Standardization body

BSTI
Functions

ISO
Benefits & Standard
Popular Standard

AATCC
Test Method & Activits

BSI

DIN

STANDARDS

Standard:

A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose.

There are several renowned standardization bodies like

A. BSTI
B. ISO
C. AATCC
D. BSI
E. DIN

Standardization body

BSTI
Functions

ISO
Benefits & Standard
Popular Standard

AATCC
Test Method & Activits

BSI

DIN

BSTI

Bangladesh Standards and Testing Institution (BSTI), the only National Standards body of Bangladesh, is playing an important role in developing and Promoting industrial Standardization. The BSTI is a body corporate and its administrative Ministry is the Ministry of Industries. The Institution so formed has become member of the International Organization for standardization (ISO) in 1974.

Only the standards approved, and passed by the Institution are called Bangladesh Standards. As a rule, the Bangladesh Standards are voluntary.

Standardization body

BSTI
Functions

ISO
Benefits & Standard
Popular Standard

AATCC
Test Method & Activits

BSI

DIN

BSTI

The main functions of BSTI

- BSTI is entrusted with the responsibility of formulation of national Standards of industrial, food and chemical products keeping in view the regional and international standards.

- BSTI is responsible for the quality control of the products which are ensured as per specific national standards made by the technical committees formed by BSTI.

- BSTI is also responsible for the implementation of metric system and to oversee the accuracy of weights and measures in the country.

Standardization body

BSTI
Functions

ISO
Benefits & Standard
Popular Standard

AATCC
Test Method & Activits

BSI

DIN

ISO

ISO is an independent, non-governmental international organization with a membership of 162 national standards bodies. Its Central Secretariat is based in Geneva, Switzerland. Today It have members from 162 countries and 3368 technical bodies to take care of standard development. More than 150 people work full time for ISO's Central Secretariat in Geneva, Switzerland.

ISO has published more than 20500 International Standards and related documents, covering almost every industry, from technology, to food safety, to agriculture and healthcare. ISO International Standards impact everyone, everywhere.

Standardization body

BSTI
Functions

ISO
Benefits & Standard
Popular Standard

AATCC
Test Method & Activits

BSI

DIN

ISO

What are the benefits of ISO International Standards?

ISO International Standards ensure that products and services are safe, reliable and of good quality. For business, they are strategic tools that reduce costs by minimizing waste and errors and increasing productivity. They help companies to access new markets, level the playing field for developing countries and facilitate free and fair global trade.

How does ISO develop standards?

ISO standards are developed by the people that need them, through a consensus process. Experts from all over the world develop the standards that are required by their sector. This means they reflect a wealth of international experience and knowledge.

Standardization body

BSTI
Functions

ISO
Benefits & Standard
Popular Standard

AATCC
Test Method & Activits

BSI

DIN

ISO

Popular standards

ISO 9000 - Quality management

ISO 14000 - Environmental management

ISO 22000 - Food safety management

ISO 26000 - Social responsibility

ISO 20121 - Sustainable events

ISO 27001 - Information security

ISO 45001 - Occupational Health and Safety

Standardization body

BSTI
Functions

ISO
Benefits & Standard
Popular Standard

AATCC
Test Method & Activits

BSI

DIN

AATCC

Founded as the American Association of Textile Chemists and Colorists (AATCC), the Association continues to evolve to meet the needs of those in the ever-changing textile and materials industries. AATCC has served textile professionals since 1921. Today, the Association provides test method development, quality control materials, education, and professional networking for a global audience.

- **Members**

Members are Employees of textile, apparel, and home goods manufacturers;

- Dye and chemical manufacturers;
- Testing laboratories;
- Consumer and retail organizations;
- State and federal government agencies; and
- Colleges and universities.

AATCC has thousands of individual and corporate members in more than 60 countries world wide.

Standardization body

BSTI
Functions

ISO
Benefits & Standard
Popular Standard

AATCC
Test Method & Activits

BSI

DIN

AATCC

Test Methods

AATCC is internationally recognized for its standard methods of testing fibers and fabrics to measure and evaluate such performance characteristics as colorfastness, appearance, soil release, dimensional change, and water resistance. New and updated test methods are published annually in the *AATCC Technical Manual*.

Activities

Today, the scope of AATCC reaches far beyond chemists and colorists. Workshops, conferences and publications address topics ranging from design technology to composite materials science.

Standardization body

BSTI
Functions

ISO
Benefits & Standard
Popular Standard

AATCC
Test Method & Activits

BSI

DIN

BSI

BSI British Standards is the UK's national standards organization that produces standards and information products that promote and share best practice.

The BSI was founded in 1901 and subsequently received a Royal Charter which meant that it became the recognised national body responsible for the development and agreement of standards. This was done in response to the demand from buyers that products would meet defined specifications and performance measures.

It serves the interests of a wide range of industry sectors as well as governments, consumers, employees and society overall, to make sure that British, European and international standards are useful, relevant and authoritative.

Standardization body

BSTI
Functions

ISO
Benefits & Standard
Popular Standard

AATCC
Test Method & Activits

BSI

DIN

DIN

DIN is a private organization that is registered as a non-profit association. The DIN **Presidial Board** is responsible for standardization policy and makes business and financial policy decisions for DIN and its subsidiary and associated companies either directly or through its commissions.

ASTM

American Society for Testing and Materials

Fabric Thickness

For measuring the thickness of a wire or a plate, calipers or micrometers are used. But the use of these things for the measurement of thickness of fabric is not possible, since fabrics are liable to compress during measuring. Therefore, the measurement of fabric thickness demands an accuracy.

The following points need to be considered in fabric thickness measurement

1. Shape and size of the pressure foot:

Normally a circular foot of diameter 3/8 inch is used. The ratio between the foot diameter to the cloth thickness should not be less than 5:1.

2. Shape and size of the anvil:

If the anvil is of circular type its diameter should be at least two inch greater than the pressure foot. When the sample is larger than the anvil a smooth plane board may conveniently surrounded the anvil for suitable support for the cloth.

3. Applied pressure:

Suitable weight may be added to the pressure foot and preferred pressure may be applied.

4. Velocity of pressure foot:

The pressure foot should be lowered on to the sample very slowly (at a rate of 2/1000 inch per sec) and carefully.

5. Time:

The thickness is read from the dial of the instrument only when the pointer ceased variations and not earlier.

6. Indication of thickness:

Usually, a clock type dial gauge is built into the thickness tester. It should be rigidly mounted in a suitable frame. After setting the dial to zero, the instrument must be capable of measuring to an accuracy of 1% for fabrics over 0.1 millimetre in thickness and to 0.001 mm of fabrics which are not excluding 0.1 millimetre in thickness.

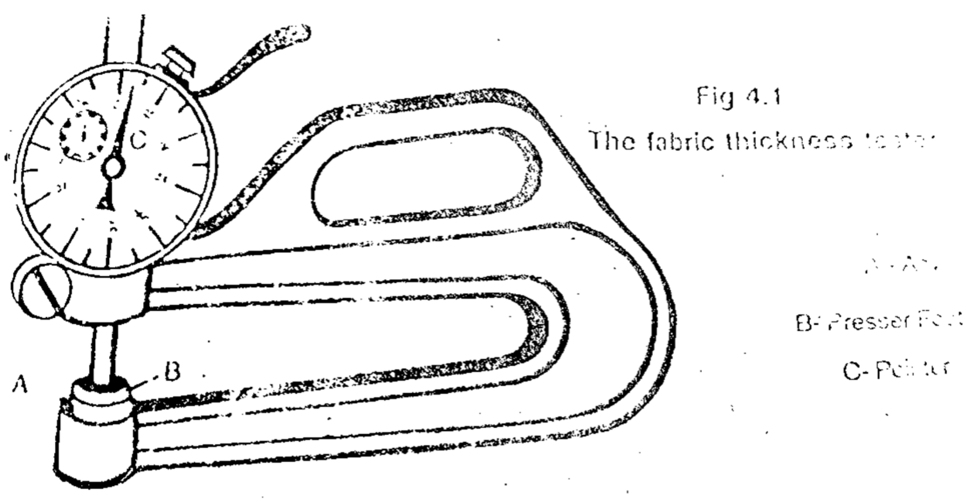


Fig: The Fabric Thickness Tester (A Anvil, B Presser Foot, C Pointer)

Method of Measuring Fabric Thickness

1. The presser foot and anvil are cleaned by a clean paper.
2. If required, weights are added to presser foot and the gauge is set to read zero.
3. No specimen preparation is required. But selvedges and creased areas should be avoided.
4. If possible, the cloth may be conditioned for about 24 hours in standard atmosphere.
5. At least, thickness is measured at 5 places and the mean value is reported.
6. In test report, details of the pressure, size of presser foot and the time should be given.

Fabric Thickness is mainly used

- for checking the conformity to the specifications

- in the study of fabric properties such as thermal insulation, resilience, dimensional stability, fabric stiffness, abrasion etc

- in the study of fabric geometry.

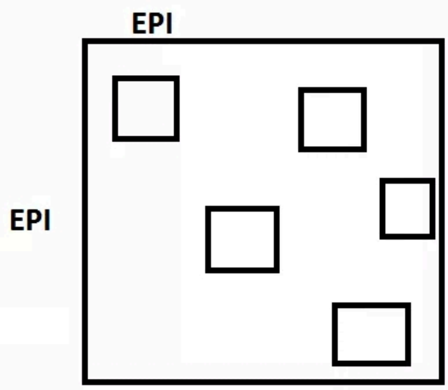
Threads/Inch in the Cloth or Fabric Count
Thread Density
Sett (Woven)

For Woven Fabric: In Warp, EPI
In Weft, PPI

For Knit Fabric: wpi, cpi

Determination of Threads per inch

1. Use of Counting Glass (Pick Glass)
2. Traversing Thread Counter
3. Fabric Dissection (Unravelling the cloth)
4. Parallel Line Grating
5. Tapper Line Grating



Method of Using Counting Glass

- Powerful Light Source and Table
- 5 Different palces has to be checked (Should not be same thread twice)
- Should avoid Selvedge

=> If the thread/inch is fewer than 25, No. of thread per 3 inch is taken and then divide the value by 3

=> If the fabric is less than 3", then Total threads has to be counted and then divide by the fabric width.

=> For Pile fabrics, Ground and pile has to be checked saperately

=> Denotaion should be 100 × 80. Should not be like 8,000

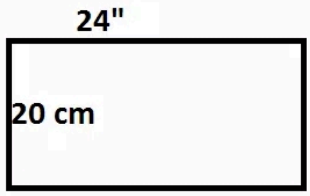
Problem 01:

Here, Length in Fabric, P = 5000 m
Straightened Lenght, L = ?
Crimp, C = 3%

We Know, $C = \frac{L - P}{P} * 100\ \%$

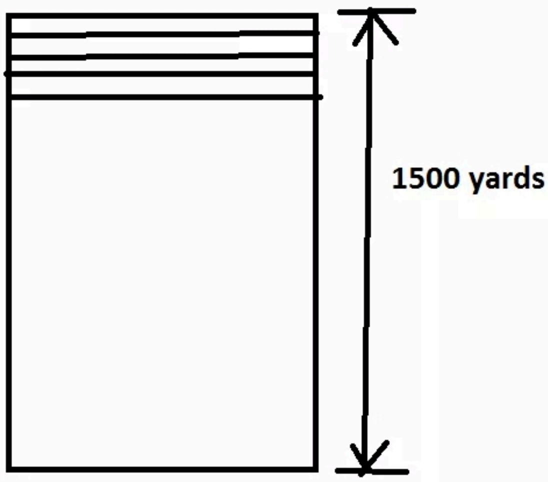
$\Rightarrow L = CP/100\% + P$

$= (3\% * 5000m \ / \ 100\%) + 5000m$
$= 5150\ m$ (Ans)



Problem 02: Do

Problem 03 :



1500 yards = 1500 * 36 inch = 54000 inch

Total No. of Picks = 54000 * 90
= 4860000

Straightended length of each picks = $\frac{6\% * 56 \text{ inch}}{100\%} + 56 \text{ inch}$

= 59.36 inch

Total length of weft yarn = 4860000 * 59.36 * (1/36) yards
= 8013600 yards

Total weight of weft yarn = $\frac{8013600}{840 * 18}$ lb

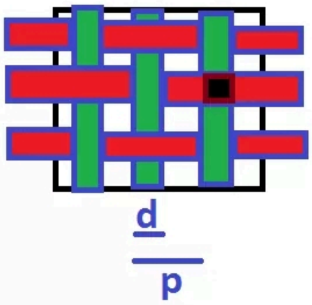
= 530 lb

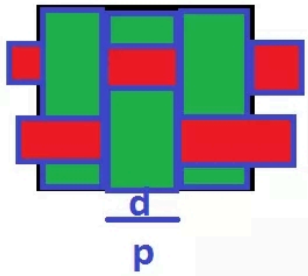
No. of cones = 530/1.5 = 353.33

= 354 (round up)

No. of cones
354 (Ans)

Cloth Cover





$d = 1/28\sqrt{Ne}$ inch

Cover = d/p

P = thread spacing

d = dia of the yarn

$p = 1/n$

n= thread density

$$Cover = d/p = \frac{1}{28\sqrt{Ne}} * \frac{\;}{1/n} = \frac{n}{28\sqrt{Ne}}$$

Warp cover, K1 and Weft Cover, K2

Total Cover = $\boxed{K1 + K2 - K1 * K2}$

where, $K1 = \frac{n}{\sqrt{Ne}}$

Therefore, Cloth Cover, Kc = $K1 + K2 - (K1 * K2 / 28)$

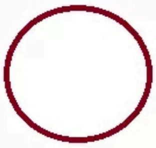
GSM Areal Density

1. $GSM = \dfrac{w * 10000}{A}$

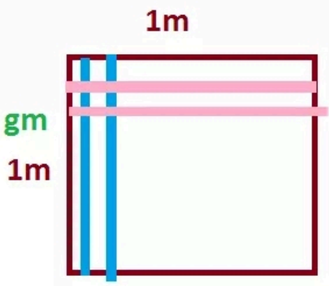
w= weight in gm
A = Area in cm^2

2. GSM = w * 100

w = weight of the GSM cutter sample in gm



3. GSM



weight of warp yarn = EPI * (39.37) * 1 * 1.0936 * {1/(840 * Ne)} * 453.6 gm

$= 23.25 \dfrac{EPI}{\text{Warp Yarn Ne}}$

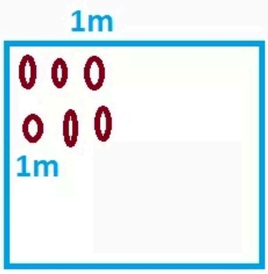
Exactly, $23.25 * \dfrac{EPI}{\text{Warp Ne}} (1 + C1\%)$

$$\boxed{GSM = \left(\frac{EPI * (1 + C1\%)}{\text{Warp Ne}} + \frac{PPI * (1 + C2\%)}{\text{Weft Ne}} \right) * 23.25}$$

25.50

4. GSM (Knit Fabric)

$$\boxed{GSM = \frac{wpi * cpi * \text{loop lenght in mm}}{\text{Yarn count in Ne}} * 0.9158}$$



(wpi * 39.37) * (cpi * 39.37) * (l) * 10 * (1/2.54) * (1/36) * {1/(840*Ne)} * 453.6 gm

Fabric Strength

Why to Test Fabric Stregth?

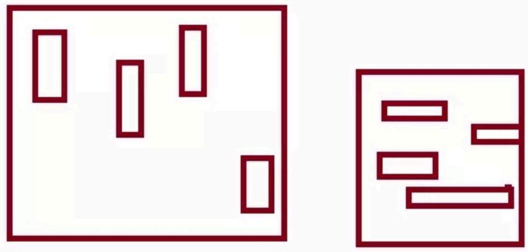
How to check fabric Strength?

Tensile Strength Dress Material such as shirting, suiting,
Tearing Strength Ribbon, tapes, bandage cloth, insulating tapes etc
Bursting Strength Parachute cloth, filter cloth, now-wovens, nets and knitted fabrics

Wear and abrasion Workman's cloth

Tensile Strength

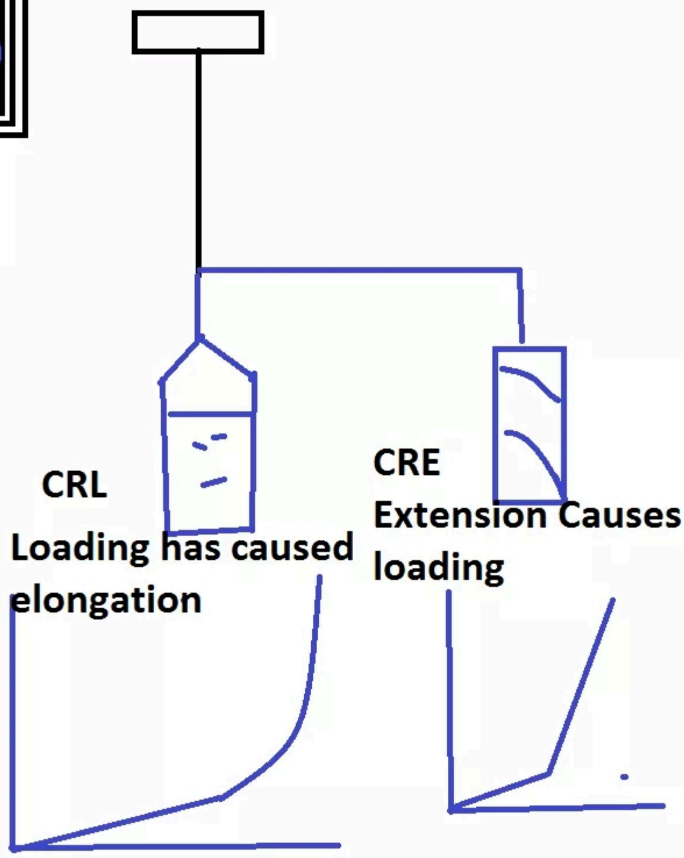
Sample preparation:



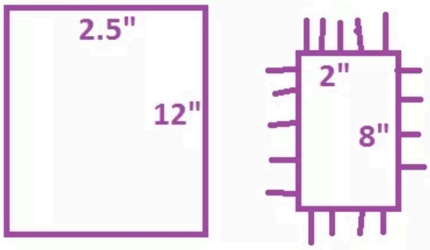
Three tests can be done

1. Ravelled Strip method
2. Cut Strip method
3. Grab method

CRL and CRE

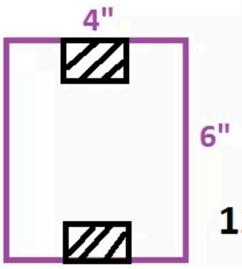


1. Ravelled Strip Method



2. Cut Strip Method

3. Grab Method



12 inches per minute

Yarn Crimp in Fabric

Due to the interlacement of warp and weft thread, a certain amount of waviness is imparted to the warp and weft threads in a fabric. This waviness is called crimp.

