RESEARCH

DURABILITY AND SERVICEABILITY CHARACTERISTICS OF FABRIC HAVING DIFFERENT WEAVES MANUFACTURED BY 2:1 SETTING RATIO

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1. Introduction

Dress is a vital piece of human life. The essential part of attire is to frame a layer or layers of obstructions that ensure the body against unacceptable physical conditions. This insurance of body satisfies 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 spot, radiation, wind, power, concoction and microbiological substances. These generally ordered elements of attire unmistakably demonstrate that it assumes a critical part at the interface between human body and it's encompassing in deciding the subjective impression of solace status of a wearer. Today clothing fabrics are relied upon to meet all prerequisites identified with comfort, medicinal services and handle and 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 plan. The present pattern in 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 in somehow, to the solace parts of the substrates and thus normal intentions are traveling toward assist enhancements. Numerous specialists are growing new crude material which improve the durability and serviceability of fabric.

Woven textiles are intended to meet the necessities of their end utilize. Their quality, thickness, extensibility, porosity and durability can be differed and rely on upon the weave utilized, the string dispersing, that is the quantity 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 interweaved yarns. Structures can likewise be fluctuated to create fabrics with broadly extraordinary properties in the twist and weft headings. The property of any fabric created relies on upon the constituent strands material, yarns and the fabric structure and how every one of these variables collaborate with each other. A definitive point of any clothing fabric is to fulfill the wearer and make him feel great. Consequently, with regards to above it is worth to examine the solace properties of various woven fabrics.

2. Methodology

This investigation focuses on the various comfort, durability and serviceability characteristics of different woven structures, woven using double yarn with 2:1 setting ratio on shuttle less weaving machine. Total 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 weaves. Cotton, polyester/cotton and cot look polyester yarn were used in weft to investigate the effect of weft material on fabric properties. Finishing treatments like singeing, desizing, mercerizing, bleaching and resin finishing were carried out on 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 testing obtained results were analyzed using Minitab statistical software.

2.1 Materials

2.1.1 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 were used in 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 in nearly equal. Characteristics of these yarns were tabulated in table 1.

2.1.2 Chemicals

Chemicals like Alpha amylase enzyme, wetting agent, sequestering agent and deformer were used for desizing of fabric. NaOH was used for mercerization. H₂O₂, peroxide stabilizer and soda ash for were used for bleaching process and Saralink ULF Resin, Acetic Acid, Extra soft Silicon softener, Expocil CEL Antisliping agent, Macl₂, Sarasoft EP Tear improver and JET-B Wetting agent were used for finishing treatment of fabric. Raymond Zambaiti LTD. Kagal provided all these chemicals.

2.2 Method

Table 1: Characteristics of yarns

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Yarn Characteristics</th>
<th>Cotton</th>
<th>Cotton/Polyester</th>
<th>Polyester</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Count (Ne)</td>
<td>42.14</td>
<td>42.3</td>
<td>44.29 (120D)</td>
</tr>
<tr>
<td>2</td>
<td>Tensile Strength (g/tex)</td>
<td>16.82</td>
<td>24.65</td>
<td>26.37</td>
</tr>
<tr>
<td>3</td>
<td>Elongation (%)</td>
<td>3.45</td>
<td>7.57</td>
<td>14.95</td>
</tr>
<tr>
<td>4</td>
<td>Hairiness Index</td>
<td>3.1</td>
<td>4.54</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Unevenness (U %)</td>
<td>7.63</td>
<td>10.82</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Twist Per Inch</td>
<td>27.2</td>
<td>22.3</td>
<td>-</td>
</tr>
</tbody>
</table>

weaves. Cotton, polyester/cotton and cot look polyester yarn were used in weft to investigate As mentioned earlier 100% Raymond Zambaiti LTD. Kagal provided cotton and P/C
Table 2: Specification of weaving machine

