Lecture Note

SUB: Textile Testing-II

BRANCH:- TEXTILE ENGG.

SEMESTER:6Th

GOVERNMENT POLYTECHNIC, BHADRAK

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YARN TWIST

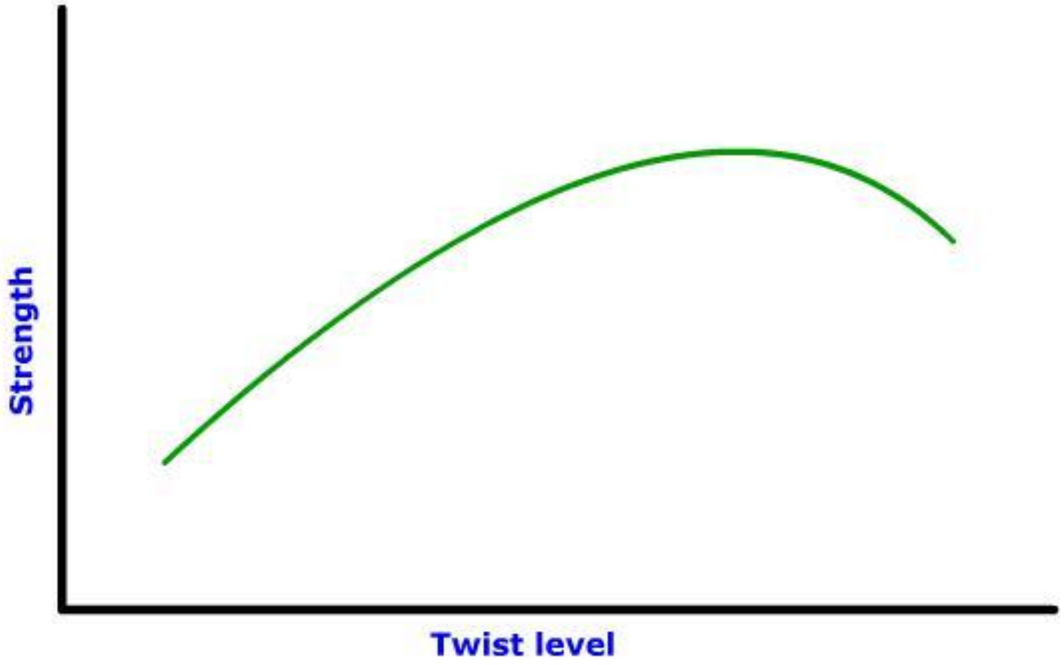
Introduction:

- Twist is the measure of the spiral turns given to yarn in order to hold the fibres or threads together.
- Twist is necessary to give a yarn coherence and strength.
- Twist is primarily instructed in to a staple yarn in order to hold the constituent fibres together, thus giving strength to the yarn.
- False twist is used in textured yarns.

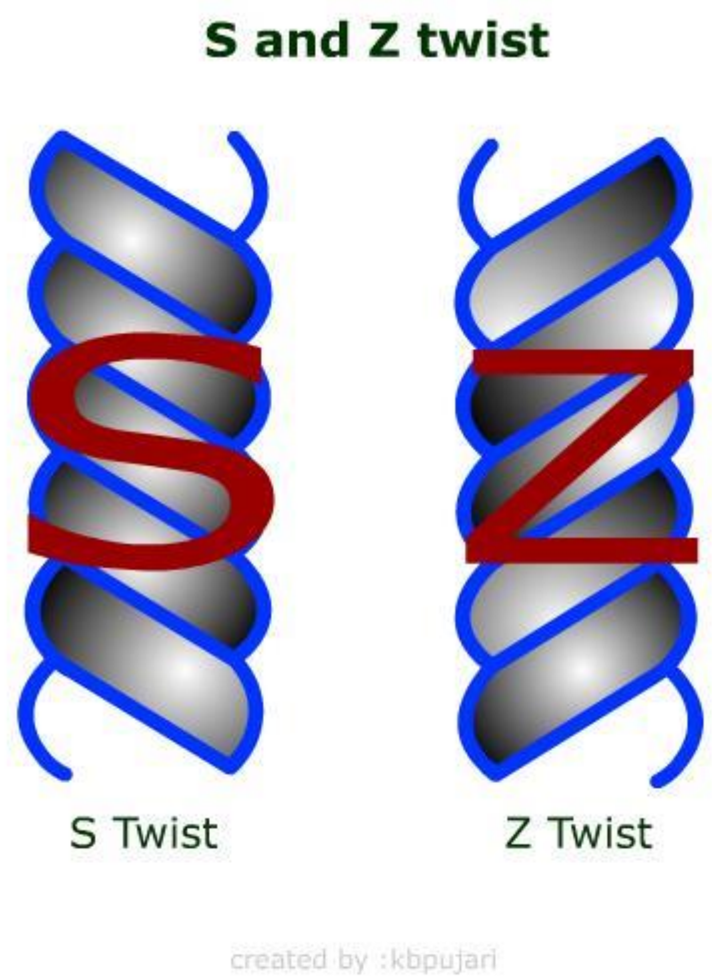
The effects of the twist are two fold:

1. As the twist increases, the lateral force holding the fibres together is increased so that more of the fibres are contributed to the overall strength of the yarn.
2. As the twist increases, the angle that the fibres make with the yarn axis increases, so prevents them from developing their maximum strength which occurs when they are oriented in the direction of the applied force.

As a result, at certain point the yarn strength reaches a maximum value after which the strength is reduced as the twist is increased still further (Fig).



The effect of twist level on strength, staple fibre yarn



Twist effects on yarn and fabric properties:

(a) Handle:

- As the twist level in a yarn is increased it becomes more compact because the fibres are held more tightly together, so giving a harder feel to the yarn.
- Because of decrease in the yarn diameter, its covering power is reduced.
- A fabric made from a high-twist yarn will therefore feel harder and will also be thinner.
- A fabric produced from a low-twist yarn will have a soft handle but at the same time weaker yarn thus resulting in pilling and low abrasion resistance of fabric.

(b) Moisture absorption:

- High twist holds the fibres tight thus restricting water to enter
- Such a high twist yarn is used where a high degree of water repellency is required, e.g. in gabardine fabric.
- Low twist yarn is used where absorbency is required.

(c) Wearing properties:

- With an increase in twist level wearing properties (abrasion and pilling) are improved.
- High level of twist helps to resist abrasion as the fibres can't easily pulled out of the yarn.

- The same effect also helps to prevent pilling (which result from the entanglement of protruding fibres).

(d) Aesthetic effects :

- The level of twist in yarn alters its appearance both by changing the thickness and light reflecting properties.
- Different patterns can be produced in a fabric by using similar yarns but with different twist levels; a shadow stripe can be produced by weaving alternate bands of S and Z twist yarns.
- Level of twist can also be used to enhance or subdue a twill effect: a Z-twill fabric produced by weaving Z-twist yarns will have enhanced Z-twill effect. Same is the case for S-twill.