- ✓ It can be in two direction like warp crimp and weft crimp
- ✓ Normally weft crimp is higher than warp crimp [As warp yarns work in group during fabric formation]
- ✓ It is expressed in percentage. For a normal fabric, warp crimp is about 3%, and weft crimp is about 5%

Mathematically, Crimp = $\frac{l-p}{p} \times 100\%$

Here, l = Straightened thread length

p = The distance between the ends of the thread while in cloth (crimped length or length in fabric)

For warp and weft crimp we can use suffix 1 and 2.

The Measurement of Crimp Percentage

From the definition of the crimp two values must be known. These are l and p. In order to straighten the thread, tension must be applied, just sufficient to remove all the crimps without stretching the yarn. The standardized tension as per British standards are given below-

Yarn	**Count**	**Tension (gm)**
Cotton	Finer than 7 tex	0.75 tex
	Coarser than 7 tex	0.20 tex + 4
Woolen and Worsted	15-60 tex	0.20 tex + 4
	60-300 tex	0.07 tex + 12
All Man-made continuous filament	All counts	Tex/2

The principle of yarn crimp determination is very simple. With a fine pen and a ruler, lines are drawn on a piece of cloth at a known distance. Some of the threads are raveled out, the yarns are straightened without stretching and the stretched length is noted and from that crimp is calculated. The difficulty lies in the straightening of the Year Without stretching it. To do this, the following three methods are available-

1. Straighten by hand; This is inaccurate since we do not know the force applied.

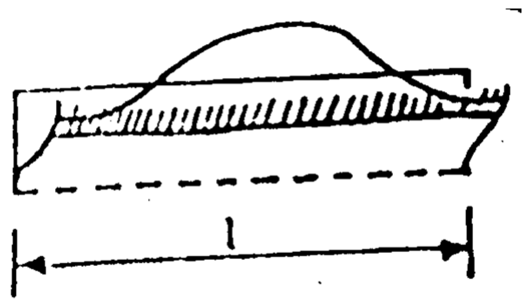
2. Straighten by a standard weight; This is satisfactory if we know what weight to use.

- Shirley Crimp Tester
- Digital Crimp Tester (Heal's Instrument)
- WIRA Crimp Tester etc

3. Determine the straightened length from the load-elongation curve; This is most accurate method.

Specimen Preparation:

Rectangular strips are carefully marked on the cloth and each strip is cut in the form of a flap. From each strip 10 threads will be removed. Normally, 3 strips in warp way and 3 strips in weft way are cut.

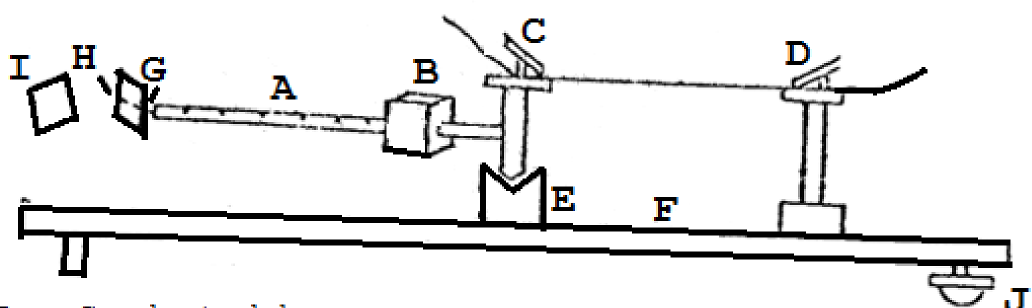


Removal of the Threads from the Flap:

The central part of the first thread is separated form the flap by means of a needle, but the two extreme ends are left secured. One end is then removed and place in the clamp of the tester and the other end is removed and placed in the second clamp. By this method, there will be no loss in the twist of the yarn and also due to minimum handling, there will be no stretch in the yarn.

Shirley Crimp Tester

The instrument consists of a scale fixed on a base. At one end of the base, V grooves are provided to support the balancing head and a mirror at the other end. At one end of the balancing head, a fixed clamp is provided and at its other end on the frame, index lines are marked. Another movable clamp is provided on the base and can be slide over the scale. Tension weight is provided on the balancing head to change the tension according to the yarn count. Tension scale is marked in two ranges, 0-35 gms and 0-175 gms.



A = Graduated beam
B = Tension weight
C = Fixed Jaw
D = Movable Jaw
E = V-Groove

F = Base Scale
G = Datum mark on the beam
H = Datum mark on the frame
I = Mirror
J = Levelling Screw

Fig: Shirley Crimp Tester

Procedure:

The counts of the warp and weft yarns are first determined and the correct tension is calculated. The sliding weight on the balancing head is adjusted to the required tension. The yarn sample si prepared as above and one end of the yarn is carefully inserted in the clamp such that the end of the yarn is in line with the rear edge of the clamp.

With the movable jaw set to a length somewhat less than the estimated length of the yarn, the other end of the yarn is inserted into it. The movable jaw is then moved slowly to the right until the index marks on the balancing head and the frame are in line. Then the length of the yarn corresponding to the red mark on the movable grip is noted from the base scale.

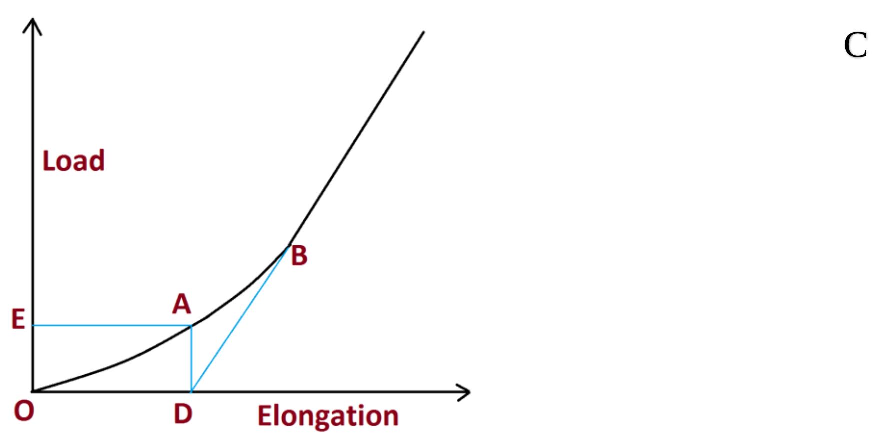
Then, the crimp can be calculated by putting l and p into the formula.

Digital Crimp Tester

Follow the link https://www.youtube.com/watch?v=bYtTLMSRYt8&t=336s

Load-Elongation Curve Method

Parallel ink lines are marked on a piece of cloth p distance apart. Five yarns are unraveled and one is tested at a time. The yarn is clamped at one of the ink spots and the yarn is allowed to hang vertically in front of the scale. A small clamp of known weight is hung on the yarn at the other ink spot. At this load, the elongation is read. Successively small loads are applied and the elongation at each new load is noted. Then a curve is drawn by taking the elongation value on the X- axis and the load values on the Y- axis.



In this curve, there is a curved portion OB and straight portion BC. The region OB represent the removal of the crimp. The region BC represent the stretch of the yarn. If there were no crimp, the curve would be all

the straight-line DC. Therefore, the distance OD represents the elongation of the yarn due to the removal of crimp. Then the original length P plus the value OD is the length of the yarn before weaving is equal to L. So, L = P + OD
Then, the crimp can be calculated by putting l and p into the formula.

Influence of Crimp on Fabric Properties

1. Thickness
2. Resistance to Abrasion
3. Shrinkage
4. Fabric behaviors during tensile testing
5. Faults in Fabric
6. Fabric Design
7. Fabric Costing
8. Let off and take up speed variation

Take up Percentage

Take up percentage or crimp rigidity is a measure of the ability of textured yarn to receive from stretch and is related to the bulking properties of the yarn.

Take up percentage, T= $\frac{l-p}{l}\times 100$

Where, T= Take up percentage.
l = ***L***ength of yarn before weaving.
p = ***L***ength of yarn in fabric after weaving.

Relation between Crimp % & Take up %

Crimp Percentage, C $=\frac{l-p}{p}\times 100$ ....*(1)*

& *Take up percentage*, T $=\frac{l-p}{l}\times 100$ ......*(2)*

From eq*ation* (1), $C = \frac{l-p}{p}\times 100$

=> $\frac{l-p}{p} = \frac{C}{l00}$ ....*(3)*

=> $\frac{l}{p} - 1 = \frac{C}{l00}$

=> $\frac{l}{p} = \frac{C}{l00} + 1 = \frac{C+100}{l00}$ ....*(4)*

From equation (2),

$$\Rightarrow \quad T = \frac{l-p}{l} \times 100$$

$$\Rightarrow \quad T = \frac{\frac{C}{100}}{\frac{C+100}{100}} \times 100 \qquad \textbf{[Using eauation (3) and (4)]}$$

$$T = \frac{100C}{100+C}$$

Similarly, following equation can be developed

$$C = \frac{100T}{100-T}$$

These two are the equations on the relationship between Crimp% & Take up%

Mathematical Problems

1. To produce 5000 m of fabric with 3% warp crimp, how many yards of each warp yarn will require?

2. Let you have 24” × 20cm dimension fabric sample. Calculate the warp crimp and weft crimp when length of yarn is 62 cm and 21.1 cm respectively.

3. To produce 1500 yards of woven fabric having warp crimp 4% & weft crimp 6% of specification $\frac{114 \times 90}{20 \times 18} \times 56"$, how many cones of weft yarn will you require if the weight of each cone is 1.5 lb.

4. If the crimp% is 4.5% for warp of a fabric, then what will be its take up percentage.

5. Calculate crimp% and take-up% of woven fabric when its straightened length of yarn is 13 m and length of the warp yarn in fabric is 12.6 m.

STRENGTH

Before any strength test of fabric is done the end use has to be clarified so that a good idea of the fabric performance can be determined.

The strength of the fabric may be determined from the following 3 approaches.

1. Its resistance to a tensile force.
2. Its resistance to a tearing force.
3. Its resistance to a bursting force.

- Strength
- Tensile Strength Testing
- Strip Test
- Grab Test Method
- Grab Test Method {Procedure}
- Comparison between Strip Test and Grab Test

- Tearing Strength Testing
- Methods of measuring Tear Strength

- Bursting Strength Testing
- The Hydraulic bursting tester

TENSILE STRENGTH TESTING

The breaking strength is a measurement of the resistance of the fabric to a tensile load or stress in either warp or weft direction.

To measure the breaking strength, there are three tests that may be used. They are-

1. Ravelled Strip Method
2. Cut Strip method(You will see it in BV)
3. Grab method.

- Strength
- Tensile Strength Testing
- Strip Test
- Grab Test Method
- Grab Test Method {Procedure}
- Comparison between Strip Test and Grab Test

- Tearing Strength Testing
- Methods of measuring Tear Strength

- Bursting Strength Testing
- The Hydraulic bursting tester

STRIP TEST (BRITISH) BS 2576

In This Method a Fabric Strip is extended to its breaking point by a suitable mechanical means which can record the breaking load and extension.

Five Fabric Sample both in warp and weft direction are prepared with each not containing the same longitudinal thread.

Samples are prepared 60 mm * 300 mm and then frayed to get 50mm wide specimen.

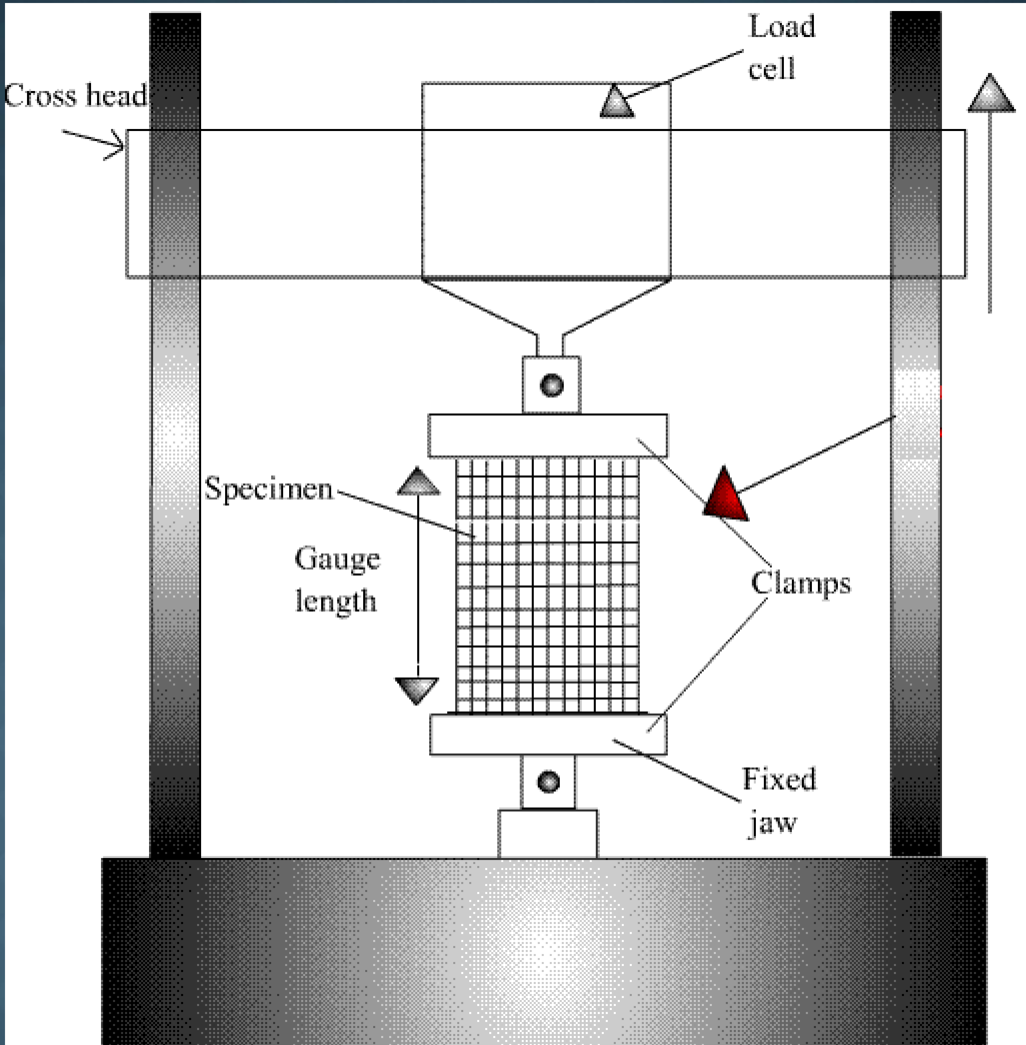
The Rate of Extension is set to 50 mm/min and gauge length is 200 mm

- ❑Strength
- ❑Tensile Strength Testing
- ❑Strip Test
- ❑Grab Test Method
- ❑Grab Test Method {Procedure}
- ❑Comparison between Strip Test and Grab Test

- ❑Tearing Strength Testing
- ❑Methods of measuring Tear Strength

- ❑Bursting Strength Testing
- ❑The Hydraulic bursting tester

STRIP TEST (BRITISH) BS 2576



The apparatus for a fabric tensile test

- ❑Strength
- ❑Tensile Strength Testing
- ❑Strip Test
- ❑Grab Test Method
- ❑Grab Test Method {Procedure}
- ❑Comparison between Strip Test and Grab Test

- ❑Tearing Strength Testing
- ❑Methods of measuring Tear Strength

- ❑Bursting Strength Testing
- ❑The Hydraulic bursting tester

STRIP TEST (BRITISH) BS 2576

Any breaks that occur within 5mm of the jaws or at loads substantially less than the average should be rejected.

The mean breaking force and mean extension% of initial length are reported.

Samples are cut (60mm * 300 mm) parallel to warp/weft

Frayed the threads from both sides of the width to bring down to 50 mm wide.

For havilly milled fabrics, no fraying is done (50 mm * 300 mm)

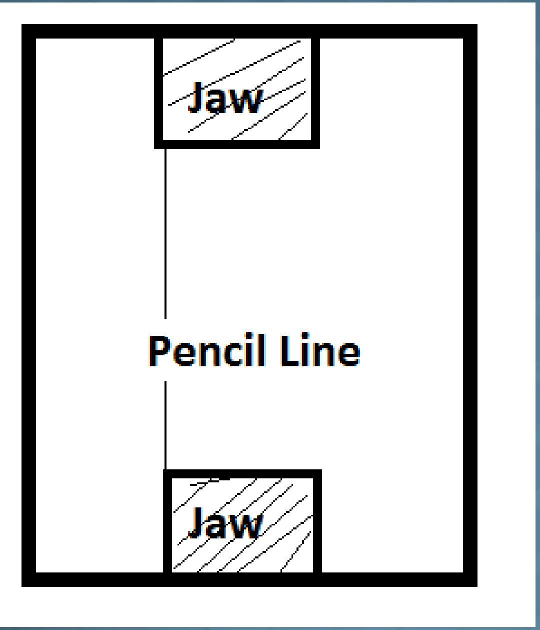
- ❑Strength
- ❑Tensile Strength Testing
- ❑Strip Test
- ❑Grab Test Method
- ❑Grab Test Method {Procedure}
- ❑Comparison between Strip Test and Grab Test

- ❑Tearing Strength Testing
- ❑Methods of measuring Tear Strength

- ❑Bursting Strength Testing
- ❑The Hydraulic bursting tester

GRAB TEST METHOD

It is a tension test on the fabric in which only a part of the width of the specimen is gripped in the clamps. For example, if the specimen width is 4 inches and the width of the jaw is 1 inch, the specimen is gripped centrally in ht clamps.