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loom type</td>
<td>Flexible Rapier</td>
</tr>
<tr>
<td>Model</td>
<td>Sliver Vamatex, Itema</td>
</tr>
<tr>
<td>Let off</td>
<td>Electronic</td>
</tr>
<tr>
<td>Speed</td>
<td>400 rpm</td>
</tr>
<tr>
<td>Total ends</td>
<td>8700</td>
</tr>
<tr>
<td>Reed space</td>
<td>178 cm</td>
</tr>
<tr>
<td>Reed count</td>
<td>24.4</td>
</tr>
<tr>
<td>No. of shaft</td>
<td>8</td>
</tr>
<tr>
<td>Colours feed in weft</td>
<td>1</td>
</tr>
<tr>
<td>No. of heald frames</td>
<td>8</td>
</tr>
</tbody>
</table>

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 warp for all the fabric specimens. 100% cotton yarn, 80:20 blended cotton/polyester yarn and cot look polyester multifilament yarn was used as weft for all the weaves. Each weave was woven using all the three type of weft yarns separately. With every possible combination, 21 fabric specimens were manufactured. After manufacturing the fabrics, finishing treatment was given. In brief, finishing treatment was explained in following points (see 3.3.2). 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: Fabric structure /weaves

2.2.2 Fabric Processing

After manufacturing the fabric with all possible combination. All the manufactured fabric samples were subjected to finishing treatments like singeing, mercerizing, bleaching and resin finishing. Singeing was done by gas singing 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 52°TW NaOH under tension and 5-6 hot as well as cold wash was given and fabric rolls were kept rotating for to achieve uniform mercerization. Peroxide bleaching was carried out on mercerized fabric at 85°C for 4 hours and resin finish was applied. Resin finishing was carried out by Pad-Dry-Cure method using stenter at 60 m/min speed. Finishing temperature was set to 140°C while pad-dry-cure. Details of bleaching and finishing were reported in table 3.

2.3 Testing

2.3.1 Strip Strength

The raveled strip tensile strength test of fabric was carried out according to ASTM D5035-11 on Instron- 5565. Following suitable sampling technique, warp and weft strips were cut using the given template. Strings from both the sides of the fabric strip were raveled to get a piece of precisely 5 cm of 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.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Process</th>
<th>Chemical</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.</td>
<td>Bleaching</td>
<td>H₂O₂</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peroxide stabilizer</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Soda Ash</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Saralink ULF resin</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Acetic acid</td>
<td>1 gpl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extra soft silicon softener</td>
<td>15 gpl</td>
</tr>
<tr>
<td>02.</td>
<td>Finishing</td>
<td>Expocil CEL</td>
<td>5 gpl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>antisliping agent</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MacI</td>
<td>7 gpl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sarasoft EP tear improver</td>
<td>30 gpl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JET-B wetting agent</td>
<td>0.2 gpl</td>
</tr>
</tbody>
</table>

2.3.2 Tearing Strength

Tearing quality of fabric was tried on 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.

2.3.3 Abrasion Resistance

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. Weight of 9 Kpa was connected to every example.

2.3.4 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 consecutive. The examples were then set under a 10 N stack for 5 min. 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 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. Higher the wrinkle recuperation point higher will be the wrinkle recuperation of fabric.

2.4 Statistical Analysis

After testing, obtained results were analyzed by using MINITAB® statistical software. Methods like ANOVA and General Linear Model were used to analyze the data.

3. Result and Discussion

3.1 Tensile Properties
The tensile behavior of woven fabrics is known to be influenced by its sett and development. In this examination, malleable properties of woven fabrics were portrayed by fabric breaking burden and prolongation.

3.1.1 Strip Strength

Tensile strength has been acknowledged as a standout amongst the most vital qualities of woven textiles. Tensile strength is characterized as a most extreme load that a test sample will continue when subjected to uniaxial tensile stacking. 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 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. Impact of weave, weft sort, and compound process on warp and weft way strip strength of fabric was 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 glossy silk weaves separately. Glossy silk weave set its position at the base of the rundown of tensile strength. At the point when fabric is extended in, one course i.e. at the point when fabric was subjected to uniaxial stack, at first the pleat toward that path decays. Henceforth, more the pleat in fabric, higher will be the fabric strength. Having higher record of interlacement and lower coats, plain weave fabrics are more tightly and minimized, having the most extreme crease. Which is the principle explanation for high tensile strength of plain weave fabrics. The yarns are not held immovably in twill, crepe and glossy silk weave structure as in the plain weave. The tensile strength of glossy silk fabrics is minor than crepe and twill weave, this is principally because of bigger buoys in the weave structures [1].