(d) Faults:

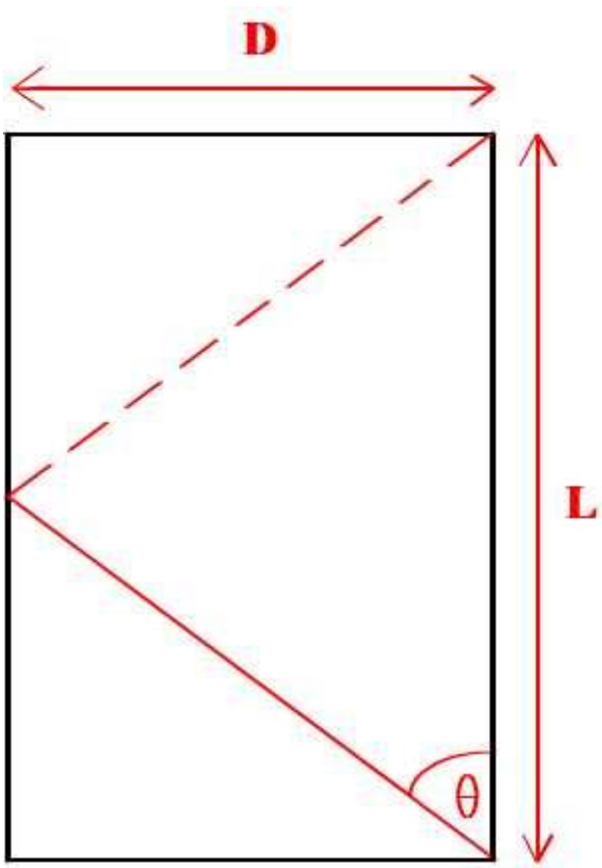
- Because of level of twist in a yarn can change its diameter and other properties such as absorption; same yarn can change the appearance of a fabric, so giving rise to complaints.

Twist Applications:

- **Georgette** is made of highly twisted yarn (upto 1000 TPM) by weaving S and Z twisted yarns alternately both in warp and weft direction.
- **Chiffon** is made in the same way but yarn is more twisted (up to 2000 TPM) and finer than that used in georgette-Cupramonium rayon is used.
- **Herringbone** is made by using yarns of different types and levels of twists.

Level of Twist:

- Twist is usually expressed as the number of turns per unit length, e.g. TPM or TPI.
- However the ideal amount of twist varies with the yarn thickness i.e., the thinner the yarn, the greater is the amount of twist that has to be inserted to give the same effect.
- The factor that determines the effectiveness of the twist is the angle that the fibers make with the yarn axis.



The twist angle

Fig shows diagrammatically a fibre taking one full turn of twist in a length of yarn L. the fibre makes an angle with the yarn axis.

For a given length of yarn, the angle is governed by the yarn diameter D:

$\tan \theta = \pi D/L$

The greater the diameter of the yarn, the greater the angle of twist (for same twist level).

As 1/L is equivalent to turns per unit length then:

$\tan \theta \propto D \times$ turns/unit length

In the indirect system for measuring linear density the diameter is proportional to $1/\sqrt{\text{count}}$. Therefore

$\tan \theta \propto$ (turns / unit length) / $\sqrt{\text{count}}$

Twist factor is defined using this relationship:

K= (turns / unit length) / $\sqrt{\text{count}}$

(K is the twist factor)

Value of K differs with each count system.

(a) In case of Tex (direct system):

K= TPM x $\sqrt{count}$

(b) For indirect:

K= TPI (or TPM or TCM)/ √*count*

(Value of K ranges 3.0—8.0 from softer to harder)

Effect of twist factor on physical properties:

- A cotton yarn having twist factor of 3 will feel soft and docile, whereas one with twist factor 8 will feel hard and lively. (a lively yarn is one that twists itself together when it is allowed to hang freely in a loop)
- Crepe yarns use high twist factors (5.5-8.0 cotton count Ne) to give characteristic decorative effects. A fabric made from such yarns is first wetted and then dried without any constraint to produce characteristic uneven crepe effect.

The twist in yarn is not usually distributed uniformly along its length, such that:

Twist x mass per unit length = constant

i.e. twist tends to run into the thin places in a yarn; twist level will vary along the yarn inversely with the linear density.

So it is suggested that twist level should be determined at fixed intervals along a yarn such as every meter.

- Fine yarns give more strength for less level of twist. For coarser yarn more twist is needed because it is made of (short) staple fibres.
- It is possible to give same strength by low level of twist in case of finer yarn.

MEASURING TWIST:

Sampling :

2-5% random sample is taken from bags that are selected from the consignment. Say if there are 100 bags, then select 5 bags randomly for testing. From each bag select one cone for testing and from each cone 10 tests are to be made thus total 50 testing.

Specimen :

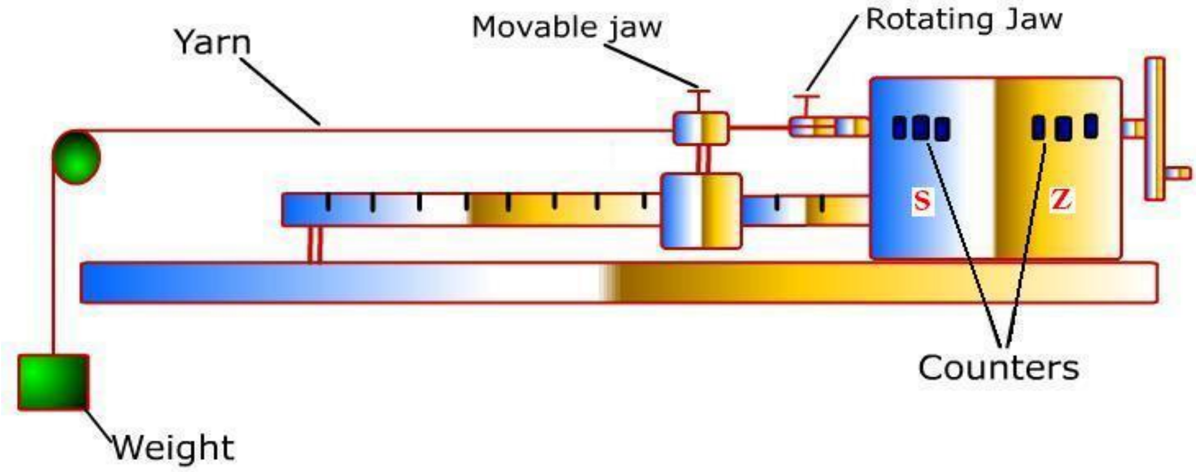
After conditioning, outer few layers from cone are removed. Then it is side-end withdrawal and mounted on the tester.

Test methods :

Following methods are used to test the twist.

a) Direct counting method :

- This is the simplest method of twist measurement.
- The method is to unwind the twist in a yarn and to count how many turns are required to do this.
- A suitable instrument has two jaws at a set distance apart. One of the jaws is fixed and the other is capal being rotated.
- A counter is attached to the rotating jaw to count the turns. Samples are conditioned in standard testing atmosphere before starting the test.
- Testing is started at least one meter from the open end of yarn. A standard tension (0.5cN/tex) is used w yarn is being clamped in the instrument.
- The twist is removed by turning the rotatable clamp until it is possible to insert a needle between the indi fibres at the non-rotatable clamp end and to traverse it across the rotatable clamp.
- A magnifying glass is needed to test the fine yarns.



