8.1 INTRODUCTION

This chapter concerns the sewability of sewing threads used in the garment industry. The other important property namely the coefficient of friction against the sewing needle is also discussed.

8.2 LITERATURE REVIEW

8.2.1 Requirements of sewing threads

Sewing threads are special kinds of yarns. They are engineered and designed to pass through a machine rapidly to form a stitch efficiently, and, to function while in a sewn product without breaking or becoming distorted for at least the useful life of the product [117]. The perfect sewing thread must be strong, round, even balanced in twist i.e. when allowed to have slack in a loop, it must not slack in a loop, it must not twist round itself or only slightly.

The fundamental functional requirements of sewing threads are:

1. The ability of a sewing thread to meet the functional requirement of producing a desired seam, and
2. The ability of a sewing thread to provide the desired functional sewability in a desired seam [118].
8.2.2 Sewing Thread Index number

A sewing thread should possess important properties such as high strength and extensibility, strength uniformity, high lusture, and, good abrasion resistance etc., which increase the sewability of thread and seam efficiency of the seams prepared out of a thread.

To assess the quality of sewing thread a consolidated index, taking into account all the desirable properties has been suggested by different workers. Guterman [119] formulated an integrated quality index to judge the performance of sewing threads [119]. The Sewing Quality Index (SQI) was based on different properties, i.e. dry and wet strength, knot strength, elastic recovery, surface friction and flexing endurances [120]. For an ideal thread, the SQI value would be 100. SQI, takes into account all the desirable properties. The use of equal weightage for all the properties was tried by Walz [120], which resulted in different relative index number for different threads from those given by Guterman. He studied dry and wet knot strength, elastic recovery, flex resistance, abrasion resistance, sewability (number of breaks on a commercial machine per 3600 stitches) and breaking strength after 30 launderings. For each property, the thread having the highest value was selected and these values were considered as 100%. The values for other threads are interpolated on the basis of the highest value. It was observed that cotton sewing thread had the highest and rayon the lowest SQI. This ranking is different from that of Guterman [119]. To improve the performance of the thread during sewing operation and to impart desirable qualities, the threads are generally given finishing treatments like singeing and lubricating.
Subsequently, a study was conducted to assess the Indian quality thread and compare the same with corresponding (equivalent) threads manufactured in U.K [121]. They found that sewing threads could be assessed and ranked from the consolidated index (SQI) and that the polyester threads were better compared to cotton threads. Characteristics of polyester threads were better compared to cotton threads. The quality of the threads could be assessed even with the four easily derivable properties i.e., breaking strength, elongation, U% and abrasion resistance, instead of determining all the desired properties. Further, fairly accurate estimation of quality could be done only from breaking strength and elongation.

8.2.3 Chemical Processing

The chemical processing i.e., mercerization, kier-boiling and bleaching are followed for the manufacture of sewing threads. There have been some reports on the effect of mercerization on tensile properties and abrasion resistance [122, 123, 124]. Further, the nature and extent of damage to the surface structure of abraded samples of a typical sewing thread at different stages of chemical treatments have been examined with a scanning electron microscope (SEM), with a view to explaining the changes in strength, elongation parameters and abrasion resistance [125]. It was found that chemical treatments modify the surface structure and as a result, there is a reduction in abrasion resistance but no improvement in tensile properties. Improvement in breaking strength may be attributed to such factors as the number of fibres, increase in fibre strength, and fibre cohesion.
8.2.4 Lustre

Lustre is one of the desirable properties of the sewing threads, as it increases aesthetic appeal of the garment. Stretch mercerization improves the lustre [126, 127, 128, 129]. The lustremeter fabricated at CTRL, used for cotton fibres, was employed to determine lustre of sewing threads. Eventhough, lustre increased after mercerization, it decreased sequentially on further treatments. After bleaching, the threads appeared more white, but their lustre slightly decreased as compared to mercerized samples.