❑Strength
❑Tensile Strength Testing
❑Strip Test
❑Grab Test Method
❑Grab Test Method {Procedure}
❑Comparison between Strip Test and Grab Test

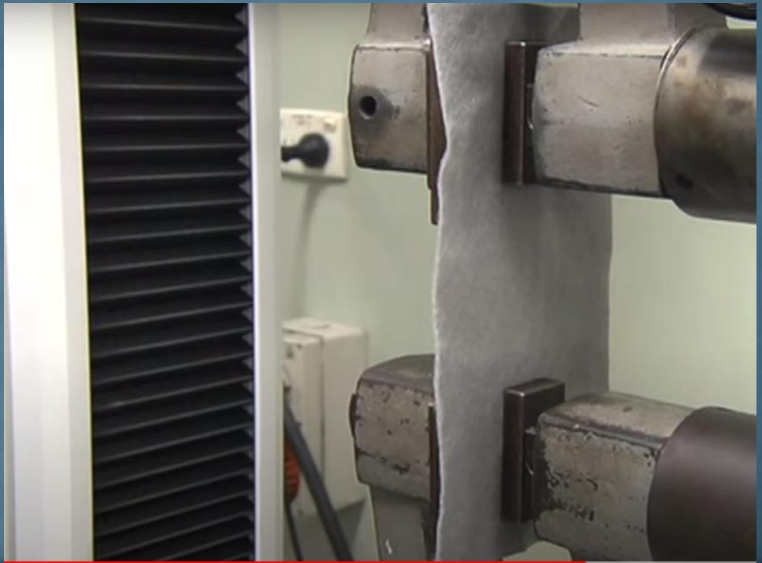
❑Tearing Strength Testing
❑Methods of measuring Tear Strength

❑Bursting Strength Testing
❑The Hydraulic bursting tester

GRAB TEST METHOD

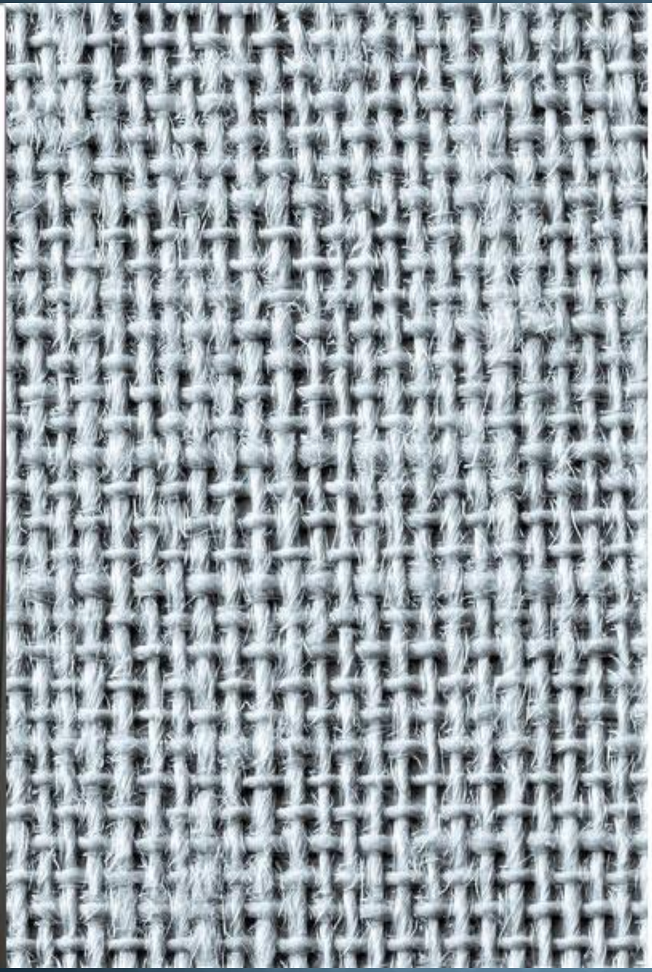
Test samples of size 4 × 6 inches are cut from the master sample. The 6 inch length is parallel to the yarn to be tested and it is dependant on the gauge length.

In setting the testing instrument, the clamps must be set 3 inches apart. The lower jaw moves at a rate of 12 inches per minutes.



- ❑Strength
- ❑Tensile Strength Testing
- ❑Strip Test
- ❑Grab Test Method
- ❑Grab Test Method {Procedure}

GRAB TEST METHOD (ASTM D4632)



- Strength
- Tensile Strength Testing
- Strip Test
- Grab Test Method
- Grab Test Method {Procedure}
- Comparison between Strip Test and Grab Test
- Tearing Strength Testing
- Methods of measuring Tear Strength
- Bursting Strength Testing
- The Hydraulic bursting tester

GRAB TEST METHOD {PROCEDURE}

1. Inspect the tester for correct size of the clamps, distance between the clamps etc.
2. If stress strain chart can be made in the instrument, the position of pen on the chart is set properly.
3. Place the sample in the clamps. It is important that the same ends are caught by both the clamps.
4. Apply the load to the sample by screw mechanism. When the sample breaks, reverse the movement of the lower clamp and raise the pen from the chart, if it is used.
5. Record the breaking strength and return the pendulum to the zero position.

Five breaks are made for warp and weft breaking strength.

- Strength
- Tensile Strength Testing
- Strip Test
- Grab Test Method
- Grab Test Method {Procedure}
- Comparison between Strip Test and Grab Test

- Tearing Strength Testing
- Methods of measuring Tear Strength

- Bursting Strength Testing
- The Hydraulic bursting tester

Comparison between Strip Test and Grab Test

During the grab test, as some loose fabric is supporting the specimen on both sides of the jaws, the strength obtained in grab test will be more.

The preparation of sample in grab test is much easier as there is no use of ravelling operation to remove the threads. Hence it is suitable for routine work and not for research work.

- Strength
- Tensile Strength Testing
- Strip Test
- Grab Test Method
- Grab Test Method {Procedure}
- Comparison between Strip Test and Grab Test
- Tearing Strength Testing
- Methods of measuring Tear Strength
- Bursting Strength Testing
- The Hydraulic bursting tester

TEARING STRENGTH TESTING

The tearing strength is a measure of the resistance to tearing of either the warp or weft series of yarns in a fabric.

A fabric which tears easily is regarded as an inferior product. The amount of resistance of a fabric to tearing is often important and particularly in fabrics like, bandage cloth, adhesive tapes, military fabrics etc.

- ❑Strength
- ❑Tensile Strength Testing
- ❑Strip Test
- ❑Grab Test Method
- ❑Grab Test Method {Procedure}
- ❑Comparison between Strip Test and Grab Test

- ❑Tearing Strength Testing
- ❑Methods of measuring Tear Strength

- ❑Bursting Strength Testing
- ❑The Hydraulic bursting tester

METHODS OF MEASURING TEAR STRENGTH

a. The Tongue Tear Test
b. The Tongue Double Rip Test
c. Trapezoid Tear Test
d. Ballistic Tear Test (The tearing tests described above are normally done at a slow rate of jaw separation, but in practice tears are produced accidentally and at a relatively high speeds. The rapid action of the ballistic test may, therefore, provide a better method which is more approximate to actual tearing of a fabric. The ballistic tester records the energy required to break the specimen)
e. Wing Rip Tear Test

METHODS OF MEASURING TEAR STRENGTH

- ❑Strength
- ❑Tensile Strength Testing
- ❑Strip Test
- ❑Grab Test Method
- ❑Grab Test Method {Procedure}
- ❑Comparison between Strip Test and Grab Test

- ❑Tearing Strength Testing
- ❑Methods of measuring Tear Strength

- ❑Bursting Strength Testing
- ❑The Hydraulic bursting tester

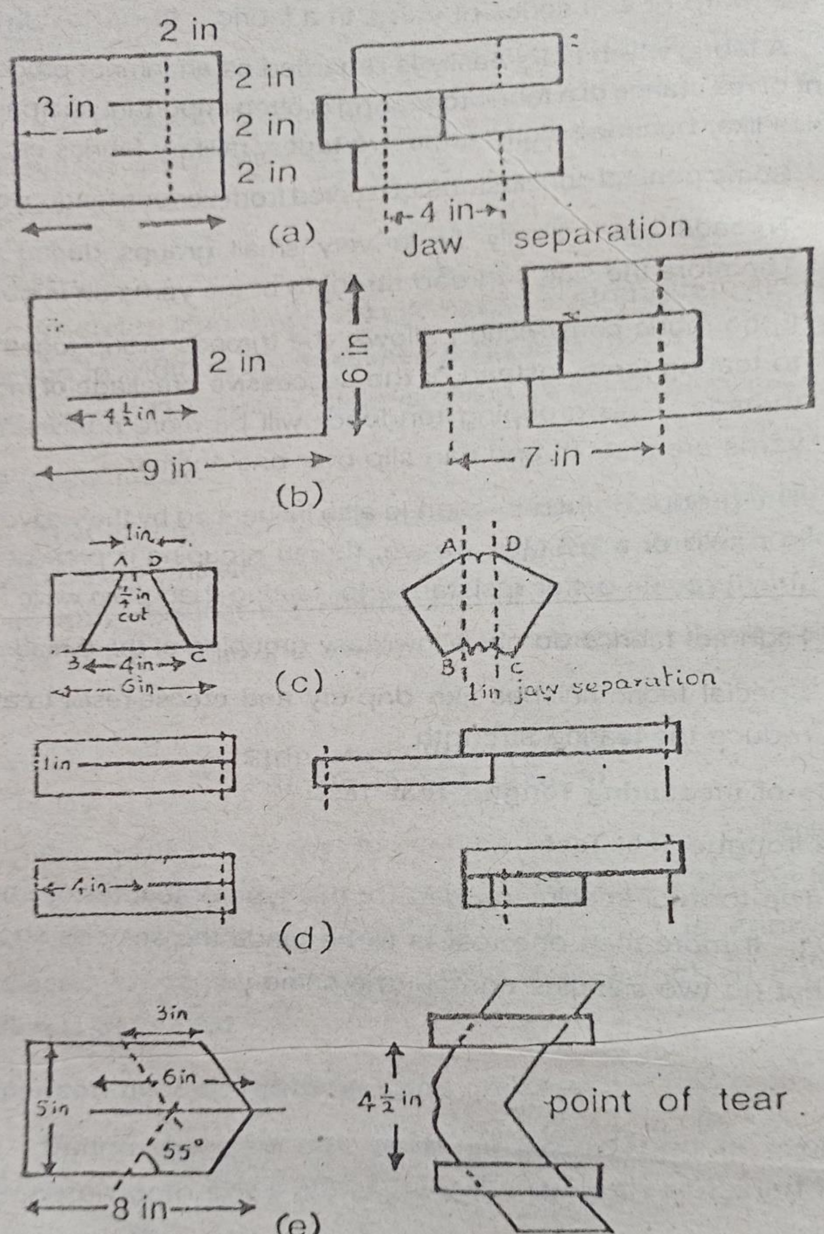


Fig: 4-10 Tearing strength test specimens,
a - Tongue tear test
b - Tongue double rip tear test
C - Trapezoid tear test
d - Ballistic Single rip tear test
e - Wing rip tear test

- Strength
- Tensile Strength Testing
- Strip Test
- Grab Test Method
- Grab Test Method {Procedure}
- Comparison between Strip Test and Grab Test

- Tearing Strength Testing
- Methods of measuring Tear Strength

- Bursting Strength Testing
- The Hydraulic bursting tester

TEARING STRENGTH TESTER (ASTM D2261)

❑Strength
❑Tensile Strength Testing
❑Strip Test
❑Grab Test Method
❑Grab Test Method {Procedure}
❑Comparison between Strip Test and Grab Test

❑Tearing Strength Testing
❑Methods of measuring Tear Strength

❑Bursting Strength Testing
❑The Hydraulic bursting tester

Tearing Strength Tester (Ballistic Tear Test)

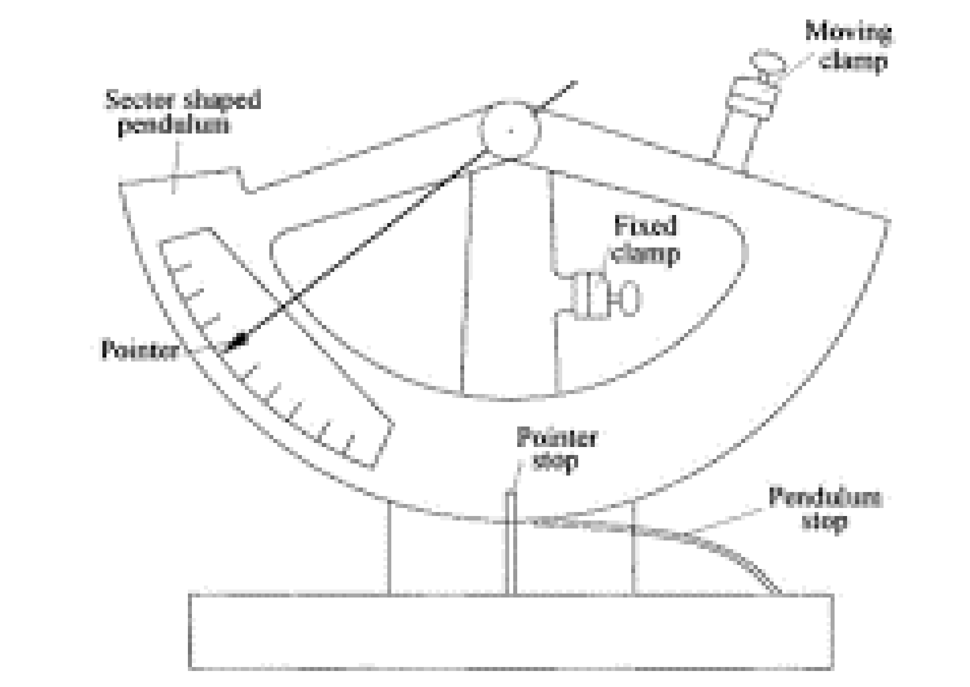


Figure: Elmendorf tear test.

- ❑Strength
- ❑Tensile Strength Testing
- ❑Strip Test
- ❑Grab Test Method
- ❑Grab Test Method {Procedure}
- ❑Comparison between Strip Test and Grab Test

- ❑Tearing Strength Testing
- ❑Methods of measuring Tear Strength

- ❑Bursting Strength Testing
- ❑The Hydraulic bursting tester

BURSTING STRENGTH TESTING

Bursting Strength is the strength of a fabric against a multidirectional flow of pressure.

The Bursting test measures a composite strength of both warp and weft yarns simultaneously and indicate the extent to which a fabric perpendicular to the surface of the fabric.

The reason for this method of tearing may be due to the material in use is stressed in many directions simultaneously. Filter cloths, sacks, nets and parachute cloths are examples for fabric stressed in all direction. Also knitted fabrics can not be easily tested in strip form and fabrics without well defined direction like felted cloth or bonded fabrics may be conveniently tested on a bursting strength tester.

- ❑Strength
- ❑Tensile Strength Testing
- ❑Strip Test
- ❑Grab Test Method
- ❑Grab Test Method {Procedure}
- ❑Comparison between Strip Test and Grab Test

- ❑Tearing Strength Testing
- ❑Methods of measuring Tear Strength

- ❑Bursting Strength Testing
- ❑The Hydraulic bursting tester

THE HYDRAULIC BURSTING TESTER

Principle: The pressure in a liquid is exerted in all directions and this phenomenon of a liquid is used for testing bursting strength in Hydraulic bursting strength tester.

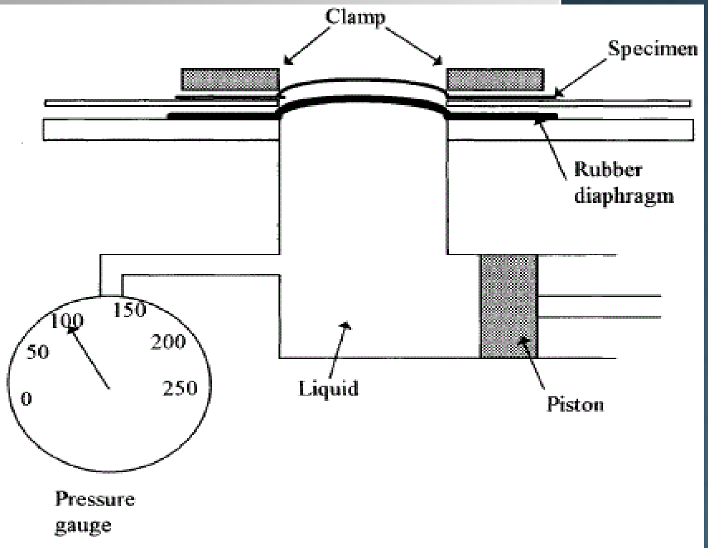
Sample Size: The specimen for this test should be cut so that the sample is ½ inch greater in diameter than the outside diameter of the clamp ring. Ten specimens are chosen avoiding inclusion of the same ends in the different specimens.

Instrument Criteria: The instrument used for testing bursting strength should have a constant rate of speed and must be capable of giving a uniform displacement of 6±0.25 cubic inches per minute. For proper operation, the machine must be stopped at the instant of rupture in order to avoid additional application of pressure and load on the specimen.

THE HYDRAULIC BURSTING TESTER

Procedure:

Briefly the specimen is clamped by a ring over a thin flexible rubber diaphragm as shown in fig which itself is clamped over a circular hole in the upper face of a reservoir. The liquid used may be water or glycerin. The pressure in the liquid is increased, by valves or screw-driven piston. Due to increase in pressure, the diaphragm bulges, taking with it the specimen. At some point the fabric bursts, and the pressure at that point is indicated by the pressure gauge.



Since the rubber diaphragm requires a certain pressure to stretch it, corrections are made by doing a blank test, i.e. noting the pressure required to distend the diaphragm the same amount without the presence of fabric.

- Strength
- Tensile Strength Testing
- Strip Test
- Grab Test Method
- Grab Test Method {Procedure}
- Comparison between Strip Test and Grab Test

- Tearing Strength Testing
- Methods of measuring Tear Strength

- Bursting Strength Testing
- The Hydraulic bursting tester

WOUNDED BURSTING STRENGTH TEST

In the Test Specimen, if cuts by chisel for ½ inch is made (either in warp or in weft direction or in both) or if a ¼ inch hole is punched and then the same test is carried out, then it is called wounded bursting strength test.

FABRIC TENSILE STRENGTH DEPENDS ON

- Raw material.

- Yarn strength (twist: more twist for more strength)

- Fabric construction (*weave*: plane weave is stronger than floats-satin, sateen which are weaker, *Density*: low density cause weave slippage which result in seam slippage).

- Finish applied (resin finish improves weave slippage).

- Adverse of "finishing" process.

Stiffness

Fabric Stiffness indicates the resistance of the fabric to bending and it is a key factor in the study of handle and Drape. It is a fabric property to describe resistance against deformation. In case of yarn, subjected to a tensile force or pull, stiffness is the ability to resist elongation and in case of circular bending of textile, resistance to multidirectional bending.

Methods of Measuring Fabric Stiffness

1. By the thickness of a folded sample
2. By the sag of projecting strip of sample-Cantilever test
3. By the length of a Heart loop (Heart loop test)
4. By means of a Flexometer
5. By means of a Planoflex
6. By the moment of rotation

The cantilever Test is the preferred method because it is simple to carry out. However, it is not suitable for testing fabrics which are very limp and which have a marked tendency to curl or twist at a cut edge. For these types of fabrics, the Heart-Loop test may carry out. The unit of stiffness is gm/denier per elongation

These methods measure the **Bending Length** of fabric, and from this the **Flexural Rigidity** and **Bending Modulus** can be calculated.

Bending Length(C)

Bending Length is also called as Drape Stiffness. This is the length of fabric that will bend under its own weight to a definite extent. It reflects the stiffness of a fabric when bend in one plane under the force of gravity and is one component of drape.
A rectangular strip of fabric is mounted on a horizontal platform and slided until the fabric overhangs like a cantilever, as shown below-

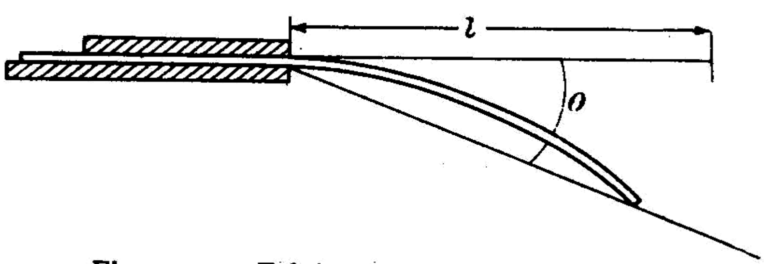


Figure . Fabric stiffness, cantilever principle

The length of overhang l when it is depressed under its own weight and the angle between the line joining the tip to the edge of the platform Θ are measured and from these values, the bending length is calculated-

Bending Length, $C = l \times f_1(\theta)$

$$c = l\left(\frac{\cos \frac{1}{2}\theta}{8\tan\theta}\right)^{\frac{1}{3}}$$

Where, l = unsupported fabric length or length of overhang.
Θ = the angle between the line joining the tip to the edge of the platform.