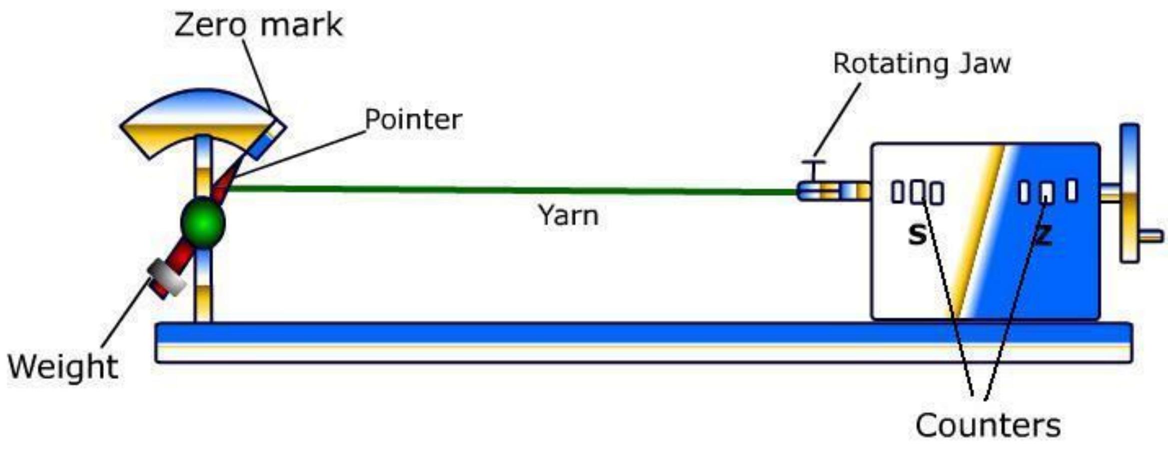
A SIMPLE TWIST TESTER

No. of tests:

- ***Single spun yarns :*** a minimum of 50 tests should be made. Specimen length for cotton is 25mm and w or worsted yarns, is 50mm.
- ***Folded, cabled and single continuous filament yarns :*** a minimum of 20 tests should be made with specimen length of 250mm.

b) Continuous twist tester :

- On twist testers, tests on consecutive lengths of yarn are not easily made because of the instrument desig the amount of yarn handling involved.
- So this tester has the extra advantage of allowing twist tests at fixed intervals.
- The straightened fibre principle is still used for the actual measurement of the twist.
- The yarn passes from the sample package, through a guide, through non-rotating jaw, then through rotat and finally wound on to a (clockwork-driven) drum.
- Assuming that a 1'' length of yarn is gripped between the jaws, the twist is taken out and the number of t noted.
- The handle is then turned until the counter reading is again zero. The spring loaded jaws of the rotating c opened and the clamp moved 1'' forward to touch the fixed clamp.
- Fixed jaw is then opened; rotating clamp is pulled back to its work position which pulls a new 1'' sample in test zone.
- The drum is allowed to take up the slack yarn, fixed clamp is again closed and the next test can be made.



A TENSION TWIST TESTER

For a longer test length say 5-10'' the sequence after a test is then:

Slide the fixed clamp upto the rotating clamp, open the rotating clamp and allow the drum to take up the slack close it again, slide the fixed clamp back to its original position, close it and make the next test.

c) Untwist-twist method or Twist contraction method :

- This method is based on the fact that yarns contract in length as the level of twist is increased and it incr length on twist removing, at last reaching a maximum length when all the twist is removed.
- The instrument shown is used for this method.
- The yarn is first gripped in the left-hand clamp which is mounted on a pivot and carries a pointer.
- After being led through the rotating jaw, the yarn is pulled through until the pointer lies opposite a zero li small quadrant scale; jaw is then closed.
- At this stage the specimen is under a small tension and has a nominal length of 10''.
- As the twist is removed, the yarn extends and the pointer assumes a vertical position, so removing the te
- Eventually all the twist is taken out but the jaw is kept rotating in the same direction until sufficient twist been inserted to bring the pointer back to the zero mark again.
- The total number of turns recorded on the revolution counter is divided by 20.
- The method is based on the assumption that the amount of twist put in is equal to the twist that has been removed. However, this is not necessarily the case.

For woollen yarns the test may give results up to 20% below the true value and for worsted it may be 15% hi

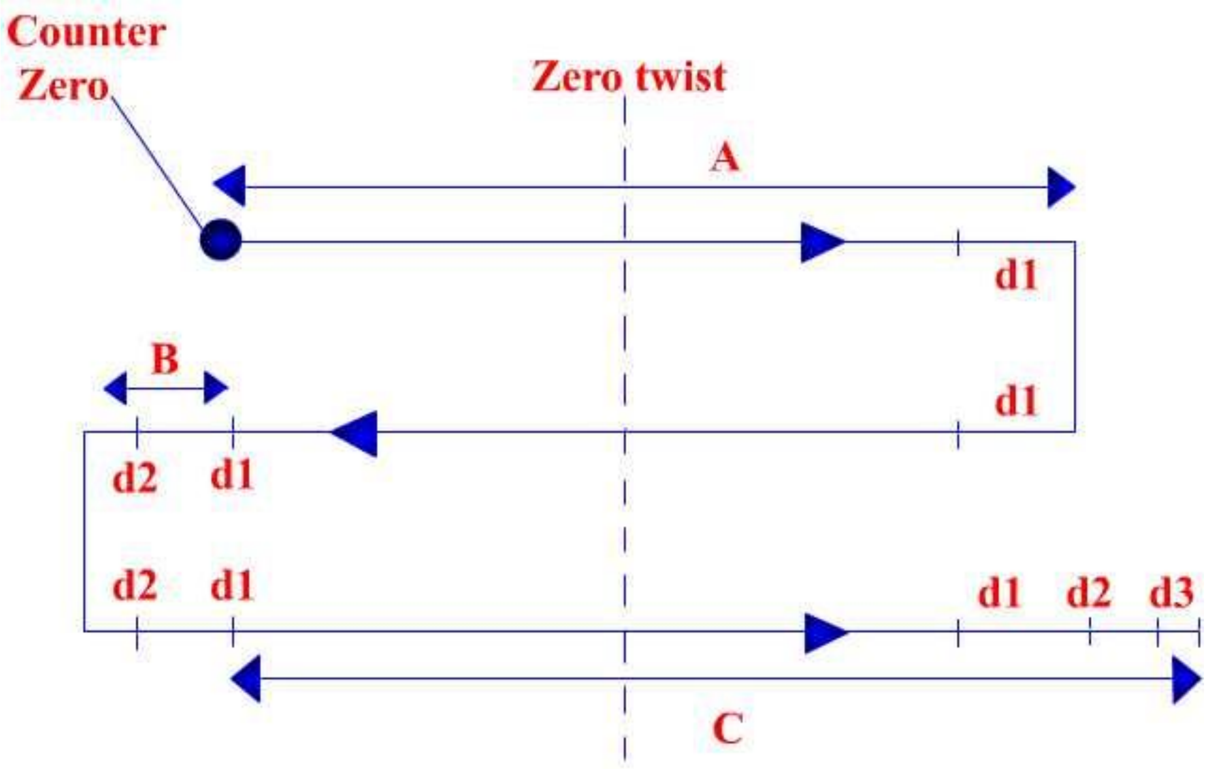
It may be due to:

- At the point of twist removal the fibres in the yarn are unsupported so that any tension in the yarn may c fibres to slip past one another, so increasing the length of yarn.
- With some yarns when the twist is removed the amount of twist to bring it back to the same length is not to the twist taken out.
- Because of these problems the method is not recommended for determining the actual twist of a yarn but use as a production control method.
- It suggests that 16 samples are tested using a gauge length of 250mm. However the method is easy to u

d) Multiple untwist-twist method:

- In the method of twist-untwist, No of turns to return the yarn to its original length is not the same as the turns to take the twist out.

- In spun yarns the distortion becomes permanently set into the fibres.
- This is particularly a problem in yarns made from wool fibres.
- In the test, shown diagrammatically in fig., the yarn is untwisted and re twisted back to its original lengt the normal test and the number of test A noted.