Polyester weft fabrics are having most noteworthy tensile strength as contrast with cotton and cotton/polyester fabrics. This is on account of the characteristic strength of polyester multifilament yarn was higher than that of cotton and P/C mixed yarns. But 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 we had kept 2:1 setting ratio of warp and weft, in the

Figure 2: Effect on warp way strip strength

Figure 3: Effect on weft way strip strength
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. Thusly, weft way strength must be more prominent yet the impact of denser warp is more unmistakable for our situation.

Synthetic preparing has negative impact on tensile properties of fabric. Activity of various chemicals and longer curing time makes more harm cellulosic fiber which assistant decreases the tensile strength of fabric. The increase of cross-connecting because of the tar could likewise cause diminishment of tensile strength of fabric [2].

3.1.2 Elongation

Extensibility alludes to the degree with which a fabric will increase long 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 uniaxial stack was connected to the fabric, 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 stops the expansion of the fabric. Higher the quantity of interlacements per unit zone, lower will be the buoys and 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 [3]. A plain weave has the best number of interweaving focuses and most minimal buoys in a given region, and in this way has most elevated level of crease. Consequently, fabrics with plain weave structure are related with higher breaking lengthening taken after by crepe, twill weave and glossy silk weave.
individually [1]. 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 most noteworthy breaking stretching taken after by P/C mixed weft. Fabric with cotton weft indicate most minimal stretching values. 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 P/C 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 increased augmentation of completed products. Notwithstanding, this impact is not noteworthy.

3.2 Tearing Strength

Tearing is a standout amongst 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 as for its imperviousness to external mechanical powers. 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 tears is reliant on two factors: the measure of yarn slippage or versatility of the yarns inside the fabric development and the quantity 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. Higher the record of interlacements, lower will be the buoys and lower strength of fabric. What's more, silicone conditioners give better tear strength to fabric [4]. In the vast majority of the cases, tearing strength will be portability of yarns, which prompts bring down tearing strength of fabric.

Higher tearing strength was related with silk weaves taken after by twill, crepe and plain weaves individually. The higher tearing strength of glossy silk weaves might be identified with the more drawn out pads in this kind of fabrics, which make yarns to be free under tearing burden [1]. Out of the every one of the weaves under examination, a plain weave will tear the least demanding. A plain weave is a tight development having minimal measure of inside slippage or yarn portability. What's more, just a single yarn bears the heap when the fabric is torn. Glossy silk 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 [3].

Tearing strength of polyester weft fabrics was observed to be higher, trailed by P/C mixed weft and cotton weft fabrics. The purpose for higher tearing strength of polyester fabrics might be related with 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 2:1 setting ration of warp and weft. In given region number of finishes are more than number of pics consequently more prominent the quantity of yarns will bear the heap in warp heading, subsequently it is harder to tear the fabric in warp course.

It was discovered that the substance preparing had constructive outcome on the tearing strength of fabric. Activity of Sarasoft EP tear improver utilized while completing treatment of the fabric had enhanced the tearing strength of completed fabric was essentially higher than that of dim fabric.

3.3 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, yet it additionally influences the presence of a fabric [5]. The abrasion resistance of textile materials is affected by numerous fac-tors like fiber fineness, yarn number, yarn sort, weave and so on [1]. In this examination, abrasion resistance of the woven fabric tests was assessed by the rate of fabric weight reduction. Lower the weight reduction of the fabric after test, more prominent the abrasion resistance of the fabrics.

Weave sort significantly affects 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 coasts and a low number of interlacements cause the ceaseless contact with scraping surface. This encourages the yarn to lose its frame all the more effectively by giving simpler development in light of the rubbing movement. Longer the buoys, higher will be the abrasion. So long, glides in a weave, for example, silk structures are more uncovered and rub quicker, for the most part cause 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 [6],[7]. In any case, the fabrics that have bring 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 [6],[8]. After silk 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 weave is: plain, warp rib, 2/2 matt, crepe, 3/1 twill, herringbone twill and silk. A similar pattern was seen in all cases.