The Labour of calculating the function of Θ is avoided by consulting a prepared Table. For example, when θ=41.5° then $f_1(\theta)=0.509$. Bending length is calculated for warp and weft way of the fabric.

Flexural Rigidity(G)

Flexural rigidity is a measure of stiffness associated with handle. It is also called Flex Stiffness. This method of testing stiffness shows a close relationship with the personal judgment of stiffness.

It is calculated from the bending length and weight of per square yard of fabric.

Flexural Rigidity, $G = 3.39 \times W_1 \times C^3$ mg/cm

Or $G = W_2C^3 \times 10^3$ mg/cm

Where, W_1=Cloth wt in oz/yd^2
W_2=Cloth wt in gm/cm^2
C=Bending length

Flexural Rigidity is calculated for warp and weft way of fabric and the overall flexural rigidity is calculated as the geometric mean of those two values.

Overall Flexural Rigidity, $G_o = \sqrt{Gw \times Gf}$

Where, G_w = Warp Flexural Rigidity
G_f = Filling Flexural Rigidity.

Bending Modulus(q)

This value is independent of the dimensions of the strip tested and may be regarded as the intrinsic stiffness. This value may be used to compare the stiffness of the material in fabrics of different thickness values. For this calculation, the thickness of the fabric is measured at a pressure of 1 lb/sq. inch then,

$$q = \frac{732G}{g_1^3} kg/cm^2$$

$$= \frac{12G \times 10^{-6}}{g_2^3} kg/cm^2$$

where **g_1**= Cloth thickness in thousands of an inch. (Thou)
g_2 = Cloth thickness in cm.
G = Flexural rigidity.

Cantilever (Principle)Test

1. The Shirley stiffness tester.
2. The Heart loop tester.
3. The drape meter.

1.The Shirley Stiffness Tester

Basic principle:

[mentioned earlier Bending Length, Flexural Rigidity and Bending Modulus]

Construction:

- The stiffness tester consists of a platform having which is supported by two side pieces made of plastic. Index lines are engraved on these side pieces, inclined at an angle of 41.5° below the plane of the platform surface. At this angle, $f_1(\theta)$ is 0.5.
- A mirror is attached to the instrument to enable the operator to view both index lines from a convenient position.
- A scale is supplied with the instrument to measure the bending length and is graduated in cm of bending length. It also serves as a template for cutting the samples of size.
- This instrument is used in the finishing departments where the control of the process is used and to note the effects of varying the process.

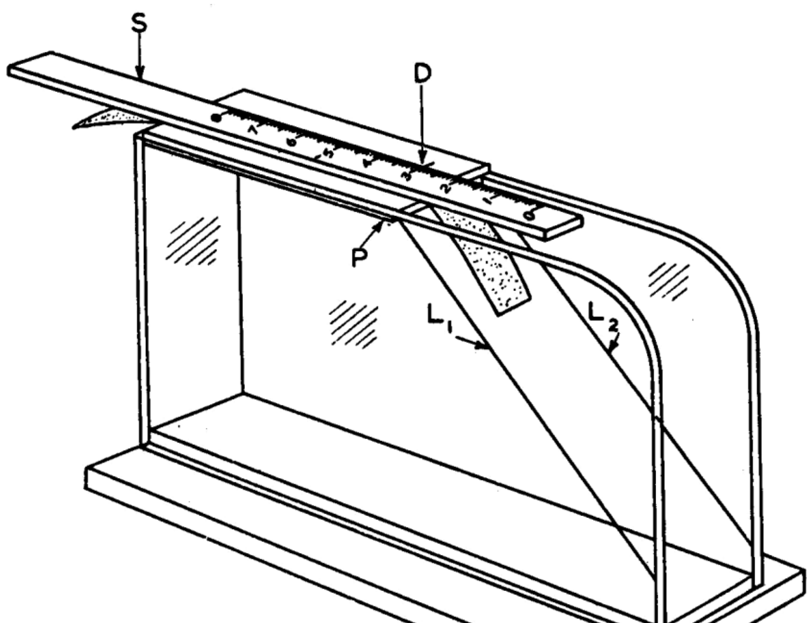


Figure . *Fabric stiffness tester* (From B.S. Handbook No. 11, *Methods of Test for Textiles* reproduced by permission of the British Standards Institution, 2 Park Street, London W.1)

S=Fabric Sample, P=Platform, D=Datum line, L_1 and L_2=Index lines

Sample Preparation:

The sample is conditioned in the standard testing atmosphere and using the template, specimens are cut to the size of 6″ × 1″. Four specimens in warp way and weft way are prepared for the test. If the fabric is not uniform or a high degree of accuracy is required then more samples can be tested. The specimens are cut in such a way that the warp specimens do not contain the same warp yarns and the weft specimens contain different warp yarns. Selvedges, end pieces, crease or folded places must be avoided and the specimens must be handled as little as possible.

Working procedure:

1. The test is carried out in the standard testing atmosphere. The tester is set on a table so that the horizontal platforms are the index line are at eye level.
2. The Specimen is placed on the platform with the template at the top of it so that the leading edges coincide. Both are slowly pushed forward until the leading edges of the specimen and the template project beyond the edge of the platform. With the eye in a position so that the index lines coincide, the sliding of the specimen is stopped when it cuts both index lines.
3. If the specimen has a tendency to twist, the reference point at the centre of the leading edge is taken. For the specimens which twist more than 45°, this method should not be used.
4. Four readings are taken from each specimen, with each side up, first at one end and then the other and again with the strip turned over. Mean values for the **Bending Length** in warp and weft way are calculated and the **Flexural Rigidity & Bending Modulus** are also determined.

$$C = l \times f_1(\theta)$$

$$c = l\left(\frac{\cos \frac{1}{2}\theta}{8\tan\theta}\right)^{\frac{1}{3}}$$

2. Heart Loop Test

Some Fabrics are too flexible or limp and they will have a tendency to twist or curl when hanging. For this type of fabrics, the heart loop test is recommended. Pierce recommended a method for stiffness called the heart loop method for use of very soft material where the stiffness can be determined by the cantilever principle.

The apparatus used for this test consists of a clamp for hanging the specimens and a scale, suitable mounted, for measuring the length of the specimen.

Sample Preparation:

1. Specimen length for various fabric types

Bending length, cm	Specimen length, cm
Less than 2	15
2 to 3	20
More than 3	at least 25

2. For fabrics having only a slight tendency to curl, a 2.5 cm wide strip is satisfactory. If the tendency to curl increases, the strip width should be increased. However, strip widths of more than about 7.5 cm have not been investigated and should be used with caution.

3. Test Specimen are cut from the samples 5 cm longer than the specimen length selected to allow for clamping at the edges. Four specimens in warp way and four specimens in weft way are prepared. If the fabric is not fairly uniform or if greater precision is required, a greater number of specimens should be tested.

Procedure:

The free ends of the specimen are mounted in a clamp in the apparatus so that the loop is free to hang vertically. A stiff fabric will hang as first figure and very limp fabric will hang vertically as shown in the right figure.

After an interval of 1 minute, the distance between the top edge of the clamp to the bottom of the loop, l is measured. In this test, stiffness is inversely proportional to the length, l.

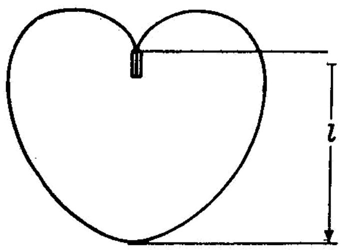


Figure . The heart-loop test (stiff fabric)

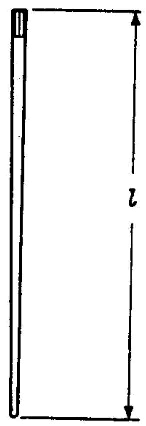


Figure The heart-loop test (limp fabric)

Then the specimen is removed form the clamp, turned over and the experiment is repeated and the length l is measured again.

The above procedure is repeated for all the test specimens and the average length l is calculated for all the warp and weft specimens. The length l is called as loop length, measured in cm.

A strip of fabric of length L is folded back on itself and is very stiff then length of loop would be 0.1337L but if the fabric is completely limp and the clamps were very thin, the length of loop would be 0.5L.

The bending length is calculated from the formula-

$C = l_0 \, f_2(\theta)$

Where $\theta = 32.85° \times \dfrac{d}{l_0}$

$d = l - l_0$

l = Actual length of loop (Loop Length)

$l_0 = 0.1337L$

L = Specimen length

$$f_2(\theta) = \left(\frac{\cos\theta}{\tan\theta}\right)^{\frac{1}{3}}$$

From the value of bending length in warp and weft directions the Flexural Rigidity and Bending Modulus of warp and weft ways are calculated.

3. Drape meter

Drape:

Drape is the property of fabric which indicates the ability of a fabric to assume a graceful appearance in use. It is the opposite characteristically feature of stiffness of the fabric. It is important property of textile materials which allows fabric to orient itself into graceful folds or pleats as a result of force of gravity.

Measurement of Drape:

Drapability of a fabric can be determined using the instrument **Drapemeter** and is expressed in terms of **Drape Co-efficient.**

Drape coefficient, F:

It is the ratio of the projected area of the draped specimen to its undraped area, after deduction of the area of the supporting disk.

Thus, $F = \dfrac{A_s - A_d}{A_D - A_d}$

Where, A_s = The actual projected area of the specimen
A_D = The area of the specimen
A_d = The area of the supporting disk

Description and Working Procedure:

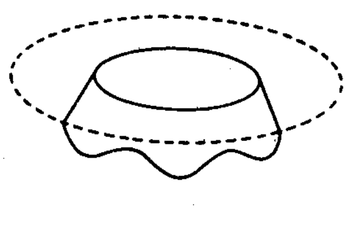


Figure . The Drapemeter. The circular specimen is 'draped' over the circular support

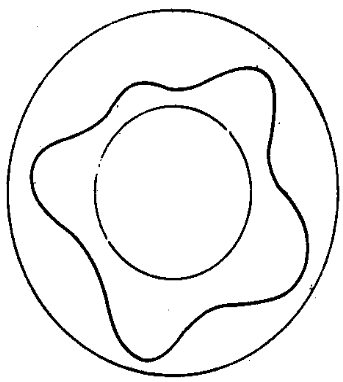


Figure . The Drapemeter. The projected outline of the 'draped' specimen

1. A circular specimen about 10″ diameter is supported on a circular disk about 5″ diameter and the unsupported area drape over the edge as fig(a)
2. If the specimen were, say, a 10 inch dia hard board, no draping would occur and the area of projection from the periphery would equal to the area of the record.
3. When its fabric, it will assume some folded configuration and the shape of the projected area will not be circular but something like the shape as fig (b)
4. The drape is then measured in terms of drape co-efficient, F considering areas.

Note: Instead of the areas of the draped and undraped specimen, their corresponding weights of paper projection can also be taken to calculate the drape co-efficient.

i.e. $$F = \frac{Ws - Wd}{WD - Wd}$$

Where, W_s= Weight of the paper whose area is equal to the area of A_s
W_D= Weight of the paper whose area is equal to the area of A_D
W_d= Weight of the paper whose area is equal to the area of A_d

Keep in Mind: The Thickness of the paper to trace the outline must be uniform.

The small value of F indicates the better drapability of the fabric and the large value of F indicates the bad drapability.

Weave/PPI	Plain	2/2 Twill	2/2 Warp Rib	2/2 Matt
56	64.6	45.6	46.8	49.2
64	67.6	53.8	51.1	51.8
72	78.8	58.1	54.0	55.1
82	81.6	63.4	62.2	59.6

From the above table, it can be seen that in all the weaves, drape coefficient increases with the increase in picks/inch which shows that the increase in picks/inch reduces the drapability.

Method of Improving the Drapability:

The drapability of a fabric can be improved by the following ways-
1. By providing the more float length by reducing the number of interlacements in the weave repeat.
2. By reducing the number of picks/inch

Fabric Handle

1. Fabric handle is concerned with the feel of mtl and so depends On the sense of touch
2. When the handle of fabric is judged the sensation of stiffness or limpness, hardness or softness and roughness or smoothness are all made use of.
3. Mr. Pierce states in the paper of the handle of cloth as a measurable quality.
4. Fabric handle depends on following factors:

    a. Weight and density.
    b. Surface tension.
    c. Flexibility.
    d. Compressibility.
    e. Resiliency.

Water Permeability

Absorbability:

It is the ability of a fabric to take up a liquid. It is a term related to the warmth of a fabric. If a fabric is permeable to air but does not absorb water, evaporation of perspiration takes place from the skin and the skin temperature falls. This is the phenomenon which occurs when nylon fabrics are worn. If the fabric absorbs the perspiration, however, the evaporation takes place from the fabric and not from the skin. Therefore, chilling does not occur.

The following are the ways in which water can pass through a fabric:

1. By wetting the fabrics, followed by capillary action which brings the water to the other side.

2. By the pressure of water, forcing it through the opening of the fabric.

3. By the combination of the above two sections.

Shower proof:

To treat textile materials in a manner to delay the absorption and penetration of water. The fabrics retain a degree of permeability to air. If a fabric is made in which there were no openings between the yarns, the cloth might still allow water to pass, if the water wet the fibres. This happens in closely woven canvas cloth. If a fabric of ordinary weave is made of fibres which had been chemically treated so that they would not be wet by water, the cloth would allow much of the water to roll off without penetrating. But if the water gathered in a thick layer on the cloth of if the water stuck the cloth with much force, it would pass through the openings. This is the case in the shower proof fabrics.

Water Proof:

To treat textile materials, e.g. with fats, waxes or rubber to prevent the absorption of water. The additions may be physical films or coating or may be physically combined. Fabrics treated with such substances have low degree of permeability to air. The following are the examples of water proof fabrics

a) Rubber in ordinary raincoats
b) Bitumen in tarpaulin
c) Waxes in some tent cloth
d) Plastic coated fabrics

Water Repellent:

It is a state characteristic by the non-spreading of a globule of water on a textile material. A water repellent fabric is one that will reset absorption and penetration of water for a given period of time, depending upon the length of exposure and the force of water.

Note: A garment is labelled as **shower resistant** will provide protection from light rain but will be penetrated by a heavy rain after 15 minutes. A garment labelled as **rain resistant** will provide protection for a few hours of exposure in a moderate rain.

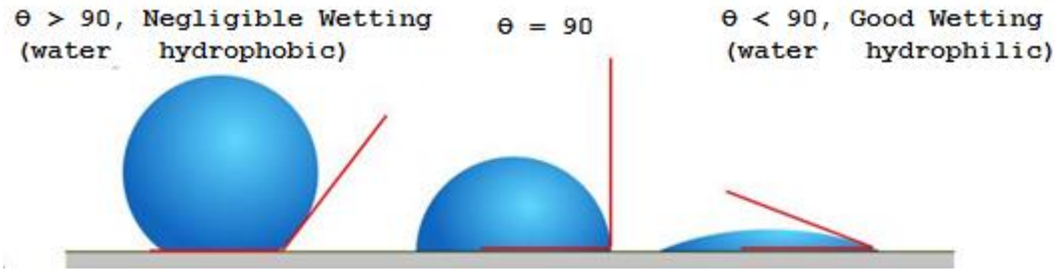
A garment labelled as **storm resistant** will resist water penetration for many hours. There will be an external material in water proof fabrics other than the yarn surface but in the shower proof and water repellent fabrics, wetting will take place after certain interval.

Difference between water proof and water repellent:

Topics	**Water proof**	**Water repellent**
Pore in the matl	Filled	Open
Air permeability	Small or nill	Large
Water or vapour permeability	Small or nill	large
Characteristics of goods	Resistance to passage of water even under hydro static head	Resistance to water and rain and spread of water but permits water under hydrostatic head.
Fabric outlook	Fabrics are stiff and not pliable	Fabrics are pliable and are not different from untreated fabrics.

Water retention:
This is the moisture remaining in and on a material after a specified mechanical treatment.

Wettability:
According to British Cotton Industry Research Association (B.C.I.R.A) A drop of water (or sugar solution) is placed on to the specimen fabric which is mounted horizontally. The time taken for the contact angle to drop to 45° is noted. The reciprocal of the time taken is called the wetting velocity or wettability.



Contact Angle (Θ):
The angle between the solid surface and the tangent to the water surface as it approaches the solid, the angle being measured in water.

Wetting Time:
The wetting time can be described by a test developed by Baxter and Cassie. A fabric stripe is immersed in water of 20 ° c. Then it is withdrawn from the water at a speed of 8 mm/min. At the start of the test a large receding contact angle is seen but after some time the angle is to decreased to 90 degree. This time is noted by a stop watch. This time taken to decrease the angle to 90 degree is called the wetting time.

Methods of testing

1. **The wetting time test.**
2. **The spray test.**
3. **The drop test or drop penetration test.**
4. **The Bundesmann test.**
5. **Shirley hydrostatic head test.**

1. The Wetting Time Test:

In this test, a strip of fabric is lowered in a trough of water and is removed from the water surface from one end of the trough. Distilled water at 20° c is used and the speed of withdrawal of fabric is maintained at 8 mm per minute. In the beginning of the test, a large contact angle is seen and after some time it reduces. The time is noted using a stop watch when the angle drops to 90°. The time to drop to 90° is called the **wetting time**.

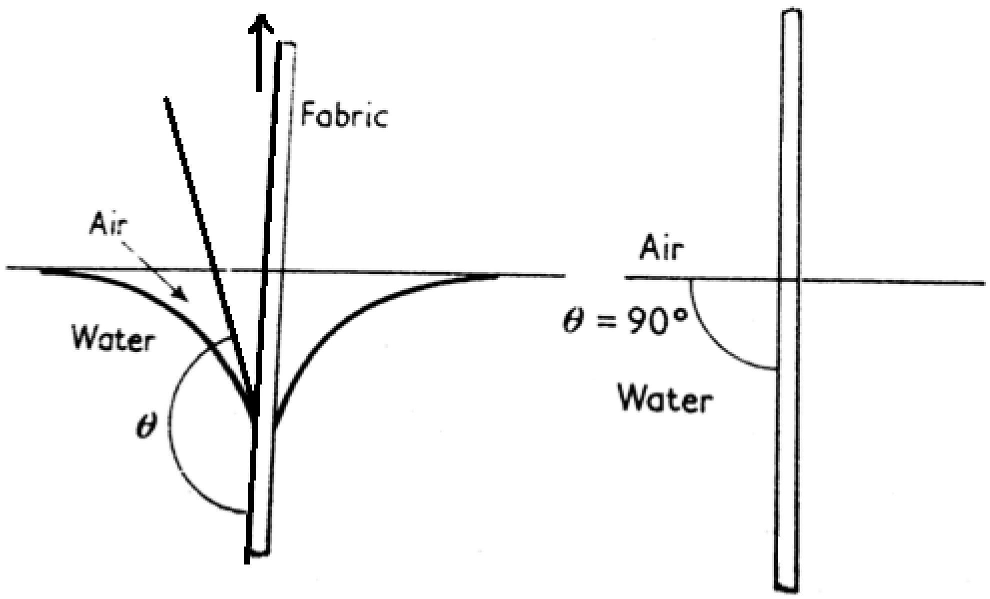


Fig: the wetting time test

This is a very useful method to assess proofing efficiency of fabrics. But for cotton, the method is not so popular, hence other methods are to be considered. The wetting time test is useful for heavy wool cloth.

