sett and development (Jeon et.al. 2003). In this examination, malleable properties of woven fabrics were portrayed by fabric breaking burden and prolongation.

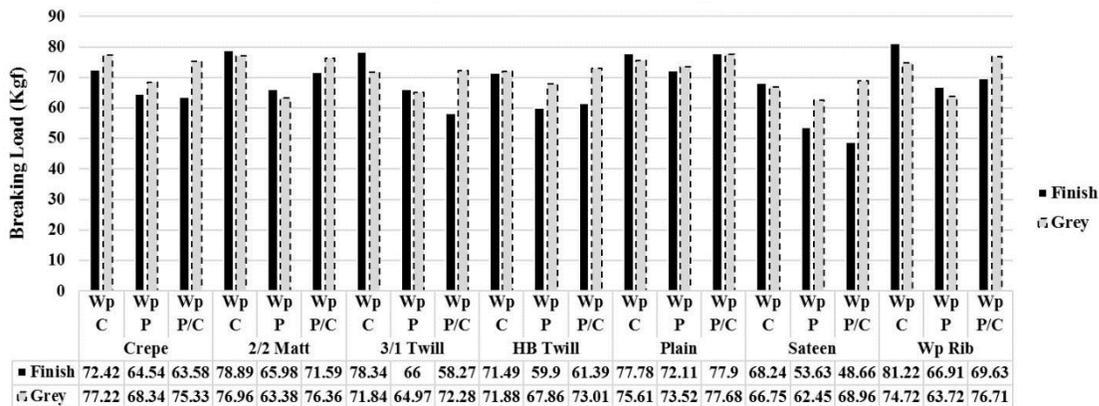
### **Strip Strength**

Tensile strength has been acknowledged as a standout among the most vital qualities of woven textiles. Tensile strength is characterized as a most extreme load that a test example will continue when subjected to uniaxial tensile stacking. Nassi (2021) noted that, the strength of a fabric depends on the strength of constituent yarns, as well as on the yarn and fabric structure and numerous different components. The elements, which have an impact on the tensile strength of fabric other than yarn strength, are yarn material, yarn fineness, number of finishes and picks per unit length, and weave plan.

The impact of weave, weft sort, and compound process on warp and weft way strip strength of fabric as shown in fig. 2 and fig. 3 separately. It can be plainly construed frame Fig. 2 and Fig. 3 that weave structure profoundly affects fabric breaking load. In all cases, plain structure and its subsidiaries demonstrated the most noteworthy breaking load taken after by fabrics with crepe, twill weaves, and satin weaves separately. Satin weave set its position at the base of the rundown of tensile strength. At the point when the fabric is extended in, one course i.e. at the point when fabric was subjected to a uniaxial stack, at first the pleat toward that path decays. Fabric is generally simple to extend amid crease measurement. From that point onward, the yarn material starts bearing the heap that would trim down the expansion of the fabric. Henceforth, the more pleat in the fabric, the higher will be the fabric's strength. Having a higher record of interlacement and lower coasts, plain weave fabrics are more tightly and minimized, having the most extreme crease which is the principal explanation for the high tensile strength of plain weave fabrics. The yarns are not held immovably in twill, crepe, and satin weave structures as in the plain weave. The tensile strength of satin fabrics is minor than

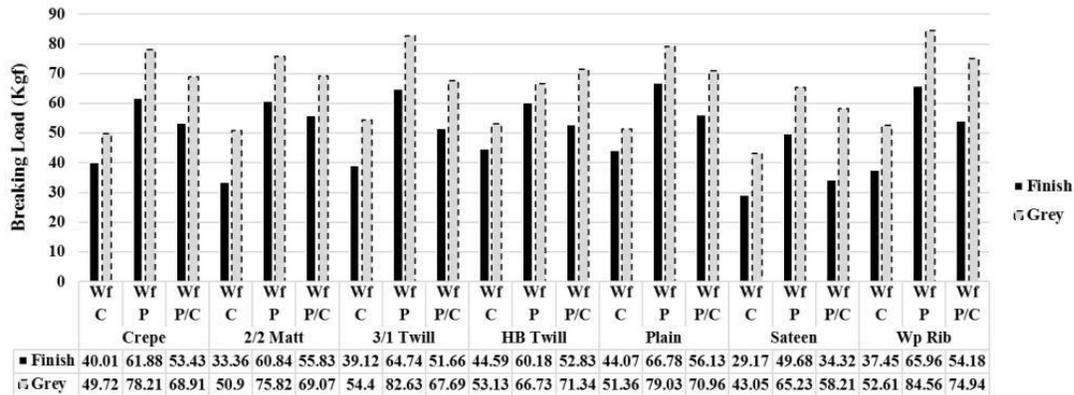
crepe and twill weave, this is principally because of bigger buoys in the weave structures. Kaynak (2008), noted that; polyester weft fabrics are having a most noteworthy tensile strength in contrast with cotton and cotton/polyester fabrics. This is on account of the characteristic strength of polyester multifilament yarn being higher than that of cotton and P/C mixed yarns. However, if there should be an occurrence of polyester weft, in all different cases, the warp path strength of fabric was observed to be