The multiple untwist········twist method

- The value A contains an unknown error d_1. Without the counter being zeroed, the direction of turning is r and the yarn untwisted and twisted back to its original length.
- This ought to bring the yarn back to its original condition; however owing to the errors the counter will sh small number of turns instead of zero.
- This reading is taken to be B and due to the errors d_1 and d_2. By untwisting and re-twisting a third time a reading C is obtained which contains the errors d_1, d_2, and d_3 as shown.
- Combing the readings A, B and C gives:

  A - 2B + C = 4X
- Where X is the number of turns in the length of yarn tested
- The method relies on the errors d_1, d_2, d_3 becoming progressively smaller so that the remaining error in above equation is the difference between d_2 and d_3 and can be ignored.

e) Automatic twist tester:

- In the method of twist-untwist, No of turns to return the yarn to its original length is not the same as the turns to take the twist out.

f) Take-up twist tester:

- Take-up is the difference between the twisted and untwisted length of a yarn.
- This tester is available with a non-rotating movable jaw which is slid away from the rotating jaw to take u slack yarn after the twist is removed. This allows the length difference to be measured.

g) Twist in Folded yarns:

- In folded or plied yarns, firstly there is the twist in the individual strands making up the ply and secondly is the twist that holds the individual plies together.
- If the twist in the single strand is required the yarns can be analyzed by first removing the folding twist a then cutting out individual yarns, leaving the one strand whose twist is then measured on twist tester.

TENSILE TESTING

Importance of Testing:

To know the level of strength provided by fibers, yarns or fabric :

a) For Industrial and Technical products - It is very important to know the strength in products likes, industrial rope,conveyor belt, etc.

b) For household or apparel use - Merely need an adequate strength in order to withstand handling during production and use.

Fibre Strength:

- Fibre strength is generally considered to be next to fibre length and fineness in the order of importance amongst fibre properties.
- Fibre strength denotes the maximum tension the fibre is able to sustain before breaking.
- It can be expressed as breaking strength or load, tenacity etc.
- Elongation denotes elongation percentage of fibre at break.

Factors affecting the strength of fibres:

- Molecular structure
- No. and intensity of weak places
- Coarseness or fineness of fibre
- Relative humidity
- Elasticity

Fibre strength is determined by either testing individual fibres or group of fibres.

Manmade fibres are usually tested for their individual strength as there is very less variation in length and fineness the fibres. Natural fibres are tested for their bundle strength due to high variation in terms of length and fineness.

Bundle fibre strength testing:

A bunch of fibres are put in to two jaws. The jaws are moved until the fibres break. The breaking load and elongation at break are noted

$$\text{Tensile strength / Tenacity of the fibre = In g/tex} = \frac{\text{Breaking load in kg x Length of sample in mm}}{\text{mass of the fibres in mg}}$$

Bundle strength of cotton:

- The "Stelo"meter – the name coined from strength and elongation which functions on pendulum lever principle.
- Pressley fibre strength tester - functions on pivoted beam balance principle.
- Uster spin lab High Volume Instrument

TERMINOLOGY AND DEFINITIONS:

1) Load:

- The application of a load to a specimen in its axial direction causes a tension to be developed in the specimen.
- The load is usually expressed in *grams* or *pounds*.

2) Breaking Load/Breaking Strength:

- This is the load at which the specimen breaks.
- It is usually expressed in *grams* or *pounds*.

3) Stress: It is the ratio between the force and the area of cross-sectional of the specimen.

i.e., Stress = Force applied / Area of cross section

- But in case of textile material, only for circular materials, it can be measured.
- Cross section of yarns and fabrics, due to unknown packing characteristics the exact cross-sectional area is very difficult to measure.
- Also the cross-section of yarns, fibers or fabrics are irregular.

4) Specific/Mass Stress:

- In case of textile material the linear density is used instead of the cross sectional area.
- It also allows the strength of yarns of different linear densities to be compared.

Specific stress = Force/Linear density (initial)

The preferred units are *N/tex* or *mN/tex*, other units which are found in the industry are *gf/denier* and *cN/dtex.*

5) Tenacity or Specific Strength:

- The tenacity of material is the mass stress at break.
- It is defined as the specific stress corresponding with the maximum force on a force/extension curve.
- The nominal denier or tex of the yarn or fibre is the figure used in the calculation; no allowance is made for any thinning of the specimen as it elongates.
- Units are grams/denier or grams/tex.

6) Breaking Length:

- Breaking length is an older measure of tenacity.
- It is the theoretical length (in Km) of a specimen of yarn whose weight would exert a force sufficient to break the specimen.
- It is usually measured in kilometres.

e.g. 10 tex yarn breaks at a load of 150grams

∴ Breaking length would be = 15km (RKm)

The numerical value is equal to tenacity in **g/tex (150/10)**

7) Strain:

- When a load is applied to a specimen, a certain amount of stretching takes place.
- The elongation that a specimen undergoes is proportional to its initial length.
- Strain expresses the elongation as a fraction of the original length.

i.e., Strain = Elongation / Initial length

8) Extension percentage:

- This measure is the strain expressed as a percentage rather than a fraction.

i.e., Extension % = Elongation / Initial length

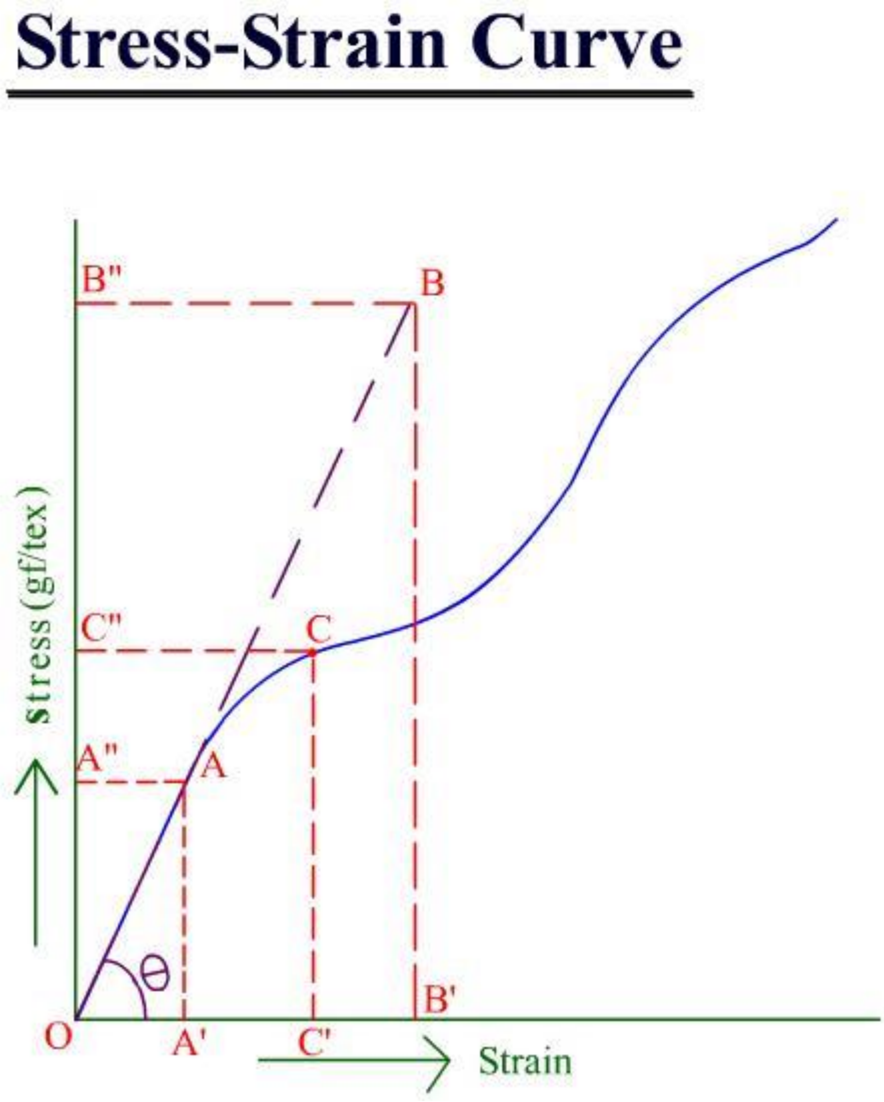
9) Breaking extension:

- Breaking extension is the extension percentage at the breaking point.