2. The Spray Test

Construction:

In this test a small-scale mock rain shower is produced by pouring water through a spray nozzle. The water falls on to specimen which is mounted over a 6″ diameter embroidery hoop and fixed at an angle of 45°.

Working Procedure:

To carry out the test, 250 cm^3 of water at 70°F are poured steadily into the funnel. The distance from the bottom of the spray to the centre of the fabric is 6″. After spraying has finished the sample holder is removed and the surplus water removed by tapping the frame six times against a solid object, with the face of the sample facing the solid object. The tapping is in two stages, three taps at one point on the frame and then three times at a point diametrically opposite.

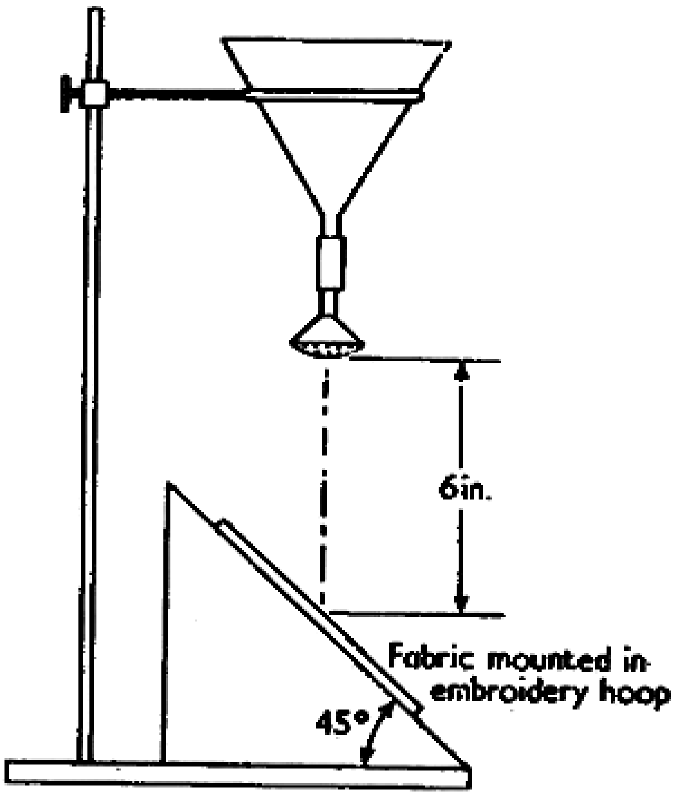


Figure . The spray test

The assessment of the fabric's water repellency is given the **spray rating**. After the removal of the surplus water is accomplished the fabric surface is examined visually by matching against the rating chart of photographs.

The ratings (AATCC) are as follows-

100→No sticking or wetting or wetting of the upper surface.
90→Slight random sticking or wetting of the upper surface.
80→Wetting of upper surface at spray points.
70→Partial wetting of whole of upper surface.
50→Complete wetting of whole of upper surface.
0 →Complete wetting of whole of upper and lower surfaces.

Five tests should be made and the nearest rating assigned to each, since no interpolation is allowed, i.e. a rating for a specimen cannot be 75. The mean of 5 ratings is reported.

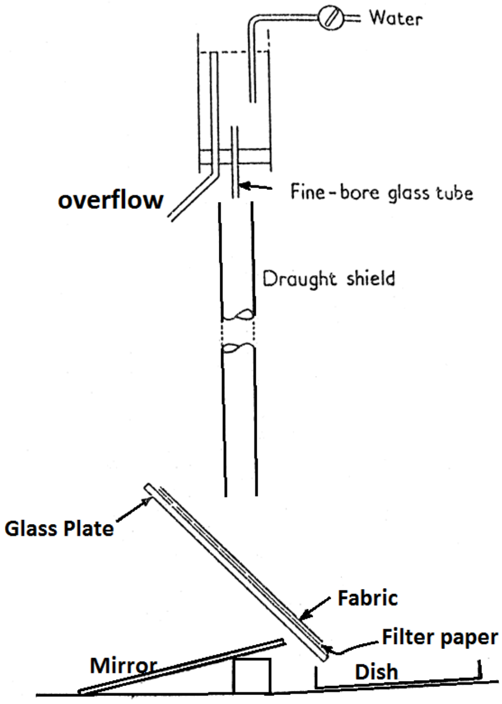
ISO rating ranges from 0 to 5.

3. Drop Penetration Test:

In the initial of wetting, the drops of water pearl of the fabric and after some time the pearling stops, the water enters the pores of the fabric, and becomes wet. Therefore, the drop penetration test is to count the number of drops required to penetrate the fabric to the inner side when all the drops fall on the same spot.

Description:

A fabric sample is clipped onto a glass plate with a piece of filter paper sandwiched between glass and fabric. The frame holds this assembly at an angle of 45° directly under the drop forming apparatus. The drop forming apparatus is a fine bore glass tube to produce a certain number of drops per minute of given size, with a constant head of water so that the size of drop and time of dropping are constant. To ensure that the drops fall onto the same spot, a draught shield is used.



Working:

With the specimen in position the water supply is started and drops begin to fall on the fabric. The end point is reached when the filter paper shows the sign of water. This can be noted on the mirror placed underneath the specimen. The time is measured with a stopwatch. Then water which penetrates the specimen is collected and the time taken to collect 10 cc under specified condition is observed to the nearest second.

Various methods are used to determine the end point with greater precision. The filter paper may be impregnated with a chemical which changes colour when wet e.g. cobalt chloride turns blue or the water can be tinted.

The size of the drop, rate of dropping, height of drop and other dimensions may be changed according to the purpose.

4. The Bundesmann Tester

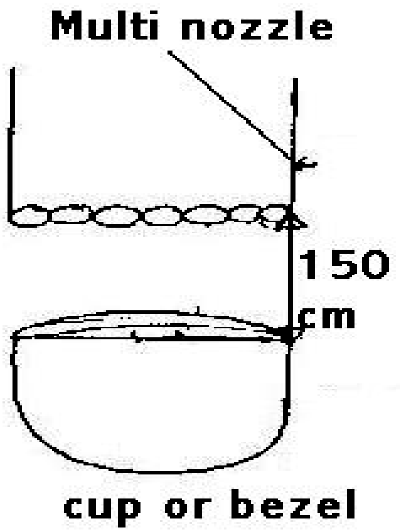
The Bundesmann tester is quite different from two tests, viz, sparay, drop penetration and they are not satisfactory, when fabric are used as a rain coat. The wearer of the fabric walks in the rain continuously exposing fabric for heavy shower and at the same time rubbing because of the movement of the limbs of the body coming into contact with the other side of the fabric. The agitation makes more amount of water to enter the fabric which is not tested in shower proof. The Bundesmann tester satisfies this condition.

Description:

The Bundesmann Test:

Fabric speciments are mounted over a special cups or bezels and subjected to a shower of water from a multi-nozzle drop producer. Water which penetrates the fabric is collected in the bezels and measured. The water which is retained by the specimen is also measured.

The shower producer is mounted 150 cm above the four bezels. The bezels are mounted on an assembly rotating slowly at 5 rpm. As the fabric circulate in the shower of water, special wipers inside the bezels rub the underside of the specimens in order to reproduce the rubbing action mechanically which occurs in practice. This rubbing action will help the water to penetrate the fabric.



After a 10 minutes shower of controlled severity, the specimens are removed and two values determined.

Penetration:

The water collected in each of the bezels is measured and the mean volume calculated to the nearest milliliter.

Absorption:

From the weight of each specimen before and after the test, the % of water retained by each specimen is calculated as follows-

$$\text{Absorption} = \frac{\text{Weight of water absorbed}}{\text{Original wt of the specimen}} \times 100$$

The mean of the four results is calculated and reported to the nearest 1%.

Points must be considered during testing:

- Temperature of water = 18℃ - 20℃
- pH of water = 6-8
- Rate of flow = 62-68 ml/min per bezel
- Drops to be uniformly spaced and the fabric to be conditioned for at least 24 hours in a standard atmosphere.
- Specimens to be weighted in an airtight container
- Surplus of water to be removed by six sharp shakes.

5. The Penetration of Fabrics by Water Under Pressure

The Pressure required to force water through fabric may be determined and the ability of a fabric to do a particular job can be assessed using the hydrostatic head test.

Hydrostatic Resistance

It is the resistance of fabrics to the passage of water under pressure when the force is applied at right angles to the plane of the fabric.

Description:

The specimen holder consists essentially of a double chambered cell. The internal diameter of the inner chamber A is 5 cm. Circular specimens are clamped between rubber gaskets over the orifice.

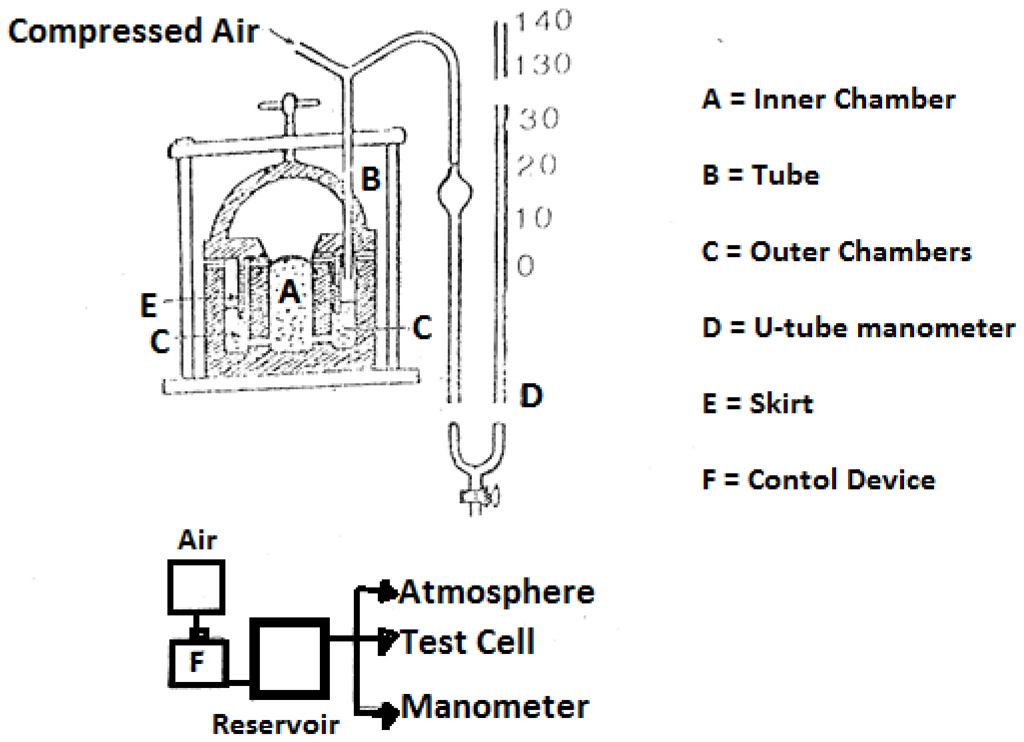


Fig: The hydrostatic head test

Compressed air is passed to the outer chamber C through a tube Brand displaces the distilled water in the outer chamber into the inner chamber.

By that way, water is forced up against the specimen. The clamp is provided with a skirt E to prevent the air leakage across the specimen outer chamber to inner chamber or to the atmosphere. Tube B is connected to a U-tube manometer and the pressure of water against the fabric can be noted on a scale mounted on the arm of the manometer tube.

The air supply is drawn from a reservoir of 3 liters capacity. This reservoir is fed through a flow control device F from a source with pressure ranging from 4 to 20 psi. The flow control device is designed so that it can be set to give the required rate of increase of pressure of 10 cm of water per minute. The rate of loading will be within the specified limits of 10 ± 0.5 cm per minute up to the limit of the instrument. The max head attainable is 150 cm of water.

Procedure:

Circular specimens 6 cm in diameter are out from the fabric to be tested, using a template. The test cell is rinsed with distilled water and filled to approximately 0.3 cm of the top. The inner rubber gasket is thoroughly dried and a test specimen is placed over the orifice and Tightened with a clamp.

Then a control tap is turned to position no 1 to communicate the air supply, manometer and the test cell. The pressure on the under surface of the specimen is allowed to increase at the specified rate of loading until water appears at third place in the specimen, the control tap is immediately turned to position no 2 to allow the air supply and the test cell to discharge to atmosphere. But the manometer retains at the pressure at which breakdown of the test specimen occurred. This value can be noted.

The hydrostatic head can be noted from one arm of the U-tube manometer to the nearest 0.5 cm of water. Then the control tap is turned to position no 3 to discharge the monometer to atmosphere.

Then the test specimen is removed, the used water thrown away, fresh distilled water is poured into the test cell and the operation is repeated for eight samples and the main value is calculated.

The Water Percolation test:

After being tested in the hydrostatic head apparatus, the samples may be immersed in water for 24 hours and then subjected to a head of 100 cm water. The amount of water which percolates through the fabric in the first 500 sec is collected and measured. The percolation may be expressed thus:

Percolation = w / 3.92   ml/1000 sec at 1 m water head

Where, w is the weight of water in grams collected from four specimens in 500 sec.

This type of test is suitable for measuring the performance of fabrics intended for use as tent cloth, water buckets, etc.

Crease

Crease: This is a fabric defect (undesirable property) evidenced by a break line or mark in a fabric generally caused by a sharp fold. Crease are a fold in a fabric introduced unintentionally. Crease appears when the fabric is distorted in such a manner that part of it is stretched beyond its elastic recovery. During creasing the upper surface of fabric goes on extension and lower surface goes on compression.

Crease Resistance: Crease is a fold in a fabric introduced on intentionally at some stage of processing and the resistance to creasing of textile material during use is known as crease resistance. The crease resistance of wool fibre is very good but for the cellulose material it is not good. Amongst the textile materials the order of diminishing crease resistance is wool, silk, acetate rayon, viscose, rayon, cup ammonium rayon, cotton, flax etc.

Crease recovery: It is the property of a textile material by which it can return to its former shape after being creased. The measure of crease resistance is specified quantitatively in terms of crease recovery angle. The crease recovery of a fabric can be increased by resin treatment.

Difference between crease resistance and crease recovery:

Crease Resistance	Crease Recovery
Crease resistance is such a property of fabric that resists fabric from creasing.	Crease recovery is a fabric property that indicates the ability of fabric to go back to its original position after creasing.
Crease resistance is generally measured by bending elasticity.	Crease recovery is the measure of crease resistance specified quantitatively in terms of crease recovery angle.
Crease resistance comes into play before the fabric is creased.	Crease recovery comes into play after the fabric has been creased.
Crease resistance resists the stretching and compression of molecular chain of fibre polymer.	By crease recovery property the stretched or compressed polymer chain comes back to normal position.

Advantages of Resin Treatments:

- Improved resistance to and recovery from creasing.
- Smooth drying properties after laundering.
- Durable effects may be imparted by intermediate mechanical treatment.
- Reduce laundry shrinkage.
- Increase dry tensile strength and greatly increased wet tensile strength of rayon.
- Improved fastness to washing and rubbing of most dyes.
- Decrease water-imbibition and more rapid drying.
- Improved handle and drape of fabrics.
- Increased weight.
- Increase resistance to distortion of fabrics with improved retention of garment shape and freshness.
- Improved resistance to slippage and fraying.
- Vehicle for modern flame-proofing.
- Increased resistance to photo-degradation and weathering.
- Increased resistance to rotting.

Disadvantages of Resin Treatments:

- Lower abrasion resistance for misapplication of the finish.
- Lower tearing strength for misapplication.
- Unpleasant odors under certain condition.

Methods of Measuring Crease Recovery

The Tootal test.
The Shirley crease recovery test.
Continental method.
The L.I.N.R.A sunray crease evaluator.

Shirley Crease Recovery Test:

Crease Recovery is measured quantitatively in terms of crease recovery angle.

Principle: A wrinkle-free rectangular specimen of prescribed dimension is folded in half and compressed under a load for a specified time. The load is then removed and the specimen is allowed to recover for the specified time. The amount of recovery is expressed as the angle between the limbs of the fold which is called the crease recovery angle.

Preparation of Test Specimens: Ten test specimens are cut from the fabric with a template, 2 inch long by 1 inch wide. Using a pair of scissors or blade with their longer side parallel to

warp and weft threads respectively the specimens cut in such a way that no two warp way specimens contain the same set of warp yarns and no two weft way specimens contain the same set of weft yarns. The specimens should not be cut from creased, bend or other deformed parts of the sample and also not from within 2 inches from the selvedges.
Since the moisture present in the fabric influences the results of the tests carried out after conditioning in the standard atmosphere.

Construction:

- The instrument consists of a circular dial, graduated in degrees along its periphery with an accuracy of 0.5 degree which carries the clamp for holding the specimen.
- Directly under the center of the dial is a knife edge and an index line for measuring the recovery angle.
- The scale of the instrument is engraved on the dial.
- Specimen clamp to hold one limb of the specimen in such a way that the fold lies in horizontal line on the axis of the circular scale.
- Leveling screw for leveling the apparatus.

