LESSON 15 TESTING OF TEXTILE FABRICS

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15. TESTING OF TEXTILE FABRICS

In Lesson 13, you were introduced to the concept of quality & quality management. Lesson 14 dealt with testing of textile fibres & yarns. In this final lesson of the unit and the course, you will learn about the tests that are performed on fabrics and the equipment and apparatus used for these tests.

15.1 Objectives

After going through this lesson you will be able to understand how:

- Fabric thickness is measured.
- Thread density of fabric is determined.
- Weight of the fabric is measured in terms of grams/m².
- Fabric properties like crease recovery, bending stiffness, pilling, drape, tensile strength, bursting strength, tear resistance and fabric extension are determined.

15.1 Introduction

The reasons for testing fabrics are the same as those for testing fibres and yarns, viz. to check whether the product is up to the required specification or not. The performance of a fabric depends on its various characteristics and properties, some of the major ones being their thickness, weight per unit area, thread density, pilling resistance, bursting strength, tensile strength, tear resistance etc.. The measurement of all these require carefully designed instruments and equipments.

Great care must be taken in making the measurements. We consider the simple measurement of thickness of a fabric as an example. Fabric being a compressible material, the thickness would obviously be pressure dependent so the pressure at which measurements have to be made has to be specified. This is generally done in the standards that are normally available for these tests. In this lesson we will not describe the tests for colour fastness during washing & rubbing as these have been already considered in detail in Lesson 12.

15.2 Fabric Thickness

The American society for testing and Materials (ASTM) defines thickness of a textile material as the distance between the upper and lower surface of a material, measured under specified pressure which has been prescribed as 5 gram/cm² or 20 gram/cm². A thickness gauge used for measuring fabric thickness is shown in Fig. 15.1. It can be used to measure thickness of various types of fabric. For example - woven and knitted fabric.
A piece of the fabric is placed on the reference plate of the instrument ensuring that there are no creases in the fabric. While placing the fabric it should not be subjected to any stretching. The pressure foot is gradually brought down and after allowing it to rest on the fabric for 30 seconds, the gauge reading is taken. The fabric thickness is read at 10 different places on the sample and the mean of these readings is taken as the average measured thickness of the sample.

Self-check Questions

1. Fabric thickness is measured under a specified pressure. Why?

15.3 Weight of the Fabric

The weight of the fabric is generally expressed in grams/m$^2$ or GSM. The following two methods are used to find GSM.

- Method 1 (Based on the use of quadrant scale)

  The apparatus and accessories comprise of a quadrant scale for GSM and a sample cutter. A traditional quadrant balance (Fig. 15.2) to check the GSM of any type of fabric is generally supplied with two cutting templates. The quadrant scale is graduated in the units of grams per m$^2$.

  The template is kept on the surface of the fabric and its outline is marked with a marker which is supplied with the quadrant scale. The sample is cut on the marked line with a pair of scissors. Five such test samples are prepared. One by one the samples are hung in the clamp of the quadrant scale and the GSM is read directly from the quadrant scale.

  A round cutter (Fig. 15.3) cuts circular specimen of diameter 113.6 mm. A weighing balance (Fig 15.4) is used to weigh the specimen.

- Method 2 (Based on the use of round cutter)
The round cutter (Fig. 15.3) is kept on the surface of the fabric and the weight of the round sample is measured with the help of the balance (Fig. 15.4). On multiplying the weight by 100 we get the GSM of the fabric.

Self-check Questions

2. What is GSM? Name two methods used for measuring GSM?

15.4 Thread Density of a Woven Fabric

In a woven fabric the warp yarns are sometimes referred to as ‘ends’ and the threads of weft are referred to as ‘picks’. In the construction of any fabric the number of ends and picks per unit length (per inch or per cm.) plays a very important role. For example cotton poplin may have a doubled yarn, say 2/100s as warp and the weft also may be the same yarn. Further, there may be 144 ends per inch and 76 picks per inch. A short description of this poplin would be 144 x 76, 2/100 x 2/100 which indicates a good quality poplin. In the characterization of fabrics the determination of the number of threads per unit length represents an important exercise and is generally achieved by using a pick glass which is a simple magnifying glass with a one inch square window at the base. A digital travelling head counter is also commercially available for thread density.