10) Gauge length:

- The gauge length is the original length of that portion of the specimen over which the strain or change of length is determined.

When an external force is applied to any material it is balanced by the internal force developed in the molecular structure of the material.



EVENNESS

Introduction:

ypes of Irregularity:

1) Weight per unit length:

- Variation in weight per unit length is the basic irregularity in yarn. All other irregularities are dependent on it. This is because weight per unit length is proportional to fibre number i.e.; number of fibres in cross section of yarn.

- Variations in number of fibres are the factor influenced by drafting. So any improvement in drafting or spinning will first reflect in improvement in variability of weight per unit length.

2) Diameter:

- Variability in diameter is important because of its profound influence on appearance of yarn.

- Variations in diameter are more easily perceived by eye.

- Latest models of evenness testers have therefore a module for determining diameter variability.

- Diameter variability is however caused by weight variability.

- As twist has tendency to run into thin place, variability in weight gets exaggerated in diameter variability.

3) Twist:

- Twist variation is important because of its influence on performance of yarn and fabric dye ability and defects.

- Soft ends are a major cause of breaks in weaving preparatory and loom shed. They arise from twist variations.

- Soft twisted yarns take more dye and so uneven dyeing is caused by high twist variation. Weft bars and bands are also caused by low twisted yarns.

- Twist variations come from slack spindle tapes, jammed spindles. A certain amount of variation is also present along the chase of cop.

4) Strength:

- Importance of strength variation is easy to appreciate.

- Yarn breaks at the weakest element and so yarns with high strength variability will result in high breakages in further processes.

- Strength variability is partly dependent upon count variability and partly upon spinning conditions and mechanical defects.

5) Hairiness:

- High variation in hairiness leads to streaky warp way appearance and weft bars in fabric.

- More light will be scattered from portions of weft where hairiness is more and this leads weft bands.

- High hairiness disturbs warp shed movement in weaving and results in breaks, stitches and floats.

- Among other factors, worn out rings and travellers, vibrating spindles, excessive ballooning and variation in humidity in spinning room cause variations in hairiness from bobbin to bobbin.

6) Colour:

Variations in colour of yarn cause batch to batch variation in fabric colour, which leads to rejects. This is particularly critical in cloth marketed to garment units.

Variations in colour of yarn and fabric are caused by variations in colour of cottons used in mixing. Larger lot sizes made from a large number of bales help to mitigate this problem.

Checking of cotton and mixing for colour will also minimize large variations in colour.

HVI testing equipments have therefore a module for checking colour.

Index of irregularity:

Two expression for irregularity has been given:

1. The average value for all the deviations from the mean is calculated and then expressed as a percentage of the overall mean (Percentage mean deviation, PMD). This is termed U% by the uster company.

2. The standard deviation is calculated by squaring the deviations from the mean and this is then expressed as a percentage of the overall mean (coefficient of variation, CV%).

When the deviations have a normal distribution about the mean the two values are related by the following equations:

$$CV = 1.25PMD$$

It is possible to achieve a lower irregularity for a given count by a selecting a better type of cotton than would be normally chosen, a practice known as 'spinning down'.

Limit irregularity:

Martindale has shown that the most uniform strand of material which our present machines can produce is one in which the fiber ends are laid in a random order in the sliver, roving, or yarn. For such a strand of material the irregularity is given by the formula

$$Vr^2 = ((100)^2/N) + (Vm^2/N)$$

where

Vr = coefficient of variation of weight per unit length

N = the average number of fibers in a cross-section of the strand , and

Vm = Coefficient of variation of the fiber weight per unit length

Thus, for a particular fiber and count of yarn, there is limit or basic irregularity upon which our present machinery cannot improve. By calculating the limit irregularity and then measuring the actual irregularity, we have a means of judging the spinning performance.

Let

Vr = the calculated limit irregularity, and

V = the actual irregularity

Then, the ***index of irregularity*** is :

$$I = V / Vr$$

Hence, a value of unity for this ratio corresponds to the limit irregularity, i.e. the best possible yarn: the higher the value of I the more irregular the yarn. For cotton fibers the limit irregularity formula may be reduced to, $Vr^2 = (106)^2 / N$, and for wool fibers, $\boldsymbol{(112)^2 / N}$. For blended of cotton with other fiber the $\boldsymbol{V_r^2 = (118.8)^2 / N}$.

Addition of irregularity:

- In formula given in limit irregularity the square of the coefficient of variation is used; in this form it is known as the ' relative variance', often abbreviated to 'variance'. By using the squares of the coefficients of variation it becomes possible to add and subtract the irregularities produced at various stages in yarn preparation and spinning
- Suppose the coefficient of variation of a sliver is V_1 and it is fed to a machine which adds irregularity to its during processing. Let V be the coefficient of variation of the processed sliver. Using the squares of the coefficients,

$$V^2 = V_1^2 + V_2^2$$

Where V_2 is the coefficient of variation of the added irregularity.

Causes of irregularity:

1) Irregularity caused by raw material:

- The natural fibres have variable varieties. They have no true fixed length, fineness, shape of cross-sectio crimp, etc., which have effect on yarn properties specially evenness.
- These variations are due to different rates of cell development due to changes in environmental conditio soil, and weather).
- In man-made fibres, variations in mass/unit length occurs due to changes in polymer viscosity, roughnes orifice, variation in extrusion pressure and rate, filament take-up speed, presence of delustrant or additives, modify the particular shape and fibre surface geometry.

2) Irregularity caused by fibre arrangement:

- Textile fibres are not rigid. Their manipulation during conversion into yarn is an immensely complex com mechanical movement which usually requires some degree of compromise.
- The desirable results of relocating large number of fibres at high speed and arranging it well ordered for difficult.
- Fibres assembled into the form of a twisted strand constitute a yarn.
- Fibres are not precisely laid end to end, and gaps are present between them. As a result of yarns twist, f spiral form in a series of folds, kinks, and doublings.

3) Effect of fibre behaviour:

- Fibres shape directly affects yarn regularity.
- The fibre cross section, arrangement of fibre section and space between the fibres will vary from yarn se
- Hence the mass of each section will differ.
- A thin place in yarn will have lower mass and less strength. In thin regions, yarn twist tends to be highe resistance to deformation is lower.

4) Inherent shortcoming of machinery:

- In many engineering processes the units from which the final product is assemb ed are positively control
machine and positioned with only a few thousands of an inch tolerance.

- In spinning it is surprising how often the individual fibres are only negatively cor trolled at times they are
by air currents or jostled along by surrounding fibres, or they are held in position by frictio and twist.

- Fibre manipulation by rollers, aprons, gills, and other machine parts is hampered by fib e variation, and
can only be set to give the best results within the limitations imposed by the materi l.