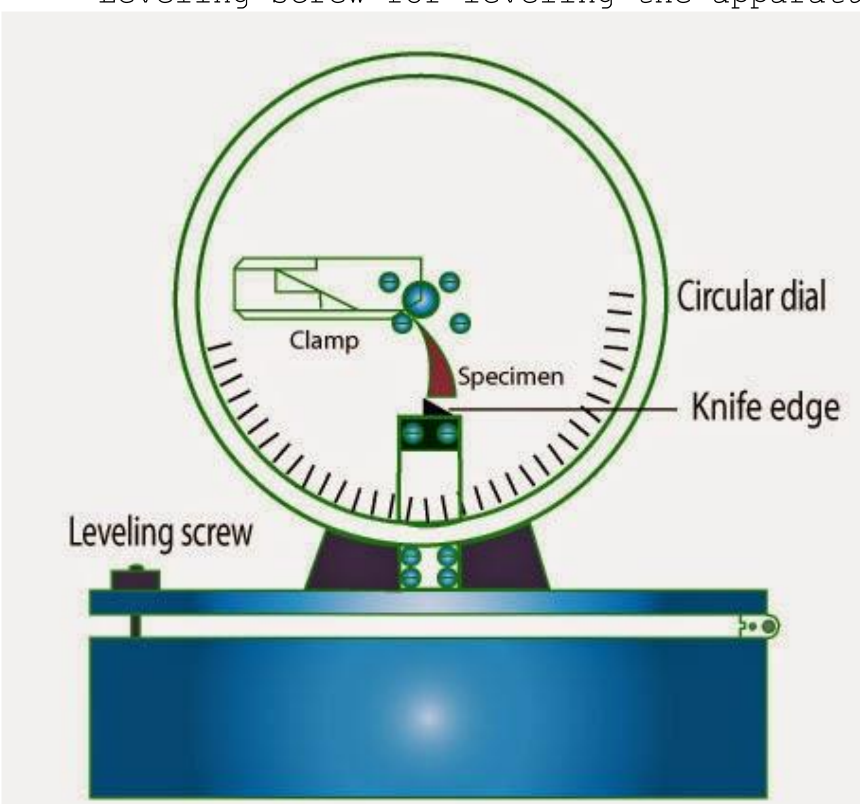


Fig: Crease recovery tester

Working Procedure:

1. A specimen is cut from the fabrics with a template 2 inch long by 1 inch wide.
2. The instrument is levelled with the help of levelling screws.
3. The specimen is folded gently end to end with its edges in one line, with the help of the tweezers. The edges should not be gripped more than 5 mm in the tweezers. The folded specimen is placed on the lower plate of the loading device and 2kg load is applied gently.
4. Half the number of test specimens, both warp and weft, should be folded face to face and other half back-to-back.
5. After 1 min the weight is removed and the specimen transferred to the fabrics clamp on the instrument and allowed to recover from the crease.
6. As it recovers, the dial of the instrument is rotated to keep the free edge of the specimen in line with the knife edge.
7. At the end of time period allowed for recovery, usually 1 min, the recovery angle in degrees is read on the engraved scale.
8. Warp and weft way recovery are reported separately to the nearest degree from the mean value of ten tests in each direction.
9. The test Should include the following:
   a) The types of fabric tested
   b) Number of tests performed
   c) Load Applied
   d) Time of creasing
   e) Time of recovery
   f) Mean crease recovery angle for Warp way specimen and Weft way specimen

Wrinkle: (Many says, same as crease)

Short and Irregular creases
Three dimensional creases
They form when fabric undergo double curvature.

Crease Mark: Crease mark are marks left in a fabric once caused by mechanical damage.

Causes of Crease:

Applied Pressure
Temperature Change
Relative Humidity Change
Poor Construction
Poor fitting garments

Factors of Crease:

Fibre Properties

Co-efficient of Friction (high inter fibre friction will not allow to reshape)
Bending Modulus
Bending Recovery

Fabric Construction

Yarn Construction
Types of weave/knit

Minimizing Crease:

- Using thick fibre
- Discouraging rapid change in Temperature and Relative Humidity
- By using flat seam during sewing
- Treating chemically during finishing

Serviceability, Wear and Abrasion

Serviceability: An Article which is serviceable is capable of performing useful service; its serviceability ceases when it can no longer do so. It's a relative term. A fabric which is serviceable for one may not be for another. For some fashion concern lady, a dress of 3 months back may be unserviceable although it's still new or not damaged.

However, there are certain factors that limit the serviceability. They are colour, wear, abrasion and time. Usually, time element is the most influencing factor in deciding serviceability.

Purpose of Serviceability Testing:

1. To determine as objectively and precisely as possible whether the application under investigation is a valid and suitable use for the fiber, yarn or fabric, and consequently will have reasonable prospects of commercial success as a long-term proposition. It will be appreciated that this statement applies particularly to the launching of a new fibre, yarn, or fabric, which can bring credit or discredit to the company.
2. To compare a number of different fibers, yarns, or fabrics, as part of market research.
3. To determine the influence of cloth structure and finishing on performance.
4. To asses suitability for purpose in instances where the fabric or article is considered "borderline" by laboratory testing against a performance specification.
5. To determine suitability for making up e.g. seaming properties, pleating and creasing properties.
6. To assist in establishing criteria for laboratory testing and standards performance.

Wear: Wear is the net result of a number of agencies which reduce the serviceability of an article. It is the amount of deterioration of a fabric due to breaking, cutting, removal of the fibres. Some of the more important agencies are –

- Bending and stretching
- Tearing
- Abrasion
- Laundering
- Cleaning

The nature and type of these agents is so varied in type.

Wear Index (W.I) = $\frac{Weight\ Loss\ in\ mg \times No.of\ Cycle\ tested}{1000}$

If wear index increases, abrasion resistance decreases and vice-versa.

Abrasion: Abrasion is one aspect of wear and is the rubbing away of the component fibers and yarns of the fabric.

Abrasion may be classified as follows-

1. **Plane or flat abrasion:** A flat area of material is abraded.
2. **Edge abrasion:** This kind of abrasion occurs at collars and folds.
3. **Flex abrasion:** In this case, rubbing is accompanied by flexing and bending.

These three types are only broad divisions and in actual service a complex mixture of some or all types is found.

Points to be consider before abrasion testing:

1. **Condition of specimen:** The fabric will be conditioned and tested in a standard testing atmosphere.
2. **Choice of testing instrument:** Depending upon the types of testing to be done the instrument may be chosen, e.g., Flat abrasion, Flexing Abrasion etc.
3. **Choice of abrasive motion:** The rubbing movement may be reciprocating, rotary or multi-directional.
4. **Direction of abrasion:** When the abrasive motion is unidirectional the abrasion resistance in specific directions can be measured. In many cases differences will be observed between warp way and weft way abrasion resistance. If desired, the direction of abrasion can be at angles to the warp and weft directions.
5. **Choice of abradant:** The severity of the abrasion will vary with the nature of the abradant. Where possible the abrasive qualities of the material used should remain constant during the test and be capable of being reproduced for successive tests. Steel and silicon carbide, for example, will give reasonably constant abrasive qualities. In other instances, the abradant may be a second piece of the tested fabric, a standard worsted or canvas fabric, emery cloth of various grades. With such materials, however, there is the risk of their abrasive properties changing during a test and a tendency for bits of abraded fibre to clog the surface. Some instruments have special methods of removing the link from the abradant.
6. **Backing the specimen:** The hardness of the backing of the specimen may affect the results. In some testes a hard backing is used in others a felt or foam rubber. In one instrument the sample is mounted over an inflated rubber diaphragm.
7. **Cleanliness of the specimen instrument:** The region to be abraded should be handed as little as possible and be free from foreign

matter such as the wax, graphite etc otherwise they will act as lubricants and affect the end-point of test result.

8. **Tension on the specimen:** Variation in the tension on the specimen will alter the result, and therefore, standardized method of mounting the specimen should be used.
9. **The pressure between abradant and specimen:** The severity of the abrasion will obviously be affected by the pressure applied. Here, again suitable standards must be set-up. High pressure will reduce the time taken to reach the end-point of a test but the acceleration of the destruction of the fabric may lead to false conclusion.
10. **The end point of the test:** The end-point may be the completion of a given number of abrasion cycles, the appearance of a hole or broken threads, the rupture of the specimen. Automatic stop motions are often built into the tester so that the motor is switched off as soon as a hole appears or the specimen breaks.

Assessment of abrasion damage:

Several methods of judging the amount of damage are given below-

1. Comparison of abraded specimen with an unabraded specimen.

2. The number of cycles required to produce a hole, broken threads or broken strip.

3. Loss in weight, often plotted against the number of cycles.

4. Change is thickness, e.g., loss of pile height. In some cases, the napping or raising effect of abrasion may cause an increase in thickness particularly in the early stages of a test.

5. Loss in Strength, e.g. tensile, bursting, or tearing strength. The loss may be expressed in percentage of unabraded strength. Some laboratories may determine residual strength after a given number of cycles.

6. Change is other properties, e.g. air permeability, lusture.

7. Microscopic examination of damage of yarns and fibres.

Interpretation of the Result: No general rule is given on the interpretation of the result from abrasion tests. The effect of special finishing treatments can be assessed by determining the abrasion resistance of the fabric before and after the finishing treatments. It’s a series of different tests which are used to make rating of the fabric.

Abrasion testing instruments:

A list of some abrasion testing instruments is mentioned below:

- The Wool Industries Research Association (W.I.R.A.) Abrasion Tester
- The Linen Industries Research Association (L.I.R.A.) Abrasion Tester
- The Taber Abraser (American)
- The Shiefer Machine (American)
- The Wyzenbeek Abrasion Tester (American)
- The Stoll Universal Wear Tester (American)
- The L.I.N.R.A. Wear Tester
- The Accelerotor
- **The B.F.T. Abrasion Testing Machine**
- **Martindale abrasion tester.**

Pilling

Pilling: Pilling is a fabric surface fault characterized by little 'pills' of entangled fibre clinging to the cloth surface and giving the garment an unsightly appearance. The pills are formed during wear and washing by the entanglement of loose fibres where protrude from the fabric surface. Pilling can be considered to be the first sign of wear by light abrasion in a fabric, made from staple fibre yarns.

Pills: Pillar are small knots or balls of mixture of large number of small fibres accumulated at the surface of the fabric and entangled by the mild frictional action during processing or wearing. They are soft but firmly held on the surface of the material.

Mechanism of Pilling: Pilling happens due to wearing of the surface. The surface of the fabric when abraded, the constituent fibres from the yarn surface get liberated and become loose, and further abrasion bring out entanglement on its surface.

These loose fibres or entangles fibres form hard pills on the fabric surface giving an unsightly appearance. The appearance of pills is more prominent in the synthetic material and also materials blended with synthetic fibres.

Pilling Test

A number of Pilling test methods and instruments have been developed in various laboratories. After rubbing under controlled conditions, the pilling of the sample may be assessed **numerically** by counting the number of pills formed; alternatively, the **appearance** of the test specimen may be compared with standard sample and given some form of rating. There are at least three types of tester which are popular to conduct the pilling test. They are-

1. Martindale Abrasion Tester

2. I.C.I. Pill Box Tester.

3. (The Du Pont) Random Pilling Tester

1. Martindale Abrasion Tester:

The Martindale Abrasion Tester can be used for Pilling test as well. The normal sample holders are replaced with lightweight square holders which are keyed so that they may have vertical movement but cannot turn on their axes. An adjustment has to be made to convert abrasion into pilling in the tester. After a certain number of rubs the samples are examined and the number of pills counted. This may be repeated, say, in stages of 500 cycles up to 3,000 or 5,000 and the rate of development of pills noted.

2. I.C.I. Pill box tester

The Method of Test: A piece of fabric measuring 5″×5″ is sewn so as to be a firm fit when placed round a rubber tube(6″ long, 1¼″ outside dia, and 1/8″ thick). The cut ends of the fabric are covered by cellophane tape and four tubes are placed in a box (9″×9″×9″) lined with cork 1/8″ thick, which is then rotated at 60 rev/min for 5 hours.

For garments normally subjected to repeated washing as well as to wear, washing may be desirable prior to preparing the tubes of fabric. Hence, it is the practice to apply a standard hand wash in 0.5% soap at 45°C for 15 min to Terylene/Cotton and Terylene/Viscose shirt and dress fabrics.

After tumbling, the extent of pilling is assessed visually by comparison with the arbitrary standards 1, 2, & 3. Under test conditions fabrics of Standard 1 become hairy but do not pill, fabrics of Standard 2 become hairy and pill slightly, while fabric of Standard 3 become hairy and pill more severely.(Figure next page)

Another Ratting is (1) No pilling, (2) Slight but tolerable pilling (3) Moderate pilling of borderline acceptability (4) Unacceptable pilling (5) Extremely high pilling. Ratting varies depending on Testing Standards.

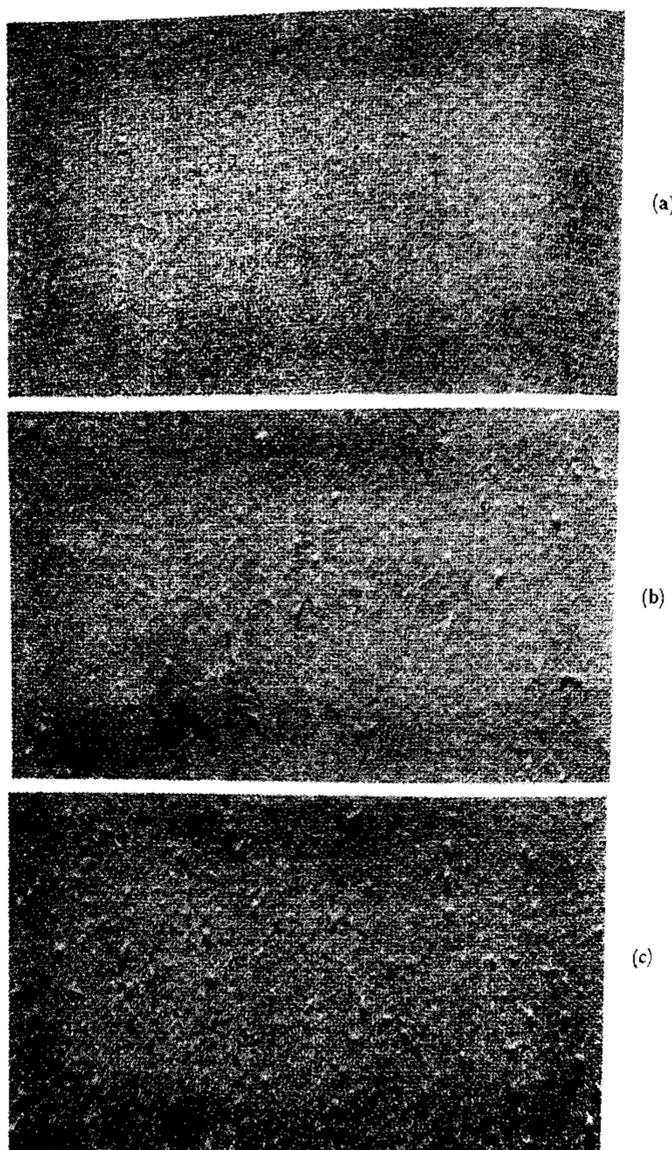
Interpretation of the result should be governed by the following principles:

1. The extent of pilling, exemplified by appearance standard, will not be produced by every person but only by those who are particularly hard on their clothes.

2. Experience has shown that when pilling does occur is it usually limited to the most susceptible parts of a garments; e.g. collars, cuffs, pocket edges, front skirt panels. When, however, pilling is severe under the conditions of test, it is probable that the body of the garment will become an affected area, and that the number of persons who will produce the effects is also likely to increase.

3. From a pilling point of view, shirts, blouses, lingerie, and dresses are considered to be critical end-use. These garments will be frequently laundered between wearing, while medium and heavy weight garments will not normally be washed or cleaned with similar frequency. In this latter group, trousers and suits are considered to be more critical than skirts, costumes, and rainwater.

(I.C.I. Pill box Tester)



(By courtesy of I.C.I. Ltd)

ure 7.33. Pilling standards: (a) Standard 1; (b) Standard 2; (c) Standard 3 ($\frac{1}{3}$ original size)

3. The du Pont Random Pilling Tester:

A six-unit tester is used, each unit consisting of a cylindrical chamber 6″ long by 5¾″ inside diameter, horizontally mounted, containing a two-bladed impeller which rotates at 1,200 rev/min. The inside of the chamber is lined with neoprene, about 1/8″ thick, which can be changed when necessary. Into each unit three 5″×5″ fabric samples are loaded together with a small amount of cotton lint, the latter being used because the pills which are formed bear a closer resemblance to pills formed during wear than those formed when the lint is absent.

After 1 hour whisking and tumbling the test fabrics are examined visually and compared with standard samples. Five ratings are used.

Factors Responsible for Pilling:(Study with effects)

1. Fibre Characteristics

(a) Morphological Structure
(b) Chemical Structure
(c) Fibre Structure
(d) Fibre Length
(e) Fibre Fineness
(f) Strength
(g) Extensibility

2. Yarn Characteristics

(a) Blend Composition
(b) Count
(c) Twist
(d) Plying
(e) Regularity (evenness) of yarn
(f) Hairiness
(g) Short fibres

3. Fabric Characteristics

(a) Weave
(b) Knitting
(c) Intersection
(d) Ends and Picks

4. Frictional or Abrasive Forces

Pill Formation During Wet Processing:

Pilling is caused on the fabric surface, where it comes in contact with an object in motion or by rubbing. In wet processing of textiles, these conditions exist in different stages such as drying, dyeing, printing, finishing etc.

Drying is one process which may cause pilling of the fabric. During drying, the water from the surface of the fabric evaporates and water from the core of the yarn comes onto the surface along with loose fibres to maintain equilibrium. Hence **improper drying temperature** my accelerate pilling.

Pilling may also be caused during drying due to abrasion between the layers of the fabric or due to **frictional contact with the rollers in motion.** Too much swelling together with high temperature may intensify pilling.

Calendaring is another process where some more pilling can take place due to abrasion with the rollers in motion. **Too much tension** can intensify such fault. The wearing forces on garments, too much tightness or too rough uses, may accelerate pilling.

Effects of Pilling:

Pilling rarely affects the actual durability of a fabric but it affects adversely in processing as well as to the physical properties of the fabric like appearance, handle etc

In dyeing, the pills are likely to absorb more dye resulting in deep shade in contrast to the ground and consequently cloth appears skittery. Further if it develops on the dyed garments during use, it will be lighter in shade resulting in skittery appearance of the materials.

In printing, the sharpness of the outlines of the printed design in the fabric will be spoiled in the presence of pills. Further if it develops on the printed fabric during wear, the printed pattern will not only be blurred but the beauty of the print will be lost.

In finishing, the presence of pills hamper to a great extent in the production of a clean and clear finish. They spoil the appearance of garment.

It also affects adversely the handle of the fabric and consequently deteriorates the comfort of the fabric.

The effect of such changes is dependent on the degree of pilling as well as on the severity of the process adopted. Thus pilling renders the materials unsuitable for domestic use.

Remedies:

1. Steps to be taken prior and during spinning and weaving:

(a) Fibres with cross section other than circular, dumb-bell, and artificially serrated cross section are the best.

(b) Longer stape length, coarser fibres, higer extensibility, greater crimp etc restrict the slippage of the fibres and hence control the tendency to pill.

(c) The common suitable blends of polyester and cellulosic fibres in order of decreasing pilling, are 80/20, 67/33, 50/50.

(d) Higher proportion of short fibres is problem so combing is essential to avoid this defect.

(e) Coarser denier, hard twist, lower hairiness of the yarn are desirable to control pilling. Ply yarn is better and ply yarn with hard doubling twist is the best.

(f) The tendency to pilling is greater, if protruding fibres are present in the yarn. By increasing the number of interlacements in wearing or knitting the loose fibres can be bound tightly at greater length and pilling can be reduced. Higher number of ends and picks minimize this fault.