A ground glass plate illuminated from below may be used for placing the sample when the threads are counted with the help of a pick glass (Fig. 15.5). The regions near the selvedges should be avoided because the spacing of the threads in them is often little different than in the body of the cloth. Likewise, the specimen to be tested should not be too close to the ends of the rolls from where it is taken. The specifications generally prescribe the conditioning procedure and usually recommend that the test specimen should be conditioned for 24 hours before testing.

The digitra or digital traverse thread counter (Fig. 15.6) has microprocessor based control panel and has five individual slots – three metric (one, two & five cm.) and two imperial (1/2" and 1"). It has built in light intensity control and other accessories. It is used for quick and accurate measurement of thread density, when the number of threads per inch is small (less than 25) than a sample of larger size could be examined on this instrument.
Self-check Questions

3. Name two methods for measuring thread density.

15.5 Crease Recovery of a Fabric

A crease is caused by folding the fabric on itself and is identified by the sharp bend at the fold. If present where required it has utility, otherwise it is undesirable. Crease resistance is defined as the resistance of the fabric to bending deformation and crease recovery is the ability of the fabric to recover from the imposed deformation.

An instrument designed to measure the crease recovery of a fabric is shown in Fig. 15.7. Ten fabric samples each 2”x1” or 4 cm x1.5 cm are cut in the warp/weft directions using the template. The specimens are folded end to end in half with their edges gripped in one line with the help of tweezers. Half of the test specimens in both cases are folded face to face and the other half back to back. The folded specimens are placed on the loading device and allowed to develop the crease under a load of two kg for one minute. The weight is removed and the sample is placed with the help of forceps in the clamp with half of the sample hanging vertically downwards. As the recovery takes place, the disc is rotated so that half the sample continues to hang vertically downwards. After a recovery time of one minute the crease recovery angle is read on the engraved scale. The specimen should be conditioned and tested in a standard testing atmosphere. The mean value of the crease recovery angle to the nearest degree is reported for the warp way and weft way test specimen.

Self-check Questions

4. What is the significance of the crease recovery angle?

15.6 Bending Stiffness

Bending stiffness is a very important property which affects the appearance and comfort of a garment. It is defined as the bending moment required to produce a given curvature. It depends on the number of yarns being bent in the fabric and the bending rigidity of those yarns. A bending stiffness tester is shown in Fig. 15.8.

A 6”x1” fabric strip is mounted on the horizontal platform such that it overhangs like a cantilever and bends downwards. The principle is shown in Fig 15.9. The overhang length l and angle $\theta$ made by the free end of the fabric
with the horizontal is used to calculate the fabric bending length and flexural rigidity. In the experiment the fabric is allowed to bend through an angle of 41.5° and the length is measured. The scale of the apparatus is calibrated to give the bending length directly which is a measure of bending stiffness.

![Fig.15.9 Fabric Stiffness, Cantilever Principle](image)

The mean values of the bending length in warp and weft directions are reported. It may be emphasized that stiffness is a key factor in the study of the handle and drape of a fibre. It is intuitively quite easy to see that a fabric with high bending rigidity would show poor drapeability.

### Self-check Questions

5. What is meant by the bending length?

### 15.7 Pilling of Fabrics

Pilling is a fabric surface fault characterized by little pills of entangled fibre mass clinging onto the cloth surface and giving the garment an unsightly appearance. These fibre balls or pills are formed during wear and washing by entanglement of loose fibres which protrude from the fabric surface. Fibres such as wool, polyester, nylon and acrylic have a tendency to pill. If the fibre tenacity is low as is the case with wool fibres, the pills tend to break off from the fabric during normal wear.