more than that of weft way strength. As 2.1 was kept setting the ratio of warp and weft, in the fabric development the nearness of closures is more than the picks. So more load-bearing segment was available in warp heading. Consequently, fabric strength in warp course is more than that of weft bearing. In any case, the strength of polyester and P/C mixed weft is higher than that of cotton warp. Thus, weft way strength must be more prominent yet the impact of denser warp is more unmistakable for the situation.



**Figure 2:** Effect on warp way strip strength

*Source: Rishante P.S*



**Figure 3:** Effect on weft way strip strength

*Source: Rishante P.S*

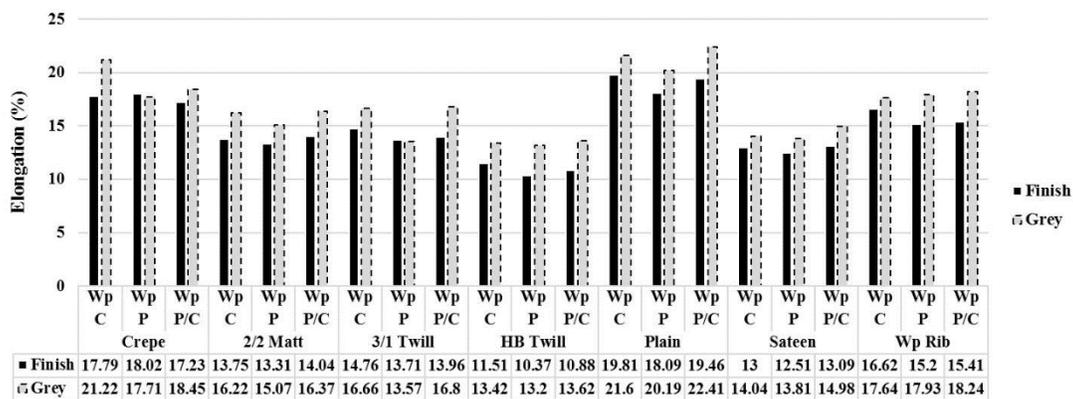
**Elongation**

Extensibility alludes to the degree to which a fabric will increase in length under pressure. Diverse weaves have distinctive degrees of extensibility. The measure of pleat inside the fabric development assumes a part in deciding the extensibility of a fabric. At the point when the uniaxial stack was connected to the fabric, the fabric begins de-pleating first. Fabric is generally simple to extend/stretch in its pleat measurement. From that point forward, the yarn material starts bearing the heap that would stop the expansion of the fabric. The higher the number of interlacements per unit zone, the lower will be the buoys, and the more noteworthy will be the crease. Likewise, higher pleat prompts higher prolongation. As

a rule, the more drawn out the buoys inside the development the less extensible the fabric will be. A plain weave has the best number of interweaving focuses and most minimal buoys in a given region, and in this way has the most elevated level of the crease. Consequently, fabrics with plain weave structures are related to higher breaking lengthening taken after by crepe, twill weave, and glossy silk weave individually (Hulle 2014). A similar pattern was found in all cases. From Fig. 4 and Fig. 5, it can be obviously observed that in a large portion of the cases, polyester weft fabrics have the most noteworthy breaking stretching taken after mixed weft. Fabric with cotton weft indicates most minimal stretching esteems. The higher stretching of polyester weft

fabrics can be attributed to the higher lengthening of polyester multifilament weft. The intrinsic prolongation of cotton weft was lower than that of polyester and mixed weft. Subsequently, their fabrics have demonstrated lower breaking stretching. The breaking expansion of fabric up weft bearing was more in all cases than that of warp course. This is on the grounds that the polyester and P/C mixed weft yarns have fundamentally higher breaking prolongation

than that of cotton warp. Preparing treatment increases the breaking prolongation of fabric. Pollutions like earth, wax, and so forth were expelled from fabric in the wake of completing treatment. Which increases the portability of strands and yarns in fabric structure. Which might be the purpose for the increased augmentation of completed products. Notwithstanding, this impact is not noteworthy.