2. Steps to be taken after weaving or knitting:

(a) Shearing and cropping
(b) Singeing
(c) Heat setting
(d) Surface carbonizing

3. Chemical Treatment:

(a) Binding agents: Resin or any such type of binding agents help is controlling pilling to a great extent. The binding agents hold the loose or protruding fibres on the surface of fabric firmly. There is very little possibility of these fibres to be removed and getting entangled on rubbing to from pills.

(b) Hydrophilic agents: Hydrophobicity or hydrophilicity plays an important rule in pill formation. Thus treatment with a special polymer composition of acrylic type froms a hydrophilic non-tacky film of good cohesion which helps in eliminating undesirable pilling to a great extent.

[Any antipilling treatment should not reduce handle properties greatly]

Colour Fastness

Introduction:

Consumers don't like their textiles to change colors or bleed during washing, under the sun or anywhere else. But how can anyone ensure textiles keep their color over time? Color fastness testing in a laboratory can help us to ensure fabric's colors stay fresh and vibrant after many uses.

During use, textiles are usually exposed to external factors such as light, washing, ironing, sweat, friction, and chemical agents. Some printed and dyed textiles are also subjected to special finishing processes, such as resin finishing, flame retardant finishing, sand-washing, and grinding. This demands that the color of printed and dyed textiles relatively maintain a specific fastness, i.e. good color fastness performance. It is therefore important to test any dyed or printed product for the fastness of the colors that have been used in its decoration. Unlike other types of fabric testing, such as flammability, there are no mandatory legal requirements for color fastness testing. But color fastness testing is essential to ensuring customer satisfaction with fabric products.

Colour Fastness:

Colorfastness is defined as the strength of the clothes against fading or running out of clothing colors. Another name for color fastness is dye fastness. It refers to the resistance of textile colors to effects such as color change or transfer during processing and use. It is a very important factor in the assessment of the quality of clothing. Clothes that don't bleed color are always consumer's favorites.

Types of Color Fastness in Textile and Apparel Sector:

1. Colorfastness to washing,
2. Colorfastness to heat,
3. Colorfastness to water,
4. Colorfastness to friction/rubbing,
5. Colorfastness to cold,
6. Colorfastness to burning.

Dependence Factors of Color Fastness:

Many factors affect the strength of colorfastness:

1. Chemical nature of clothing,
2. Molecule structure of dye (Dye Types),
3. Molecular state of dye,
4. Amount of dye.
5. Types of Fibre and compatible Dye
6. Type of conditions to which clothing is exposed

Some Terms Related to Colour Fastness:

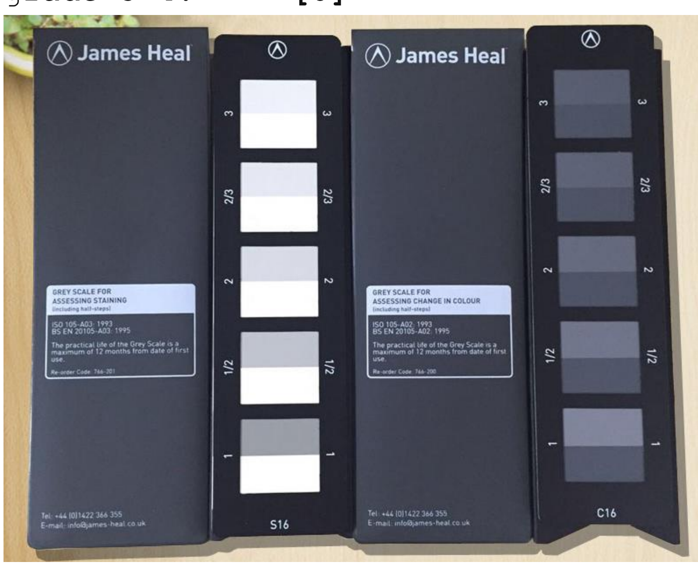
Discoloration: In printing and dyeing textiles under specific environmental factors, certain activities and reactions within the textile may result in color chroma, hue, and brightness changes. This effect is referred to as discoloration. Some of these occurrences within textiles include; when part of the dye is separated from the fiber, or the luminescent group of the dye is destroyed, or a new luminescent group is generated.

Staining: Staining is a phenomenon where part of the dye on a piece of fabric is separated from its originally attached fiber and transferred to other lining fabrics when placed under various environmental factors, thereby staining the lining fabric.

For garments composed of parts with different colors, dyes sometimes migrate from one area of the fabric to another, during storage and usually from dark parts to light parts.
The color transfer is mainly due to two reasons: the first is the transfer of dyes, especially the floating color of dispersing and reactive dyes. These dyes may migrate and be released from the fiber, dyeing the fiber on another sample’s surface. This usually happens with dark colors that dye light colors and stay on the other sample’s surface in a granular and embossed form. The second is that the fibers fall off under the action of friction and transfer from one sample to another.

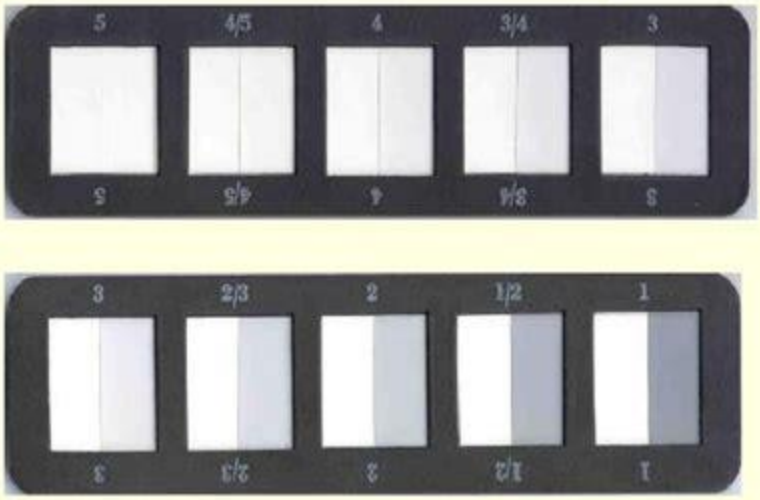
Color changing gray card: This contrast card comprises one standard scale of gray and a decreasing scale of gray chroma. The grayscale rating for the color change is determined using 5-grade levels and nine grades system with grade 5 representing the best Color Fastness and grade 1 representing the worst Color Fastness. The middle levels can be assessed as half grade such as grade 4-5, grade 4, and grade 3-4.

Stained gray card: This comprises of a standard scale of white with a corresponding group of increasing gray chroma. There are five grades and nine grades system; grade 5 implies virtually no staining occurred. Hence great Color Fastness while grade 1 signifies the worst Color Fastness, and the middle can be assessed as half grade, such as grade 4-5, grade 4, and grade 3-4. **[0]**

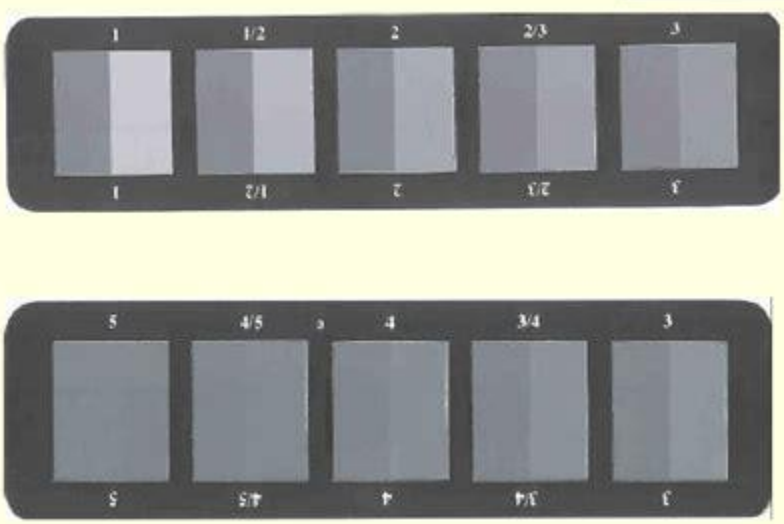


(full view)

Grey Scales for Staining



Grey Scales For Coloring



Environmental requirements for Color Fastness ratings

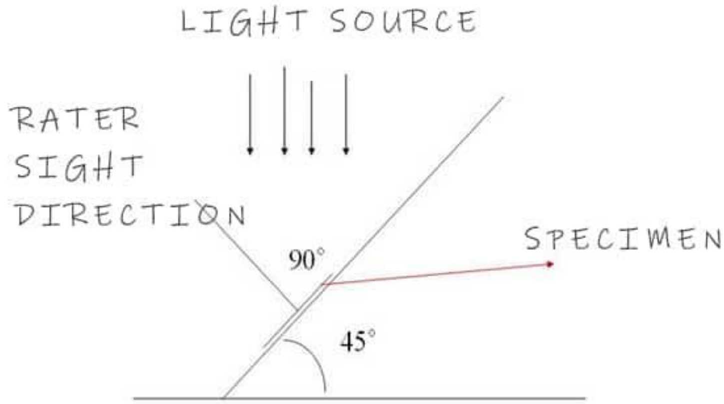
Light source and equipment: The preferred general light source is the D65 light source. Its service life tube is 2000 hours. Customers can also specify other light sources, such as the F light source, 84-P light source, UV light source, etc.

Personnel requirements: The grader should not be color-blind. They can be tested using a color-blindness detection chart or Farnsworth-Munsell 100 hue test kit.

Clothing requirements:

- Gray clothes are best.
- Avoid bright-colored clothes, bright-colored nail polish, and any items that may reflect the light source.
- Do not wear colored glasses.
- Do not rate when tired or sick. Rating is a subjective activity, and mood will affect the psychological, subjective judgment of color; for the same sample, when one is happy, it is one result and when they are down, it is another result.
- Observers must adapt to standard lighting conditions for at least 2 minutes before observation commences. This is to let the eyes adapt to the current light source environment.
- The raters require strict training and must pass the preset assessment.

Environment: darkroom: The rating process should be done in a darkroom of constant humidity and constant room temperature. The color of the darkroom wall and the objects on the wall should be painted in neutral gray as well, which is similar to the rating gray card between level 1 and level 2 (approximately Monsell color Card N5). It is required that the entire darkroom must not have any other light sources except the light source of the rating lightbox. Also, ensure that no other sundries appear on the rating platform.



Rating angle: To use the gray card to rate the samples, you need to use the correct rating angle. The standard generally used entails that the sample and the horizontal plane be at 45° while the light source for rating and the sample are kept at 45°. The grader's eyes are meant to be at 90° to the sample while the distance between the eyes and the sample should be 50-70cm. *It is necessary for different personnel to carry out eye calibration on the same sample periodically to ensure that the error between personnel is minimized. It is also necessary to carry out eye calibration between laboratories occasionally. Since each brand cooperates with many laboratories, the consistency of eyesight between laboratories is particularly important.*

How professional laboratories evaluate color fastness:

The American Association of Textile Chemists and Colorists (AATCC) and the International Organization for Standardization (ISO) color fastness standards are the most commonly used in the U.S.A and EU, respectively.
For most ISO and AATCC color fastness tests, the fabric specimen's color after testing is compared to a "Grey Scale for Color Change" and a "Grey Scale for Staining".
The Grey Scale for Color Change rates the color fading of the specimen on a scale from 1 (greatest change) to 5 (no change). The Grey Scale for Staining rates the staining of an undyed material tested with the specimen from 1 (greatest color transfer) to 5 (no color transfer).

1. COLOR FASTNESS TO WASHING (DETERGENT) [00]

Washing is one of the most common cleaning and maintenance methods for clothes. The Color Fastness to washing determines the color firmness of textiles in different detergents and different washing environments. There are many ways to test Color Fastness to washing. The general principle is to imitate the state of household or commercial washing. Under the specified time and temperature conditions, after stirring, rinsing, and drying, use a gray sample card or instrument to compare the original sample to evaluate the color change of the sample and the lining fabric's staining. Various methods may have certain differences in temperature, test solution, washing procedures, drying procedures and a decision to add steel balls or not.

Test process of Color Fastness to soap and washing:

(1) **Sample:** Take a 100mm×40mm sample with the front side in contact with a 100mm×40mm multi-fiber lining fabric, stitched along a short side to form a combined sample. Or take a 100mm×40mm sample, sandwich it between two 100mm×40mm single fiber lining fabrics, and stitch along a short side to form a combined sample.

(2) **Preparation of test solution:** Five (A,B,C,D,E) different types of washing are specified as different washing methods. 5 grams of soap per liter of tertiary water is used for tests A and B, and 5 grams of soap and 2 grams of sodium carbonate per liter of tertiary water are used tests C, D and E, respectively.

(3) **Test:** Put the combined sample and the specified number of steel balls in the container, according to the standard test conditions. Then inject the required amount of soap solution preheated to the test temperature ±2℃, so that the bath ratio is 50:1. Close the container, adjust the temperature and time according to the standard and start the machine. Remember to start timing when the container is closed.

(4) **Washing and drying:** For all tests, take out the combined samples after washing, wash them twice in tertiary water, and then wash them in running water until they are clean. Squeeze the excess water from the combined sample by hand, flatten the sample between two unused filter papers to remove the excess water, and then hang it to dry in the air of temperature not exceeding 60℃.

(5) **Grading:** Use the gray sample card or the instrument to compare the original sample to evaluate the sample's discoloration and the staining of the lining fabric.

(6) **Result report**

Features of Washing Fastness Tester:

- It is fabricated out of quality stainless steel.
- Possess electric heater to heat water in water bath.
- The microprocessor-based programmer is provided for temp. control.
- Buzzer to indicate the completion of the process cycle or step.

Factors affecting colour fastness to washing:

- The fabric structure, fiber composition and corresponding dyeing process conditions are the primary factors that affect its Color Fastness to washing.[1]
- Using different test methods, the same test method, and different links of the operating methods also have an important impact on the test results of Color Fastness to washing.[2]
- Sampling on the test results of Color Fastness to washing.[3]
- Selection of multi-fiber standard lining fabrics on the test results of washing fastness.[4]

- Different grading methods on the test results of Color Fastness to washing.[5] & [6]

Comparison of common standards of textile Color Fastness to washing:

Detergent washing testing determines the resistance of textile colors to domestic or commercial laundering procedures. The two main standards for detergent washing are ISO 105 C06 and AATCC 61. Aim for a **color change rating of 4** and a **color staining rating of 3 to 5** for detergent washing.

ISO 105 C06

There are 16 different ISO 105 C06 test procedures, ranging from A1S to E2S. The "S" in the ISO 105 C06 test number refers to a single commercial or domestic laundering. The "M" refers to multiple washes, or approximately five domestic or commercial launderings. The "2" test procedures include a peroxide-based bleach, sodium perborate (NaH_2BO_4), in the washing water. The "A" and "B" ISO 105 C06 test methods are most common, as they test fabrics at 40°C and 50°C, respectively. The "C", "D" and "E" methods test fabrics at higher temperatures with different bleaches and softeners.

AATCC 61

There are five test procedures under AATCC 61, but the most common test procedures are 1A and 2A. 1A applies to hand washing at 40°C, while 2A applies to machine washing at 49°C. The lesser used 3A procedure tests fabrics at 71°C, while 4A and 5A add a chlorine-based bleach, sodium hypochlorite, to the washing water. All AATCC 61 test procedures mimic five domestic or commercial launderings. For both the EU and U.S. standards, the lab washes the fabrics with stainless steel balls to mimic abrasion. The number of balls, the amount of detergent and the washing time vary based on the test method.

Test method	Test no.	Temp (° C) ± 2°C	Detergent (g/l)	Sodium perborate (g/l)	Liquid volume (ml)	# of steel balls	Time (mins)	Specimen size (cm)
	A1S			None			30	
	A1M	40		None		10	45	
ISO 105 C06	A2S		4	1	150		30	4x10
	B1S			None		25	30	
	B1M	50		None		50	45	
	B2S			1		25	30	
AATCC 61	1A	40	0.37% of total volume	None	200	10	45	5x10
	2A	49	0.15% of total volume	None	150	50	45	5x15

Summary of sampling methods for Color Fastness to washing:

The sampling of Color Fastness to washing must first consider the problem of lining fabric. Taking GB/T 3921-2008 as an example, this standard specifies that the choice of lining fabric can be a multi-fiber lining fabric or two single-fiber lining fabrics.

The multi-fiber lining fabrics include:
(1) Multi-fiber lining fabrics containing wool and cellulose acetate (used for tests at 40°C and 50°C, and in some cases can also be used for tests at 60°C, but needs to be indicated in the test report).

(2) Multi-fiber lining fabrics without wool and acetate (used for some 60°C tests and all 95°C tests). Single-fiber lining fabrics include cotton, wool, viscose, polyamide (nylon), polyester (polyester), polyacrylonitrile (acrylic), ramie, silk, and acetate.

The laboratory's daily test samples are roughly divided into[7]-

- Plain samples,
- Yarn-dyed samples,
- Printing samples,
- Dark and light gradient dyeing samples,
- Embroidery and car pattern samples,
- Sequins,
- Hot diamond samples,
- Yarns and loose fibers,
- Hollow fabrics, etc.

When GB/T 3921-2008 requires the sample to be fabric, the sample size is 40mm×100mm.

2. COLOR FASTNESS TO CROCKING TEST (WET AND DRY RUBBING)

"Crocking" is an industry term referring to a transfer of a colorant through rubbing. The crocking test determines the resistance of textile colors to rubbing off and staining other materials. A fabric with poor color fastness could rub colorants off on consumers, furniture, other textiles or miscellaneous items.

Color Fastness to rubbing is a type of textile Color Fastness inspection, and it is generally one of the most common inspection types in the textile trade. It refers to the ability of the color of textiles to resist friction, and that is both dry friction and wet friction.

The test is quite sensitive and for getting consistent result, it is necessary to use

- Standard crock meter
- Cloth,
- Maintain uniform pressure for applying rubbing strokes and number of strokes.

Test template of Color Fastness to rubbing

The model generally followed to test for Color Fastness to rubbing textiles to fix the specified size textile sample on a friction tester platform with a clamping device. Then, rub it with a dry friction cloth and a wet friction cloth, respectively. In the end, the degree of staining of white cloth is used as the evaluation basis, and it is graded against a set of standard Color Fastness to staining gray scales.

The gray sample card used to determine the fastness rating is divided into five grades; the higher the grade, the better the rubbing fastness. A fabric with poor rubbing fastness could rub off dyes on basically anything, and that is undesirable for end-users.

Dry friction test

Put a piece of (50×50) mm rubbing cloth (standard white cotton cloth) on the rubbing head under standard atmosphere (temperature 20℃±2℃, humidity 65%±4%), humidity control for more than 4 hours. Make sure the direction of the friction cloth is consistent with the movement direction of the friction head. Adjust the running speed of the rubbing head to one reciprocating friction cycle per second, ten times, which amounts to a total of 10 cycles of friction. The friction stroke or reciprocating movement on the sample should be (104±3) mm, and the applied direction is vertically downward. This downward force should be (9±0.2) N. After the entire ten cycles are completed, remove the friction cloth, adjust the humidity (over 4 hours), and remove any excess fibers on the friction cloth that may affect the rating.