Weft sort likewise significantly affects rough conduct of the fabric. Cotton yarns are more inclined to rough wear and bristliness of cotton yarn has negative impact on grating conduct of fabric. Because of shagginess, fabric has more prominent propensity of pilling and along these lines weight reduction. Fabric woven with polyester weft has 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 less 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 a similar development. Silicone conditioner treatment causes decrease in abrasion resistance of the fabrics. It is the plausible aftereffect of fiber portability inside the fabric, which is increased by silicone conditioner. Additionally as a result of crosslinking instrument while sap completing, abrasion resistance of fabric decreases [2],[4],[6].

3.4 Crease Recovery

The crease recovery is one of the basic properties of fabrics, which influences item execution. Crease recovery alludes to the capacity of the fabric to come back to its unique shape subsequent to evacuating the collapsing disfigurements. The crease recovery of fabrics is dictated by measuring the crease recovery edge. As the crease recovery edge increases, crease
recovery of the fabric increases i.e. higher recovery edges demonstrate fabric having great resistance against wrinkling [1]. Impact of weave, weft sort, and synthetic handling on warp way and weft way crease recovery of fabric was as appeared in fig. 9 and fig. 10 separately.

The capacity of a fabric to oppose wrinkling is controlled by the measure of versatility the filaments and yarns have inside the development. The more opportunity they need to move, the simpler it is for them to come back to their casual state or the state they were in before twisting. The more tightly the weave, the less opportunity the yarns and filaments need to move [3]. Yarns and filaments inside a plain weave development have little flexibility to move about restricting their capacity to recoup after twisting. Consequently, plain weave fabrics have minimal imperviousness to wrinkling. Glossy silk and herringbone twill fabric have most astounding number of buoy and structure is relatively free which have most elevated wrinkle resistance and great crease recovery. 3/1 twill and crepe weave have direct crease recovery. While plain weave subsidiaries i.e. matt and warp rib fabrics have bring down crease recovery. Comparable pattern was seen in the vast majority of the cases. The capacity of a glossy silk weave to oppose wrinkling after home washing is an attractive component to the client.

From fig. 9 and fig. 10, it was discovered that there is noteworthy impact of weft sort on wrinkle resistance property of fabric. At the point when a heap is connected on to the cotton fabrics, the cellulosic chain in the fiber twists and this bowing stays perpetual since the cellulosic chains are Inflexible. This bowing of the cellulose chains of the fiber under the use of load causes the development of crease [2]. Subsequently, cotton fabric has least crease resistance. In any case, because of nonattendance of any cellulosic chains in polyester, polyester fabrics have most elevated wrinkle resistance. P/C mixed weft fabrics have direct wrinkle resistance. It was discovered that there is no critical distinction in crease recovery point of a fabric in warp and weft heading.

It can be effectively closed from fig. 9 and fig. 10 that there is noteworthy contrast in crease recovery properties of dim and completed fabrics. At the point when a heap is connected on to the cotton fabrics, the hydrogen bonds shaped between the –OH gathering of adjoining cellulose chain in the crystalline district are broken (being a feeble obligation of constrain) when a cotton fabric is collapsed and squeezed. The breakage of the hydrogen bonds in the crystalline area and the development of new hydrogen bonds in the shapeless locale causes the arrangement of creases. The presentation of cross-connecting operator in pitch completing grants dimensional security and flexibility to the sinewy material and makes it crease safe and crease recoverable. The pitches respond with the –OH gatherings of cellulose shaping cross-joins, which is tough and henceforth increases the crease recovery along these lines dimensional strength of the fabric [2]. Silicone conditioners additionally give better wrinkle recovery [4].

Conclusions

1. Index of interlacement plays vital role in changing fabric properties.
2. Fabrics with highest index of interlacement like plain and plain weave derivatives have better abrasion resistance and tensile properties.
3. Fabrics with lower index of interlacement like satin, herringbone twill results in loose fabric structure having high tearing strength and wrinkle resistance.
4. Due to 2:1 setting ratio tensile and tearing strength of is higher in warp direction.
5. Twill and crepe weave 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 yarn surface.

References


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