- The drafting wave is one example of irregularity due to the inability of a drafting syster to control each
roller drafting is used, the distance from one nip to the other is greater than the len th of he shorter fibres.

- These short fibres 'float' in the drafting zone and move forward in an irregular bu t cycli al manner which
drafted strand having thick and thin places.

- The wavelength of this type of irregularity is about 2-5 times the mean fibre len th but it is not necessar
a particular strand.

- In addition to a varying wavelength, the amplitude of the drafting wave is also v riable

5) Mechanically defective machinery:

- Since machines even in good condition produce irregular yarns, it is reasonable o assu me that defective
increase the amount of irregularity.

- The implementation of an efficient maintenance system is essential if the level o irregu arity is to be kep
bounds.

- Machines drift out of adjustment, bearings become worn, components get dama ed, ar d lubrication syst
dirt works its way into the mechanism.

- Faulty rollers (top roller eccentricity) and gear wheels usually produce periodic v riatior .

xpression of "Unevenness" Or "Irregularity":

- The mass per unit length variation due to variation in fibre assembly is general y kn wn
as ***"IRREGULARITY"*** or ***"UNEVENNESS".***

- It is true that the diagram can represent a true reflection of the mass or weigh per nit length variati
assembly. For a complete analysis of the quality, however, the diagram alone is not e oug .

- ***Variability in properties***, i.e. weight/unit length, diameter, twist, thickness, s reng th etc.

- Most popular approach is to measure the variability in weight/unit length.

- It is also necessary to have a numerical value which represents the mass varia ion.

The mathematical statistics offer two methods:

1.*The irregularity U%*

It is the percentage mass deviation of unit length of material and is caused by uneve fibr distribution alon strand.

U% = PMD = Mean Deviation / Mean ×100

= [{(ΣIx-xI) / n} / x] ×100

2.*The coefficient of variation C.V.%*

- In handling large quantities of data statistically, the coefficient of variation (C.V.%) is commonly used to and is thus well-suited to the problem of expressing yarn evenness.

- It is currently probably the most widely accepted way of quantifying irregularity.

It is given by,

CV% = Standard Deviation / Mean × 100

- The irregularity U% is proportional to the intensity of the mass variations around the mean value.

- The U% is independent of the evaluating time or tested material length with homogeneously distributed

- The larger deviations from the mean value are much more intensively taken into consideration in the ca coefficient of variation C.V. %.

- C.V. % has received more recognition in the modern statistics than the irregularity value U%.

- The coefficient of variation C.V.% can be determined extremely accurately by electronic means, wherea the irregularity U% is based on an approximation method.

Classification of Variation:

There are two types of variation and they are classified as the following:

(1) Random variation

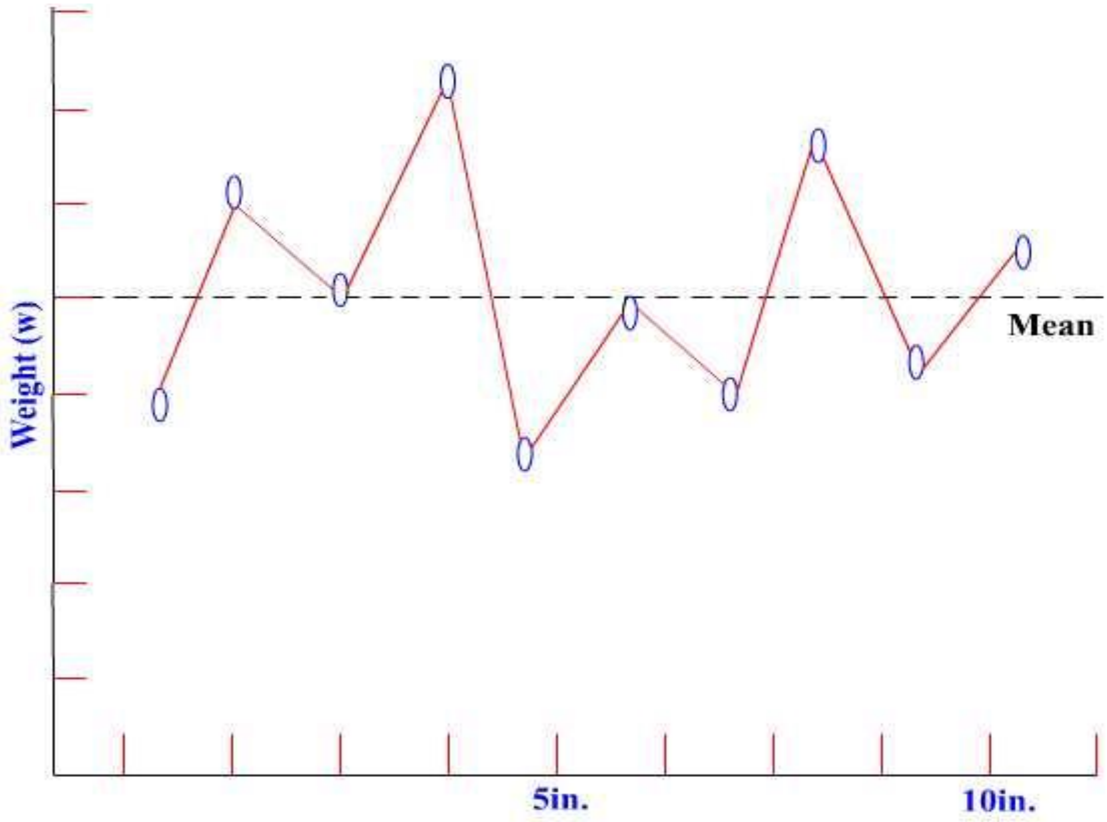
(2) Periodic variation

(1) Random Variation:

- Random variation is the variation which occurs randomly in the textile material, without any definite order.

Suppose a yarn is cut into short equal lengths, say, of 1 inch, and weight of each consecutive lengths are found out.

The weights are plotted in a graph against the lengths similar to the figure shown below,



Weight(W) of consecutive 1inch lengths cut from yarn

Variation in weight per inch

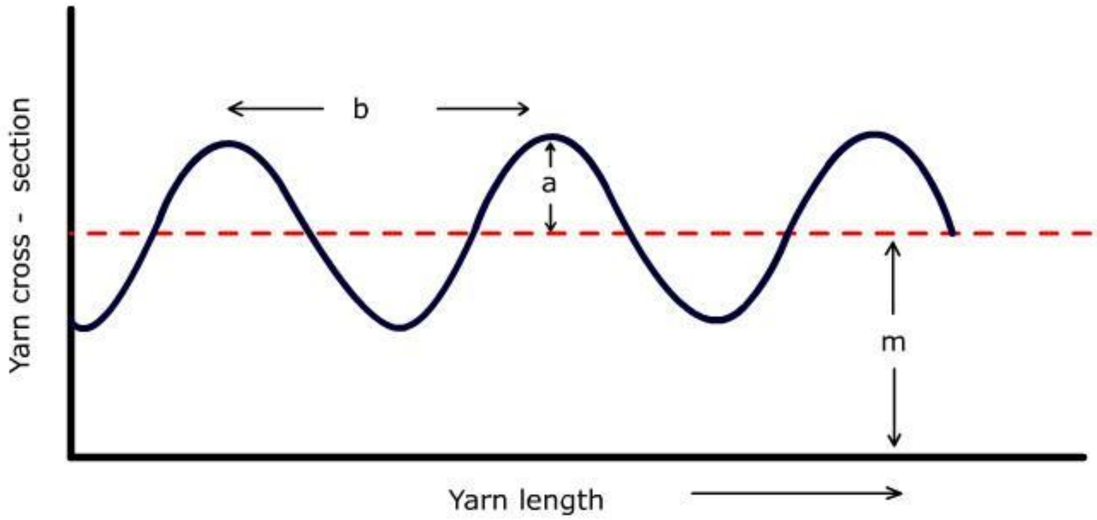
By joining the points a trace is produced, called ***irregularity trace.***

(2) Periodic Variations:

- All traces of irregularity do not show random distribution of the deviations from the mean

- Suppose traces show definite sequences of thick and thin places in the strand of material. These forms of irregularity are called as periodic variations.