The instrument (Fig. 15.10) used for laboratory evaluation of the tendency of an article to pilling consists of boxes whose internal surface is covered with moderately abrasive layer, normally cork. A piece of fabric measuring 5”x 5” is sewn so as to be a firm fit when placed around a rubber tube 6” long and 1.25” outer diameter. The cut ends of fabric are covered with cello tape and four tubes are placed in the box lined with cork and rotated for 5000 revolutions. After tumbling, the extent of pilling is assessed visually by comparison with arbitrary standards. The pilling may be assessed numerically by counting the number of pills. Alternately the appearance of the test specimen may be compared with standard samples and given some form of rating.
Self-check Questions

6. How is abrasion of fabrics achieved in a pilling machine?

7. Why does a pill form?

15.8 Fabric Drape

Fabric drape is an important property of flexible materials. It is defined as the ability of a fabric to assume graceful appearance in use. The aesthetic characteristics of fabrics are said to be determined first by colour and then by drape. The concept of bending length which was developed in section 15.6 provides an approach for drape testing and evaluation in apparel products. Its only limitation is that it involves two dimensional deformation whereas drape is often a three dimensional deformation.

The three dimensional approach to evaluate fabric drapeability has found expression in the development of an instrument called the drapemeter for objective measurement of drape of fabrics. As shown in Fig. 15.11, this instrument contains a centrally located disc as the horizontal fabric support. A larger circular specimen of fabric is placed centrally on it. By the action of gravity the unsupported outer portion of the fabric specimen is deformed. A quantity called drape coefficient is used to describe the degree of fabric deformation which is defined as a percentage of the draped fabric area over its initial flat state and can be achieved by vertical projection of the fabric. This means that a high drape coefficient indicates a low drapeability of the fabric. In this instrument the coefficient of drape is calculated by tracing a shadow of the draped fabric on paper. The instrument is lighted by a halogen light source. A cutting template and a roll of ammonia paper for tracing are supplied along with the instrument.

![Fig. 15.11 Drape Tester: Principle](image)

Self-check Questions
15.9 Fabric strength

Fabric strength may be considered under three headings namely Resistance to tensile force, resistance to bursting force and resistance to tearing force. Depending on the type of fabric and its end use, the strength properties of a fabric will be measured in one, two or all these three modes.

15.9.1 Tensile strength and breaking elongation

The tensile strength of a fabric represents its resistance to tensile force and is used for both quality control and as a performance test. Breaking strength tests are used mainly for woven fabrics and to a small extent for non-woven fabrics. A tensile testing machine is shown in fig. 15.12.

Two types of fabric strength tests are commonly used: “ravelled strip” and “grab” methods (Fig. 15.13). Breaking strength and breaking elongation can be obtained either from the load either from the elongation curves or directly read. Five samples each of the dimensions shown in the figure in mm are cut from the fabric in the warp and weft directions.

In the case of the ravelled sample the strip is unravelling from the sides to reduce its width. The average breaking load and breaking elongation are reported along with the type of test and the gauge length used.
15.9.2 Bursting strength test

In several applications like filter cloth, socks, nets, parachutes etc. the fabric is stressed in all directions. A bursting strength test simulates this situation and provides useful data for such applications. A knitted sample distorts under a tensile test and therefore a bursting strength test is appropriate for such fabrics. A bursting strength tester is shown in fig. 15.14. This apparatus has a chamber of oil which is used to apply pressure to the sample. A sample of the fabric is clamped across an aperture of a few cm. diameter and subjected to pressure on one face by means of a rubber diaphragm. The fabric is deformed in all directions until it bursts and the stress at which this occurs is known as the bursting pressure of the fabric.

![Fig. 15.14 A bursting strength tester](image1)

15.9.3 Tear strength & tear energy

Tear resistance is an important property of a fabric. The tear strength of a fabric refers to the resistance offered to a tearing force. While inducing a tear in a fabric maybe difficult, once a tear is formed it can propagate at a comparatively low load. Resistance to tearing is of importance in fabrics used for shirting and other apparel fabrics and in technical fabrics such as those used for parachutes. Tear tests are not suitable for knitted and non woven fabrics.