Wet friction test

Immerse the weighed piece of friction cloth completely in distilled water, take it out, and reweigh the friction cloth to ensure that the moisture content of the friction cloth reaches 95%-100%. Then apply the same operating method as in the dry friction test.

Textile rub resistance test rating

After performing the above test process, we need to take the moistened friction cloth to the grading room and place it in the standard light source box, then use the gray sample card to evaluate the staining grade of the friction cloth.

Fig: Crock Meter

Fig: Electronic Crock Meter

Comparison of common standards of textile Color Fastness to Rubbing:

ISO 105 X12 and AATCC 8 are the primarily standards for measuring color fastness to crocking. The standards are partly equivalent and largely similar in their test methods.

ISO 105 X12 and AATCC 8

In both the ISO 105 X12 and AATCC 8 test methods, the test samples are rubbed with a dry rubbing cloth and then a wet cloth. Both methods use a machine known as a "crockmeter" to rub the fabric. The crockmeter has a "rubbing finger” which the lab technician rubs across the fabric by turning a mechanical lever. The rubbing fingers vary in size for pile fabrics and other textiles. The rubbing direction can also vary based on the type and design of the fabric. But the crockmeter typically rubs the fabric in the warp and weft directions separately. The direction is particularly important for striped or pattern fabrics for which results can vary. The staining of the rubbing cloth is then assessed using the Grey Scale for Staining. Many textile importers will accept a **grade 4 rating for dry rubbing** and **grade 3 rating for wet.** Color fastness to wet rubbing is typically lower than for dry rubbing for most fabrics.

ISO 105 X12 and AATCC 8 vary mostly in the amount of water used to wet the cloth rubbed on the test specimen. The amount of water is calculated as “wet pick up”, or the amount of fluid by percent weight picked up by the fabric. ISO 105 X12 requires the cloth be wetter than that following the AATCC 8 standard.

Test method	Specimen size	Dimension of rubbing finger	Downward force	Wet pick up for wet rubbing	Number of cycles/turns
ISO 105 X12	50 x 140 mm	Pile fabrics: 19 x 25.4mm block	9 ± 0.2 N	95-100 %	10 complete turns at the rate of one turn/sec
AATCC 8	50 x 130 mm	Other fabrics: 16 ± 0.1mm		65% ± 5%	

<u>Factors affecting Color Fastness to rubbing </u>[9]

- Fabric surface morphology
- Fabric structure
- Reactive dye chemical structure
- Reactive dyeing degree
- The effect of softener

3. COLOR FASTNESS TO LIGHT TEST [09]

The lightfastness of textiles has been paid progressively more attention at home and abroad. Presently, China’s textile industry product standards (especially the new standards endorsed in recent years, excluding underwear standards) all use lightfastness as one of the assessment standards. For example, the silk product standards publicized by China before did not stipulate the assessment of lightfastness. Still, the promulgated standards have now taken the lightfastness of elastic silk as the assessment index. With chemical fiber like silk fabric and cotton product standards, lightfastness is also taken as an important evaluation index, and some product standards even take lightfastness as an evaluation index.

The color fastness to light test determines the effect of natural sunlight on textile colors.

All textile colorants are susceptible to some fading in sunlight, as colorants by nature absorb certain wavelengths. But you don't want your colored fabric to fade too quickly over the course of its life.

Color fastness to light testing might be particularly important to importers of clothing worn predominately outdoors. But even retail display lighting can cause fading. So, all textile importers should consider this test for their products.

Comparison of common standards of textile Color Fastness to washing:

ISO 105 B02 and AATCC 16 are the most common international standards for color fastness to light. Both standards test fabrics under a Xenon Arc lamp that closely resembles natural sunlight. But the standards vary significantly in their assessment methods.

ISO 105 B02

ISO 105 B02 has four different exposure cycles with different humidity and temperature levels, including A1, A2, A3 and B. Many importers use A2 because it mimics extreme low humidity conditions.

ISO 105 B02 varies from AATCC 16 in that a blue wool reference material with a known reaction to light is simultaneously exposed to light during the test. The fading of the test sample is then rated in comparison to the fading of the blue wool reference. The Blue Wool Scale ranges from 1 (very low color fastness to light) to 8 (very high color fastness to light).

In ISO 105 B02 A2, the lamp can also have either a black panel (uninsulated) or black standard (insulated) sensor to control the temperature.

AATCC 16

AATCC 16 includes five different testing options. Option 3 is the most commonly used because it simulates extreme low humidity conditions and is most equivalent to the ISO 105 BO2 A2 cycle.

The Option 3 procedure subjects the fabric to continuous light, while some other AATCC 16 options subject the fabric to alternating light and dark conditions. Option 3 uses a Xenon lamp with a black panel sensor, while Option 4 and 5 use black standard sensors.

AATCC 16 differs from ISO 105 B02 in that light exposure in the former case is measured using a specialized unit of irradiance known as "AATCC Fading Unit" (AFU). Most apparel units are exposed to 20 AFU and rarely need to be exposed to more than 40 AFU. Upholstery should be exposed to 40 AFU and draperies to 60 AFU. The greatest exposure time is 80 hours on this scale. The color change of the fabric is measured using the Grey Scale for Color Change, as in other AATCC color fastness test standards. Importers will typically accept **a grade 4 rating** for this test.

Test method	Effective humidity	Relative humidity	Max black panel/standard temp.	Chamber air temperature	Irradiance at 420 nm:	Irradiance at 300-400 nm	Assessment
ISO 105 B02 – A2	Less than 15%	Determined by effective humidity	Panel: 60 ± 3º C Standard: 62 ± 3º C	N/A	1.1 ± 0.02 $W/m^2/nm$	42 ± 2 W/m^2	Blue Wool Scale 1 to 8
AATCC 16 – Option 3	N/A	30 ± 5%	63 ± 1º C	43 ± 2º C	1.1 ± 0.03 $W/m^2/nm$	48 ± 1 W/m^2	Standard Grey Scale 1 to 5

How to improve the lightfastness of textiles? Three reliable methods:

The light-fading mechanism of dyes is very complicated. But simply put, it is due to the dyes being excited after absorbing photons, and the occurrence of a series of photochemical reactions to destroy the fundamental dye structure, which ultimately leads to discoloration and fading. The lightfastness of textiles mainly depends on the chemical structure of the dye and its aggregation state, combination state and mixed color matching. Therefore, selecting dyes rationally is very important.

a. Choose dyes according to fiber properties and textile applications. [10]
b. Dyes should be selected according to the color depth.[11]
c. Dyes with good light resistance stability and compatibility should be used for color matching [12]

4. COLOR FASTNESS TO PERSPIRATION TEST

The color fastness to perspiration test determines the resistance of textile colors to human perspiration.

Fabric dyes and human perspiration can often react and cause color fading in clothing items. A color fastness test for perspiration is particularly relevant for sports apparel and swimwear, which will most likely be exposed to heavy perspiration during use.

As we all know, the composition of human sweat is complex, the main component of which is salt, of which the amount varies from person to person. Sweat is acidic and alkaline. The short-term contact between textiles and sweat may have little effect on its Color Fastness, but long-term contact with the skin and sweat will have a greater impact on certain dyes. Clothing with unqualified Color Fastness is likely to cause dyes to transfer from textiles to human skin through sweat. The human body may absorb dye molecules and heavy metal ions through the skin, and this would endanger health.

Fastness to perspiration

The fastness of colored fabric with reference to alkaline and acidic perspiration was evaluated. For the alkaline (pH-8) and acidic (pH-5.5) liquors were prepared and the composite specimens were dipped in acidic and alkaline solution separately for 30 minutes. Good and uniform penetration of the solution was ensured. The liquor was poured off and the excess water and air bubbles, if any were removed by passing the specimens in between two glass rods. Composite specimens were then placed between glass/acrylic plates with a pressure of 12 kpa per spirometer.

The perspirometer, was kept for four hours at a temperature of 37 (±20C). Afterwards, the fabrics were removed, separated and dried in air below 60°C. The values were rated as per the grey scale.

The details of the values assigned for these properties are:

The values were rated as per the grey scale. The details of the values assigned for these properties are:-

- •5 =Negligible (Excellent)
- •4 =Slightly changed (Good)
- •3 =Noticeable changed (Fairly good)
- •2 =Considerably changed (Fair)
- •1 =Much changed (Poor)

Comparison of common standards of textile Color Fastness to Perspiration:

ISO 105 E04 and AATCC 15 are the two main standards for perspiration testing. For this test, the lab attaches a strip of multifiber fabric to the test specimen to measure staining. This multifiber fabric has swatches of different kinds of fibers, such as nylon, cotton, acetate, polyester, wool and acrylic fabrics.

The lab then compares the staining of the multifiber fabric to the Grey Scale for Staining, with a desired **grade 3 rating**. The lab compares the color of the test specimen with the Grey Scale for Color Change, with a desired **grade 4 rating**.

ISO 105 E04

During this test, the lab soaks the fabric in a simulated perspiration solution for 30 minutes under a fixed pressure and then dries it slowly at an elevated temperature.

ISO 105 E04 tests for color fastness to both acidic and alkaline perspiration. Human sweat is typically acidic, though it can become alkaline in higher temperatures or when bacteria are present.

AATCC 15

AATCC 15 only tests color fastness to acidic perspiration. The AATCC previously included alkaline test methods in the standard but removed it in 1974, as they didn't believe it reflected normal end usage.

The drying time, pressure and temperature also vary between ISO 105 E04 and AATCC 15. AATCC 15 requires the fabric to be heated for longer at a slightly higher temperature than ISO 105 E04.

Test method	Solution	$C_6H_9O_2N_3$ .HCl.H_2O	NaCl	Na_2HPO_4. $12H_2O$	Na_2HPO_4. $2H_2O$	Na_2HPO_4	Lactic acid (85%)	Specimen size	Drying conditions
ISO 105 E04	Alkaline solution: PH 8.0	0.5 g	5.0 g	5.0 g	2.5 g	N/A	N/A	100 x 40 mm	37 ± 2º C for 4 hours under a pressure of 5 kg
	Acid solution: PH 5.5	0.5 g	5.0 g	N/A	2.2 g	N/A	N/A		
AATCC 15	Acid solution: PH 4.3 ± 0.2	0.25 ± 0.001 g	10 ± 0.01 g	N/A	N/A	1 ± 0.01 g	1 ± 0.01 g	60 x 60 mm	38 ± 1º C for 6 hours under a pressure of 4.54 kg

How to improve the Color Fastness to perspiration? Examples of techniques for improving the Color Fastness of nylon fabric to perspiration

Weak acid dyes are mostly used in nylon printing and dyeing. It's important to note that dyes and fibers are mainly combined with van der Waals forces and hydrogen bonds, which accommodates poor Color Fastness. Although the commercially available acid dye fixing agents can improve the Color Fastness to soaping and rubbing, it still lacks effective perspiration fastness fixing agent. Although the Color Fastness to acidic perspiration can be improved through sufficient soaping, dye selection, optimization of the fixation process and the development of new fixing agents or fastness enhancers, the Color Fastness to alkaline perspiration is still poor.

The improver of the Color Fastness to perspiration of acid dyes is still mainly the polyamide fixing agent that is a quaternary ammonium salt. The polyamine compound and dicyandiamide polycondensation reaction are mostly used to prepare the formaldehyde-free polyamide fixing agent, such as perspiration fastness Agent SF-30A, a polycationic fixing agent. Although the quaternary ammonium salt type polyamide fixing agent can significantly improve the perspiration fastness of acid dyes, it will significantly reduce the fabric's rubbing fastness.

The purpose of this research is not to reduce the Color Fastness to rubbing, but to correspondingly improve the Color Fastness to the sweat of the quaternary ammonium salt type polyamide fixing agent. The test firstly measured the color fixation effect of perspiration fastness agent SF-30A, and then investigated the effect of perspiration fastness agent SF-30A and wet friction enhancer HS-222, adhesive SD-20B, and acrylate monomer comprehensive treatment on nylon Improved Color Fastness to rubbing and Color Fastness to perspiration of printed fabrics.

Factors influences colour fastness to perspiration [13]

- The influence of perspiration agent on the Color Fastness of nylon
- The influence of perspiration fastness agent and wet friction enhancer
- The influence of perspiration fastness agent and adhesive
- The influence of micro-polymerization of acrylic monomers
- The influence of monomer and Color Fastness additives on the Color Fastness of nylon fabric to perspiration

5. COLOR FASTNESS TO WATER TEST

Color fastness to water determines the resistance of textile colors to immersion in water.

You might think this test sounds like the washing test. But color fastness to water testing is specifically used to measure the migration of color to another fabric when wet and in close contact. The washing test also typically uses a basic PH solution due to the addition of detergent, while this test is conducted at neutral PH levels.

ISO 105 E01 and AATCC 107 are the most common standards for color fastness tests to water. The standards are technically equivalent, but the testing methods vary slightly between them.

Comparison of common standards of textile Color Fastness to Perspiration:

ISO 105 E01 and AATCC 107 procedures

For this test, the lab technician attaches a strip of multifiber fabric specimen to measure staining, as with the perspiration test. The test specimen and multifiber fabric are immersed together in water under specific conditions of temperature and time.

After soaking, the fabric is then placed between glass or plastic plates and dried under specified time, pressure and temperature conditions.

The multifiber fabric is then compared to the Grey Scale for Staining and the test specimen is compared to the Grey Scale for Color Change. **Many importers will accept a grade 3 rating for staining and a grade 4 for color change.**

ISO 105 E01 and AATCC 107 vary most in the heating time of the test specimen after immersion. AATCC 107 requires the specimen to be heated for longer than ISO 105 E01.

Test method	Specimen size	Immersion time	Water temperature	Drying conditions
ISO 105 E01	40 mm x 100 mm	Unspecified	Room temperature	37 ± 2 °C for 4 hours under a pressure of 12.5 kPa
AATCC 107	60 × 60 mm ± 2 mm	15 minutes for normal fabrics	Room temperature	38 ± 1°C for 18 hours under a pressure of 4.5 kg

Testing for thermal sublimation (dry heat) of textiles

Comparison of the main test methods for the Color Fastness to heat pressure and ironing of textiles:

The operation process of the standard three test methods is roughly the same. The preparation tools are as follows:

Take the AATCC Color Fastness test method as an example:

This test method is a test method to determine the color resistance of various textile materials and textiles and the ability of heat-resistant roller processing.

Textiles can be subjected to hot press tests in dry, wet, and wet states, usually determined by the textile's final use.

Testing process:

- **Sample size:**

AATCC 133-2009: 40*120mm (sample size for other test methods: 40*100mm)

- **Heating device:**

It is composed of a pair of smooth parallel plates equipped with a precise control electric heating system. The pressure of the sample is 4±1kpa. The heat should only be transferred from the upper parallel plate to the sample. Regardless of if the lower parallel plate is heated or not, the asbestos plate should always be covered. The m2 two-layer synthesis contains about 3mm thick wool flannel, undyed and bleached cotton fabric without mercerizing treatment.

- **Test procedure**

Dry pressing: The dry sample is pressed for a certain period of 15 seconds in a heating device at a specified temperature and pressure.
Tidal pressure: After the dry sample is covered with a wet cotton lining fabric, it is pressed for a certain period of 15 seconds in a heating device at a specified temperature and pressure.

Wet pressing: After the wet sample is covered with a piece of wet cotton lining fabric, it is pressed for a certain period of 15 seconds in a heating device at a specified temperature and pressure.

- **Hot pressing temperature**

110 ± 2℃
150 ± 2℃
200 ± 2℃
If necessary, different test temperatures can be used, but they must be noted in the report. The critical temperature is determined according to the type of fiber and the structure of the fabric. If it is a blended product, it is recommended to adapt it to the most heat-resistant fiber.

- **Rating**

Immediately after the test, use the grayscale to evaluate the sample's color change and the staining of the lining fabric. Make another assessment after 4 hours of humidity control in a standard atmosphere.

5.4.3 Regarding ironing Color Fastness, ironing tips in daily life:

1. Before ironing clothes, be aware of the fabric characteristics of the clothes, because some fabrics are not resistant to high temperatures, while others are. For instance, natural fibers like silk and wool are not suitable for high-temperature ironing, while textiles such as cotton and linen are.

2. For some special fabrics, it’s advisable to iron directly on the fabric’s surface, and the fabric will be shiny and white. At this time, you only need to cover the surface of the fabric with a piece of lining cloth or cloth of the same texture and then iron; it will not appear in this case.
3. Before ironing, it is best to spray the clothes evenly with water mist with a sprayer and put the clothes in a plastic bag so that the moisture can be spread evenly, and the clothes will be ironed better.
4. Hang the ironed clothes in a ventilated place to dry for a while to evaporate the water vapor, so that the clothes can be kept flat and mildewed.

CONCLUSION

Some color fastness tests might be more important to you than others, depending on the design and intended use of your textile products. Other standards also exist for color fastness to sea water, chlorinated water, hot pressing and other unique conditions.

Color fastness issues aren’t usually noticeable until after sale. But textile fading and staining can cause serious headaches for your business when customers later discover these issues (**related:** 3 Ways to Manage Garment Quality Control).

So, if color resilience is important to your customers, don’t take unnecessary risks. Hire a professional laboratory to test your fabrics and ensure optimum color fastness levels before your next shipment.

Your fabrics will retain their vivid and vibrant colors for long after the initial sale, keeping your customers satisfied and coming back for more.

How to improve the Color Fastness of textiles (general rules)[14]

The dye fastness of the fabric is related to fiber, yarn structure, fabric structure, printing and dyeing method, dye type and external force.
The following are the general principles for improving the Color Fastness of textiles. When it comes to individual Color Fastness, there will be targeted improvement methods.

Start with the following three aspects:

1. Selection of dyestuff

How fast a product is heavily dependent on the choice of dyestuff. If the choice of dyeing materials is inappropriate, no matter how good the auxiliary agent and the best dyeing process are, there is no way to dye high-quality

Color Fastness. Only by choosing the right dye can we talk about the next step.

- Choose dyes according to fiber characteristics.
- Choose dyes according to the color depth.
- Select the dye according to its Color Fastness grade.
- The dye uptake rate of the fiber.
- There should be good compatibility between dyes.

2. Selection and use of additives

- Choose suitable additives.
- Minimize the amount of retarder.
- Selection of fixing agent.
- Soaping and washing.
- Use of softener.

3. Improvement in the dyeing and finishing process

Fully reduce the crystallinity of the crystalline part of the fiber macromolecular structure and increase the non-crystalline area's crystallinity. The crystallinity of the various areas inside the fiber tends to be consistent. This is so that after the dye enters the fiber, the fiber's combination is more-so evenly.

To sum up:

Many factors affect the dyeing fastness of textiles. For internal factors, all production processes are in place to ensure that the product can have excellent Color Fastness indicators to meet the requirements of daily use and reprocessing; for external factors, We must pay attention to the washing temperature, detergent and washing method, friction strength, exposure time and other factors that can reduce the Color Fastness according to the use requirements of the product, so that the product can be used better.

Reasons for poor Color Fastness of silk fabrics and their care [15]