- Periodic variations are the variations with definite sequences of thick and thin places in the strand of material.



Wave length and amplitude

m= mean chart height

a = amplitude of wave or variation

b = wave length periodic variation

a /m x 100 = percentage amplitude

Two terminologies **wave length** and **amplitude** are used in order to describe a periodic variation from the figure.

- **Wave length** is the distance from the one peak of the wave to the next on the same side of the mean line.

- **Amplitude** is a measure of the size of the swing from the mean level. Usually this is expressed as a percentage of the mean.

Short, Medium and Long Term Variations:

Using the fibre length as a length unit, the periodic variations in the fibrous strand are classified according to their wavelength with respect the fibre length used to form that particular strand.

There classification is as follows:

1. **Short term variation:** wave length 1 to 10 times fiber the length
2. **Medium term variation:** wave length 10 to 100 times fiber the length
3. **Long term variation:** wave length 100 to 1000 times fiber the length

This classification is used when causes of faults are being investigated.

The amplitude of short-term variation are generally greater than long-term variation because they are occur at the last machine, and have had no chance of being reduced by doubling.

CV of doubled strand = CV of individuals / √n

where 'n' is number of doublings

1) Short term variation:

- These variations are of the wave length 1-10 times of fibre length.
- Amplitude of these variations is greater than long term variations.
- These result due to faulty processing at the last machine.
- Such variations if excessive produce a fabric of objectionable appearance.

2) Medium term variations:

- These variations are of the wave length 10-100 times the fibre length.
- Such variations do not cause a pattern as it hides into the adjacent warp yar .
- In weft it will appear as a thick line again hidden by adjacent weft. However xc ssive variations g streaky appearance.

3) Long term variations:

- These variations are of the wave length 100-1000 times the fibre length.
- Such variation cause periodic faults known as diamond bars or block bars in ne voven fabric alon direction.
- A weft yarn to cause a diamond bar pattern must have a long term periodic aria tion of wave leng the pick length.

ffects of irregularity:

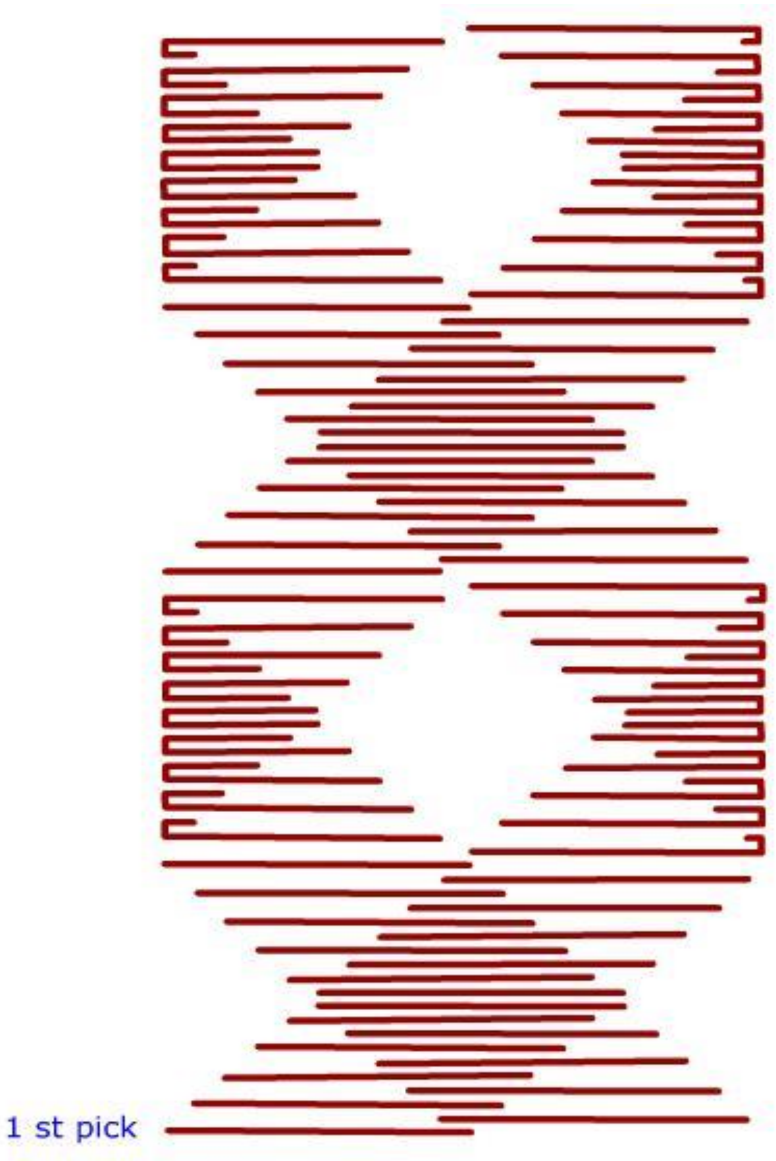
1. Strength:

Thin places in sliver, roving or in yarn will be weak places. The greater will be the chance of breakage for more irregular yarn.

2. Fabric appearance:

- Yarns free from strong periodic variations but with a high degree of general irregularity will tend to produce patchy fabric.

- Under certain conditions yarns with periodic thick and thin portions will cause the fabric to exhibit an unwanted pattern.



37. diamond barring Cloth width = 39 in.wave length of variation = 40 in.

i.e. 20 in thick yarn followed by thin yarn

a) In warp it gives streaky appearance.

b) In weft – "Diamond Bars" and block bars can arise

The conditions for diamond bars:

$$W = (R+x) \times \lambda$$

Where, λ = wave length of periodic variation

R = an integral multiple of ½

x = value less than ¼

This means, to cause a ***"diamond bar"*** a weft must have a periodic variation whose wave length is less than twice the fabric width.

$\lambda < 2W$

3. Dyeing faults:

One effect of yarn irregularity on the dyeing process is the thicker and the softer parts of the yarn take up more size than the thinner and harder region; after the desizing process prior to dyeing, the distribution of the residual size may be uneven and cause difficulty in achieving a level dyeing.

. Yarn breakage:

Processability of the material is affected by yarn irregularity. For example passing neps through heald eye or reed in weaving, needle eye during knitting or in sewing machine leads to yarn breakage.

Methods of Measuring Yarn Evenness:

In fact, to measure irregularity, many methods are available involving from no equipments to electric instruments.

Of all these we are to see,

Visual Examination Methods:

Using Black Boards, Drums, Photographic Devices, Projectors, and Lap Meter.

Cutting and Weighing Methods:

Lap Scale, Lap meter, Sliver, Roving, and Yarn Wrapping.

Electronic Capacitance Testers:

Fielden- Walker Evenness Tester and Uster Evenness Tester.

Variation In Thickness Under Compression:

WIRA Roving Levelness Tester and LINRA Roller Yarn Diameter Tester.