8.2.5 Flex Abrasion Resistance

An attempt has been made to develop and standardize a method for the determination of flex abrasion of sewing threads on Stoll Quarter Master Universal Wear Tester (SQMUWT) which has been designed mainly for measuring fabric abrasion [130]. The applicability of the method has been established by testing 40 sewing threads of different types. It was concluded, that the sewing thread abrasion resistance can be determined fairly accurately by testing skeins of threads on SQMUWT.

8.2.6 Seam Quality of Cotton Threads

The seam quality for a fabric depends on the quality of the sewing thread. During the sewing operation, the samples of the thread were collected immediately after passing through the needle, removed from the seamed
condition and stitched with coarse and fine fabric separately. Care was taken while removing the thread from the seam in the fabric, not to disturb the structure of the thread. It was observed that the hairiness increased from control to thread passed through the needle, thread removed from fine fabric and removed from coarse fabric respectively. The changes were due to the change in surface geometry from friction and rubbing the thread and the needle surface or the cross yarns from the fabric. The abrasional effect was higher in the case of coarse than on fine fabric. For the same reason, the breaking strength, tenacity, elongation and toughness index also decreased. Since these changes impair the seam quality, this problem can be minimized by proper selection of thread, number of stitches per unit length, and speed of the sewing machine for a specific type of fabric. It was suggested that special finishes, if necessary, may be applied to alter the protective coating such as lubrication, glazing, softening etc. to minimize the losses due to friction [127].

8.2.7 Sewability of Sewing Threads

SITRA (South India Textile Research Association) recently reported on the sewability test and the variations existing in the quality parameters between makes of the same Ticket No. have been investigated. According to them the numbering system currently followed creates confusion among thread consumers. Therefore they have suggested that the Ticket Number be normalized to standard international numbering system. Also they feel that the construction details must be given in the labels and the thread manufacturer should give due considerations to these
factors for further improvement, in addition to strength and yarn abrasion [120, 131]. SITRA's report is thus significant, as they have come out with an useful suggestion.

8.2.8 Friction

Friction is the force that holds together the fibres in a spun yarn and the interlacing threads in a fabric. If the friction is too low, the yarn strength will fall, and the dimensional stability of cloth will be reduced. Here high friction is advantageous enabling a greater proportion of the strength of the individual fibres to be utilized. In many other places, however, fibre friction is disadvantageous [132]. Since yarns rub against machine parts, the friction of yarns against metal surfaces has an important bearing on the yarn tension as well as on the wear of machine parts.

It has been stated that in the stitching of fabric, high friction causes trouble for two reasons: the needle may become hot, and the threads will not slide over one another in order to allow the needle to pass between them. This causes many more threads to be broken; for example, in a particular unlubricated mineral-khaki dyed cloth there were nearly twenty cut threads per 100 punctures, but after lubrication the number of cut threads was significantly less.
The process of textile manufacturing needs the movement of yarn over and through a number of surfaces like travellers, knitting needles, ceramic and metallic rollers and guide surfaces in spinning, winding, weaving and stitching operations. Lower friction saves energy and helps towards faster production [133, 135].

Much work has been done on the measurement of friction and all the earlier instruments are based on the measurement of tension in the yarn before and after its contact with the corresponding metallic surface made in the form of a cylinder.

8.3 MATERIALS

8.3.1 Sewing Threads

Six samples of sewing threads of three ply threads belonging to different Ticket Numbers, two of polyester, one soft thread (four ply), three mercerized threads were obtained from reputed manufacturers, and, were used in the study. They were selected as per British Standard, and also based on their availability. The information obtained from a survey of hundred ready made garment factories in Madras and Bangalore also assisted in their selection.

The identification numbers and details are presented in Table 8.1.