**Figure 4:** Effect of warp way elongation

*Source: Rishante P.S*

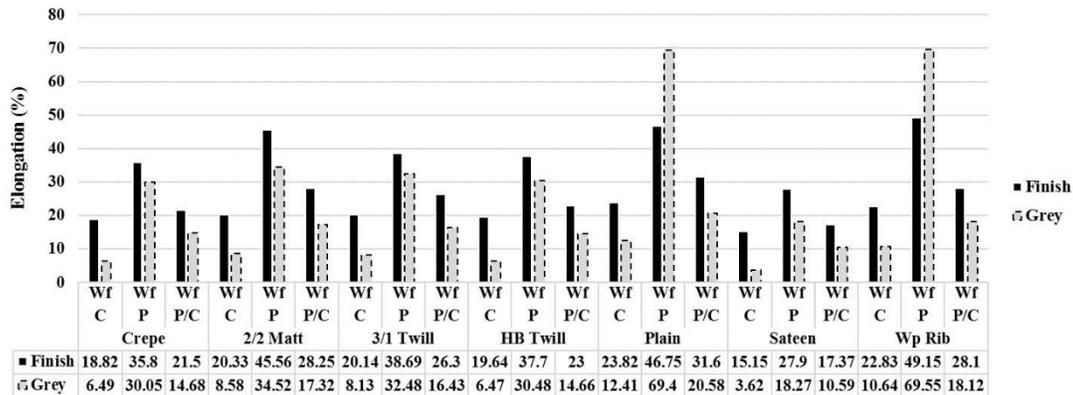


Figure 5: Effect of weft way elongation

Source: Rishante P.S

**Tearing Strength**

Tearing is a standout among the most well-known sorts of disappointment in textile fabrics and decides the durability of fabrics. The tear resistance is the strength parameter, which portrays the textile item for its imperviousness to external mechanical powers. The impact of weave sort, weft sort, and compound preparing on warp way and weft way tearing strength of the fabric was as appeared in fig. 6 and fig. 7 separately. The simplicity with which a fabric tear is reliant on two factors: the measure of yarn slippage or versatility of the yarns inside the fabric development and the number of yarns, which will bear the heap.

These two factors are dictated by the record of interlacement. The more noteworthy versatility or the straightforwardness with which the yarns can move, the harder it is to tear the fabric. The higher the record of interlacements, the lower will be the buoys and the lower strength of the fabric. What's more, silicone conditioners give better tear strength to the fabric. In the vast majority of cases, tearing strength will be the portability of yarns, which prompts bring down the tearing strength of the fabric. Higher tearing strength was related to satin weaves taken after by twill, crepe, and plain weaves individually. Celik et.al (2010) observe that, higher tearing strength of satin weaves might be identified with the more drawn-out pads in

this kind of fabric, which make yarns to be free of tearing burden. Out of every one of the weaves under examination, a plain weave will tear the least demanding.

A plain weave is a tight development having a minimal measure of inside slippage or yarn portability. What's more, just a single yarn bears the heap when the fabric is torn. Satin and herringbone fabrics have looser development. The looser development will be harder to tear since it will take into consideration more inward versatility or yarn slippage. The tearing strength of polyester weft fabrics was observed to be higher, trailed by P/C mixed weft and cotton weft fabrics. The purpose for the higher tearing strength of polyester fabrics might be related

to the higher tensile strength of polyester weft. Free of weave sort, weft, and handling, tearing strength in warp bearing was essentially higher than that of in weft course. This is a direct result of the 2:1 setting ratio of warp and weft. In a given region number of finishes are more than the number of pics consequently more prominent the number of yarns will bear the heap in warp heading, and subsequently it is harder to tear the fabric in warp course. It was discovered that the substance preparation had a constructive outcome on the tearing strength of the fabric. The activity of the Sarasoft EP tear improver utilized while completing the treatment of the fabric enhanced the tearing of the completed fabric was essentially higher than that of dim fabric.