The Elmendorf type of tear tester shown in Fig. 15.15 is extensively used for measuring tear resistance. It employs a pendulum to apply energy sufficient to tear through a fixed length of the fabric. The tear is of the tongue type and is made using the cutter knife provided with the instrument. The sample is clamped, the pendulum is brought to the raised position and then allowed to swing under the force of gravity. In this experiment five warp and five weft samples are subjected to the tear test. The work done on the specimen is the difference between the initial potential energy and the sum of the remaining kinetic and potential energies at the completion of the tear. The average tearing resistance of the given fabric in both principal directions is thus determined.

![Fig. 15.15 Elmendorf type of tear tester](image2)

**Self-check Questions**

6. Describe three tests which are in some ways related to fabric strength.
7. Which method is appropriate for characterizing strength of knitted fabrics and why?

15.10 Fabric Extensiometer

A fabric Extensiometer is an instrument designed to determine stretch and recovery of textile fabrics, both knitted and woven. The instrument (Fig. 15.16) consists of a loading frame with clamps and a screw tensioning device. Three different weights (two of 2 kg and one of 1 kg) along with a sample cutting template are supplied. The extension and recovery of fabric sample can be measured using this instrument. The elastic recovery of fabrics which is one of their most important properties, can be determined at different extensions using this instrument.

Fig. 15.16 A fabric Extensiometer

15.11 Assignments

15.11.1 Class assignments

i) A number of physical tests have been described in this lesson. List them and describe one test of your choice in detail.

ii)

15.11.2 Home assignments

i) You are required to set up a quality control laboratory for a handloom factory producing silk saris. Which tests in your opinion would you recommend to the management for quality control purposes and why?

15.12 Summing Up

In this lesson, the various physical tests performed on fabrics have been described. These include fabric thickness, fabric weight, thread density of the fabric, crease recovery, bending stiffness, pilling, drape, tensile strength, tear resistance, bursting strength and fabric extension. The instruments used for making these tests have also been briefly described. The significance of these tests and the fabric applications for which they are relevant have also been mentioned.

15.13 Possible Answers to Self-check Questions

1. Fabrics are flexible and compressible and therefore their thickness is pressure dependent.
2. GSM stands for gram per square meter. The two methods for measuring GSM are i) Quadrant scale and a template for cutting the fabric & ii) Round cutter and a sensitive balance.

3. i) Pick glass which is a magnifying glass. ii) Digitra which is a digital traverse thread counter.

4. Crease recovery angle is related to the elastic recovery of the sample.

5. When a fabric bends under its own weight and makes an angle of 41.5° with the horizontal, the length of the fabric is equal to the bending length.

6. Abrasion of the fabric is achieved by using cork as the inside lining of the box in the pill tester.

7. During wear & washing of fabrics pills are formed by entanglement of loose fibres which protrude from the fabric.

8. Drape is defined as the ability of the fabric to assume graceful appearance in use.

9. The three tests are i) Tensile test, ii) Bursting strength & iii) Tear test.

10. For knitted fabrics the strength is best characterized through the bursting strength test as the fabric distorts when subjected to a tensile test.

### 15.14 Terminal Questions

1. Why is the measurement of fabric thickness not as simple as it sounds?

2. How are crease recovery and fabric extension / recovery measurements related?

3. Which are the applications of fabrics for which a bursting strength test is relevant?

4. What does bending stiffness mean and how does it affect the drape characteristics of a fabric?

5. What is implied by pilling of a fabric and how do weak fibres help in getting rid of pills?

### 15.15 References


### 15.16 Suggested Further Reading
15.17 Glossary

1. Crease Recovery  Ability of a fabric to recover from an imposed Crease
2. Bending stiffness  The bending rigidity of the yarns in a fabric
3. Ravelled  Loose yarns detached from a fabric for testing
4. Bursting strength  The strength of fabric like filter cloth, socks, nets, parachutes against stretching in all directions
5. Rubber diaphragm  A thin rubber strip like a thin organ beneath the lungs called diaphragm
6. Propagate  To move forward, proceed
7. Extension  Extended length