8.3.2 Fabrics

The fabric is used for testing the sewability of threads. The fabric is just a carrier for threads in the seam, without undergoing any damage. However, the fabrics
<table>
<thead>
<tr>
<th>THREAD CODE</th>
<th>TICKET NUMBER</th>
<th>PLY</th>
<th>FIBRE% CONTENT</th>
<th>RESULTANT COUNT(Ne)</th>
<th>TPI</th>
<th>DIRECTION</th>
<th>FINISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1</td>
<td>58</td>
<td>3</td>
<td>100 PE</td>
<td>34.5</td>
<td>19</td>
<td>Z</td>
<td>-</td>
</tr>
<tr>
<td>ST2</td>
<td>80</td>
<td>3</td>
<td>100 PE</td>
<td>34.3</td>
<td>22</td>
<td>Z</td>
<td>-</td>
</tr>
<tr>
<td>ST3</td>
<td>40</td>
<td>4</td>
<td>100 C</td>
<td>54.2</td>
<td>26</td>
<td>S</td>
<td>SOFT</td>
</tr>
<tr>
<td>ST4</td>
<td>50</td>
<td>3</td>
<td>100 C</td>
<td>38.1</td>
<td>20</td>
<td>Z</td>
<td>MERCZD</td>
</tr>
<tr>
<td>ST5</td>
<td>60</td>
<td>3</td>
<td>100 C</td>
<td>29.2</td>
<td>22</td>
<td>Z</td>
<td>&quot;</td>
</tr>
<tr>
<td>ST6</td>
<td>80</td>
<td>3</td>
<td>100 C</td>
<td>22.3</td>
<td>26</td>
<td>Z</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

PF - Polyester
C - Cotton
were selected, depending on the end use as per British Standard. For testing the sewability of threads ST1 and ST2, the fabric H2 (Table 3.1), ST3, the fabric M1 (Table 5.2), and for the threads ST4, ST5 and ST6, the fabric B2 (Table 3.1) were selected.

8.3.3 Needles

The singer sewing needle No.11 having an eye of 0.62 mm was used for testing of all the threads except ST3; for testing sewing thread ST3, the singer sewing needle No.16 with the diameter of the eye 0.8 mm was used. For the purpose of testing all the threads with chain stitch, the singer sewing needle No.14 with the diameter of the eye 0.75 mm was the only needle used, as this machine could be operated with only one size needle and due to the non-availability of needles as per British Standard. To measure the co-efficient of friction between the needles and sewing threads needles described in Table 7.1 were used (Tables 8.4, 8.5).

8.3.4 Sewing machine

A Rimold two thread chain stitch and singer lock stitching machine were used; the former was used for putting chain stitch while the latter was employed for lock stitch.

8.4 METHODS

8.4.1 Twist per unit length

Twist was determined by a twist and untwist tester [12,13].
8.4.2 Count

Count was determined by using spinlab and the tex was converted to count.

8.4.3 Evenness

The 'Uster evenness tester was used for determining the evenness of the sewing thread.

8.4.4 Tenacity and Breaking Extension

An Instron tensile tester model 4301 was used to measure the tenacity and breaking extension. The load cell of 100N with the gauge length of 300 mm at a cross head speed of 300 mm per minute was used. The breaking load and extension displayed were recorded. The mean of fifty readings was considered.

8.4.5 Test for Sewability using Chain Stitch

The test for sewability was essentially based on Guterman's [119] work and SITRA's methods [120,131]. Chain stitch is extensively used for knitted fabrics. However, this was also used in the present study for comparison. Rimoldi sewing machine with the speed of 3000 stitches per minute, and needle size No14 singer (for all the samples) was used. The standard stitch density and thread tension were maintained. The fabrics and sewing thread as quoted in 8.3.2 and 8.3.3 were selected. Two layers of fabric strips of 30 cm wide and 100 cm long consisting of 2 plies were stitched together to make a continuous belt. These strips were sewn for 25,000 stitches. The machine was
stopped as and when the thread broke, and breaks were counted, and, the machine was rethreaded. Five measurements were made on each sample and the average number of breaks was calculated and expressed as number of breaks per $10^5$ stitches.

8.4.6 Test for sewability using lock stitch

The method of assessing sewability was the same as described in section 8.4.5. The sewing machine used was a Singer lock stitch machine with the speed of 4000 stitches per minute.

8.4.7 Coefficient of friction

Coefficient of friction was measured by an instrument which is based on the inclined plane method. This instrument uses the principle of Howell and Mazur [134]. This can be used for measuring static and kinetic friction coefficients of yarns against metal. In this instrument, the angle of inclination of the yarn can be easily varied by suitable arrangement.