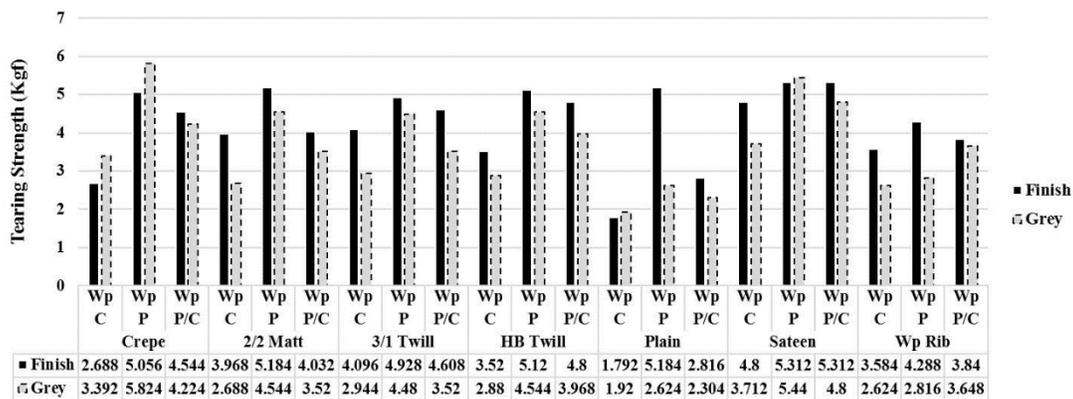


Figure 6: Effect of warp tearing strength

Source: Rishante P.S

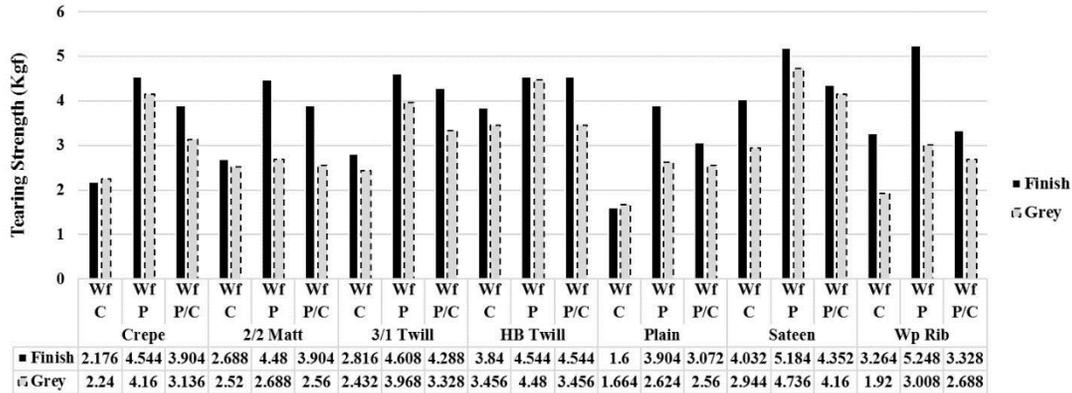


Figure 7: Effect of weft way tearing strength

Source: Rishante P.S

**Abrasion Resistance**

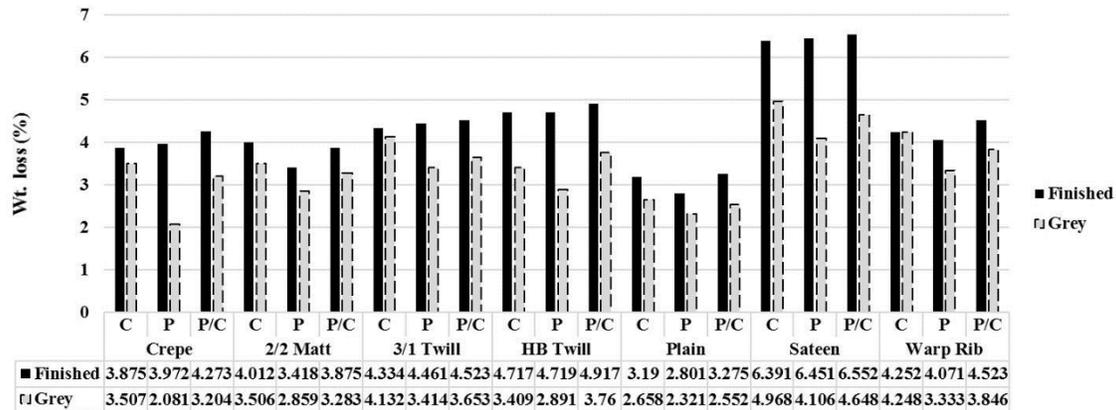
Abrasion is the mechanical deterioration of fabric parts by rubbing them against another surface. Abrasion ultimately brings about the loss of execution attributes, for example, strength additionally influences the presence of a fabric. The abrasion resistance of textile materials is affected by numerous factors like fiber fineness, yarn number, yarn sort, weave, and so on (Adamiak 2012). In this examination, abrasion resistance of the woven fabric tests was assessed by the rate of fabric weight reduction. The lower the weight reduction of the fabric after the test, the more prominent the abrasion resistance of

the fabrics. Weave sort significantly affects the abrasion resistance of the fabrics. On the off chance that one arrangement of yarns is overwhelmingly at first glance, at that point this set will wear most. Long yarn coats and a low number of interlacements cause ceaseless contact with scraping surfaces. This encourages the yarn to lose its frame all the more effectively by giving simpler development in light of the rubbing movement. The longer the buoys, the higher will be the abrasion. So long, glides in a weave, for example, satin structures are more uncovered and rub quicker, for the most part, causing breaking of the yarns and expanding

the mass misfortune. In the event of long buoys, upon abrasion, holding the filaments in the yarn structure ends up noticeably harder and the expulsion of fiber ends up noticeably less demanding. In any case, the fabrics that have brought down buoys, for example, level plain weave fabrics have preferable abrasion resistance over different weaves in light of the fact that the yarns are all the more firmly secured structure and the wear is spread all the more equally over the majority of the yarns in the fabric. After satin weave herringbone twill has, higher buoys taken after by 3/1 twill, crepe, matt, and warp rib. Subsequently, the diminishing pattern of abrasion resistance as far as the weave is: plain, warp rib, 2/2 matt, crepe, 3/1 twill, herringbone twill, and satin. A similar pattern was seen in all cases. Weft sort likewise significantly affects the rough conduct of the fabric.