The instrument shown in Fig 8.1 consists of a base with a long screw capable of making rotations in the plane of the base. While the handle $H$ is rotated, the moving block $M$ mounted on the screw supporting a frictionless pulley $F$ moves along the scale $S$. The movement is measured with the help of a pointer $P$. There is a fixed block $B$ at one end of the base. The yarn or filament whose coefficient of friction has to be estimated is tied to the top of the fixed block at $O$, is stretched across the base to the moving block, and passes over the frictionless
pulley. The yarn is tensioned with the help of a dead weight W. By rotating the handle H the moving block can be moved, and as it moves towards the fixed block, the angle of inclination of the yarn increases. Thus, by working the handle, the angle of inclination of the yarn can be increased or decreased.

The static coefficient of friction between the yarn and sewing needle was measured by passing the thread through the eye of needle, while the other end was tied to the top of the fixed block. The handle was moved manually maintaining uniform speed and the inclination of the yarn increased until the horizontal scale was measured (l). The height (which is the instrument constant) was measured and h/l was taken as tan θ or the coefficient of friction. Each sewing thread was tested with the needle eye diameter 0.74mm, 0.9mm, 0.98mm, and 1.1mm and the mean of fifty readings was taken.

8.5 RESULTS AND DISCUSSION

8.5.1 Yarn Evenness and imperfections

It is seen from the Table 8.2 that a wide variation is observed in the evenness and the number of thin, and thick places, and, neps are high in ST1. U% percentage is also high in case of ST1. Thick places and neps are very low in ST2. The regularity is good in ST2 and the values are more less the same in other samples ST3, ST4 and ST5. Thin places are nil in all the samples except ST1. Thick places range from 11 to 18. The number of neps are high in ST4 sample. In other samples neps range from 12 to 23 only. The yarn quality index (YQI) is 0.79 for ST2 which is good compare to ST6.
## TABLE 8.2 EVENNESS AND IMPERFECTIONS OF SEWING THREADS

<table>
<thead>
<tr>
<th>THREAD CODE</th>
<th>U%</th>
<th>THIN PLACES PER Km</th>
<th>THICKS PLACES NEPS PER Km</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1</td>
<td>9.5</td>
<td>3</td>
<td>125</td>
</tr>
<tr>
<td>ST2</td>
<td>7.5</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>ST3</td>
<td>8.2</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>ST4</td>
<td>8.7</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>ST5</td>
<td>8.8</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>ST6</td>
<td>9.0</td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
</table>
8.5.2 Extension

The extension of the polyester threads is higher than that of cotton; this is the known phenomenon (Table 8.3).

8.5.3 Sewability using chain stitch

It is observed from the table 8.3 that the number of breaks per $10^5$ stitches is nil in all the threads, which is due to the type of stitch. Chain stitch is more extensible compared to lock stitch. There is no tension in chain stitch and thus it provides high elasticity. Chain stitch is commonly used for knitted goods. Therefore, it is found that the type of stitch has an effect on the thread breaks while sewing. The disadvantage of this stitch is that, it is easily removable.

8.5.4 Sewability using lock stitch

There is no thread break in ST1, and ST2 as expected. Though the thick places and neps are very high in ST1, there is no thread break, as it is polyester. Among the cotton threads, ST4 is the only thread which did not break because it is coarser than the other threads. As regards ST3, eventhough it is four ply, the number of breaks is 8 per lakh stitches. Probably, it is soft thread and not mercerized. Eventhough, ST3 is suitable for suiting material as per British Standard. (resultant count). many tailors and ready made garment factories do not use this thread. The reason is that this thread is coarse and conspicuously visible which spoils the appearance of the garment. Another information revealed, after survey, is that, instead of ST3, ST4 is generally preferred by tailors
### Table 8.3 Properties and Sewability of Threads

<table>
<thead>
<tr>
<th>Thread Code</th>
<th>Tenacity</th>
<th>Extension N/TEX</th>
<th>Initial Modulus gms/TEX</th>
<th>Lock Stitches</th>
<th>Chain Stitches</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1</td>
<td>0.26</td>
<td>18</td>
<td>15.3</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>ST2</td>
<td>0.33</td>
<td>18</td>
<td>12.6</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>ST3</td>
<td>0.18</td>
<td>9</td>
<td>15.3</td>
<td>8</td>
<td>NIL</td>
</tr>
<tr>
<td>ST4</td>
<td>0.18</td>
<td>8</td>
<td>10.26</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>ST5</td>
<td>0.21</td>
<td>9</td>
<td>9.09</td>
<td>4</td>
<td>NIL</td>
</tr>
<tr>
<td>ST6</td>
<td>0.23</td>
<td>9</td>
<td>2.52</td>
<td>24</td>
<td>NIL</td>
</tr>
</tbody>
</table>
and ready made garment factories and the customers are also satisfied with this type of thread on jeans and other coarser materials. The sewability test conducted also supports the above statement. The number of breaks is very high in ST6, which is readily understandable, as it is a fine thread. The YQI seems to have been responsible for the high incidence of breaks in respect of ST6.

8.5.5 Coefficient of static friction

Values of the static friction show a decrease with an increase in the needle size and thereafter show an increase (Table 8.4 and Fig.8.2); the drop in friction can be, to some extent, attributed to the decrease in the contact area. As a low friction between the needle and the sewing thread is desirable to avoid needle breakages and yarn breakages, it seems that needle eye diameter 0.98mm is to be preferred. However, it has been found practically that it is not suitable for thin fabrics in view of hole formation.

8.6 CONCLUSION

The number of thin and thick places, neps and mean percentage, are very high in ST1. In spite of this, sewability is good as the number of thread breaks is nil, with both the type of stitches, chain stitch and lock stitch. This is because, ST1 is a polyester thread.

The initial moduli are high in ST1 ST2 and ST3 whose tenacity is also high. ST6 being very fine, the initial modulus is also very low.
## TABLE 8.4 STATIC COEFFICIENT OF FRICTION

<table>
<thead>
<tr>
<th>Needle Eye Diameter</th>
<th>ST1</th>
<th>ST2</th>
<th>ST3</th>
<th>ST4</th>
<th>ST5</th>
<th>ST6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.74mm</td>
<td>0.83</td>
<td>0.73</td>
<td>-</td>
<td>0.49</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.91mm</td>
<td>0.49</td>
<td>0.47</td>
<td>0.24</td>
<td>0.24</td>
<td>0.17</td>
<td>0.16</td>
</tr>
<tr>
<td>0.98mm</td>
<td>0.32</td>
<td>0.30</td>
<td>0.17</td>
<td>0.18</td>
<td>0.16</td>
<td>0.15</td>
</tr>
<tr>
<td>1.1mm</td>
<td>0.54</td>
<td>0.56</td>
<td>0.25</td>
<td>0.26</td>
<td>0.24</td>
<td>0.12</td>
</tr>
</tbody>
</table>
Fig. 8.2 Coefficient of friction between the needle eye diameter and the sewing thread.

ST1 - 58/3 PE
ST2 - 60/3 PE
ST3 - 40/4 SOFT C
ST4 - 50/3 MERC.
ST5 - 60/3 MERC.
ST6 - 80/3 MERC.
The polyester threads exhibit greater extensibility than those of the cotton threads. The yarn quality index of ST2 is found to be good.

The sewability tests show that the type of stitch has a significant effect on the thread breaks while sewing. The chain stitch being more elastic than the lock stitch, has not shown any break. The polyester threads did not break with both the chain stitch and lock stitch.

Among the cotton threads, ST4 exhibits good performance; this thread is highly preferred by tailors and garment factories for coarser fabrics including jeans. ST3 is not preferred for suiting materials, even though B.S. (resultant count) specifies. The performance as well as the appearance of ST4 is considered good for garments.

There appears to be an optimum needle size at which the friction is minimum; this has been found to be needle size 16 in this study. Values of the coefficient of friction are low at this needle size.