Cotton yarns are more inclined to rough wear and bristliness cotton yarn has a negative impact on the grating conduct of fabric.

Because of shagginess, fabric has a more prominent propensity of pilling and along these lines weight reduction. Fabric woven with polyester weft has the most noteworthy abrasion resistance. Being a multifilament yarn, polyester yarn can endure more rough wear and because of nonattendance or hairs on yarn structure, there are fewer odds of fiber misfortune. P/C mixed weft fabrics indicate direct abrasion resistance. From Fig. 8, it can be surmised that in all cases, dim fabrics have higher abrasion resistance contrasted with completed fabrics with similar development. Silicone conditioner treatment causes a decrease in the abrasion resistance of the fabrics. It is the plausible after-effect of fiber portability inside the fabric, which is increased by silicone conditioner. Additionally, as a result of the cross-linking instrument while sap completing, the abrasion resistance of fabric decreases



**Figure 8:** Effect on Abrasion Resistance

*Source: Rishante P.S*

## Conclusions

1. Index of interlacement plays a vital role in changing fabric properties.
2. Fabrics with the highest index of interlacement like plain and plain weave derivatives have better abrasion resistance and tensile properties.
3. Fabrics with a lower index of interlacement like satin, and herringbone twill result in loose fabric structures that have high tearing strength and wrinkle resistance.
4. Due to the 2:1 setting ratio tensile and tearing strength polyester is higher in warp direction.

5. Twill and crepe weaves have shown temperate properties in all cases.
6. Polyester weft fabrics have better durability and serviceability characteristics.
7. Cotton yarns are more prone to abrasive wear due to protruding hairs on the yarn surface.
8. Finishing treatment softens the fabric, and improves fabric crease recovery.
9. Finished plain weave fabric with P/C blended weft will offer optimal performance in connection with the durability and serviceability of apparel.

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