Photoelectric Testers:

WIRA Photoelectric Testers and LINRA Tester.

Miscellaneous Methods:

Airflow, Mercury Displacement, etc.

Before actually going into the methods in detail it must be kept in mind that the most important property of a yarn is the number of fibres in a cross-section and the variation of this number along the yarn is the fundamental measure of irregularity.

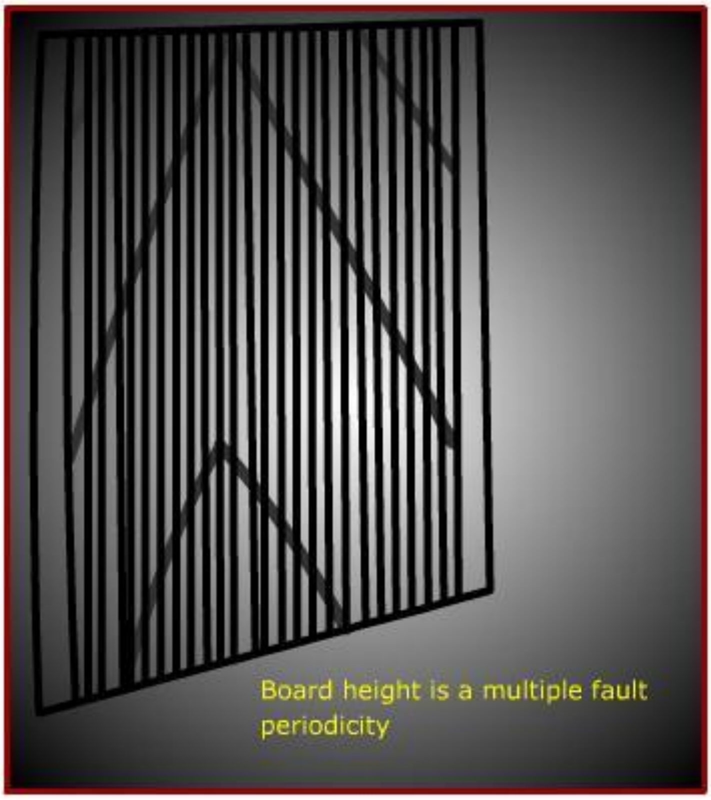
1. Visual Examination Method:

(a) Yarn appearance board:

➔ Yarn to be examined is wrapped onto a matt black surface in equally spaced turns.

➔ The black boards are then examined under good lightening conditions using uniform non-c ctional light. A.S. Cotton Yarn Appearance Standards which are photographs of different counts with the appear e classified in fou

➔ The test yarn is then wound on a blackboard approximately 9.5 x 5.5inches with the corre pacing and comp corresponding standard.



➔ Motorized wrapping machines are available: the yarn is made to traverse steadily along th card as it is rotat even spacing.

➔ It is preferable to use tapered boards for wrapping the yarn if periodic faults are likely to b resent.

➔ This is because the yarn may have a repeating fault of a similar spacing to that of one wra f yarn.

➔ By chance it may be hidden behind the board on every turn with a parallel sided board wh as with a tapered point appear on the face.

➔ Subjective measuring technique

➔ Provides important additional information that can be correlated with the appearance to be expected in fabrics made from yarn.

➔ Grading after viewing a sample of yarn wound with a designated traverse (depend on count) on a black board.

ASTM standard test method describes the yarn appearance into five grades. The board is compared with standard photographs and then graded.

***Grade A*:** No large neps, very few small neps, must have very good uniformity, less fuzziness.

***Grade B*:** No larger neps, few small neps, less than 3 small pieces of foreign matters per board, slightly more irregular and fuzzy than A.

***Grade C*:** Some larger neps and more smaller neps, fuzziness, foreign matters more than B, more rough appearance than B.

***Grade D*:** Some slubs (more than 3 times diameter of yarn). More neps, larger size neps, fuzziness, thick and thin places, foreign matters than Grade C yarn. Overall rougher appearance than C.

***Grade E*:** Below grade D, more defects and overall rougher appearance than grade D yarn

2.Gravimetric Method (Cutting and Weighing Method):

Lap-to-lap variation:

- By weighing individual laps, i.e. cut length in this case being the lap length.

a) Lap meter:

- Automatically unrolls the lap, break off a 1 yard length, and deposit into the pan of scale
- Weights are recorded subsequently.
- Data analysis.

b) Slivers, roving and yarn:

- The count (hank) and count CV% are checked by measuring a test length and weig ng it on an accura

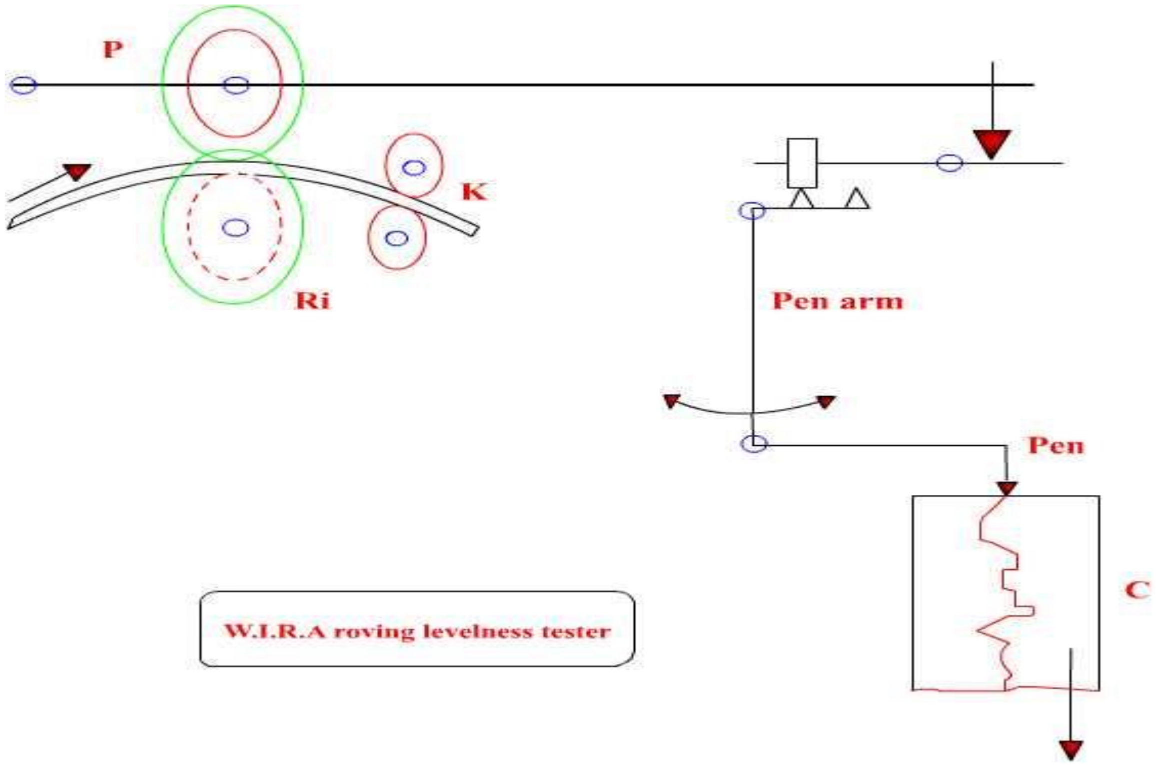
Normally, for sliver - 6 yard– by wrap block

For roving -15 yard – by wrap block

For yarns - 120 yard– by wrap reel

3. By Measuring Variation in Thickness Under Compression:

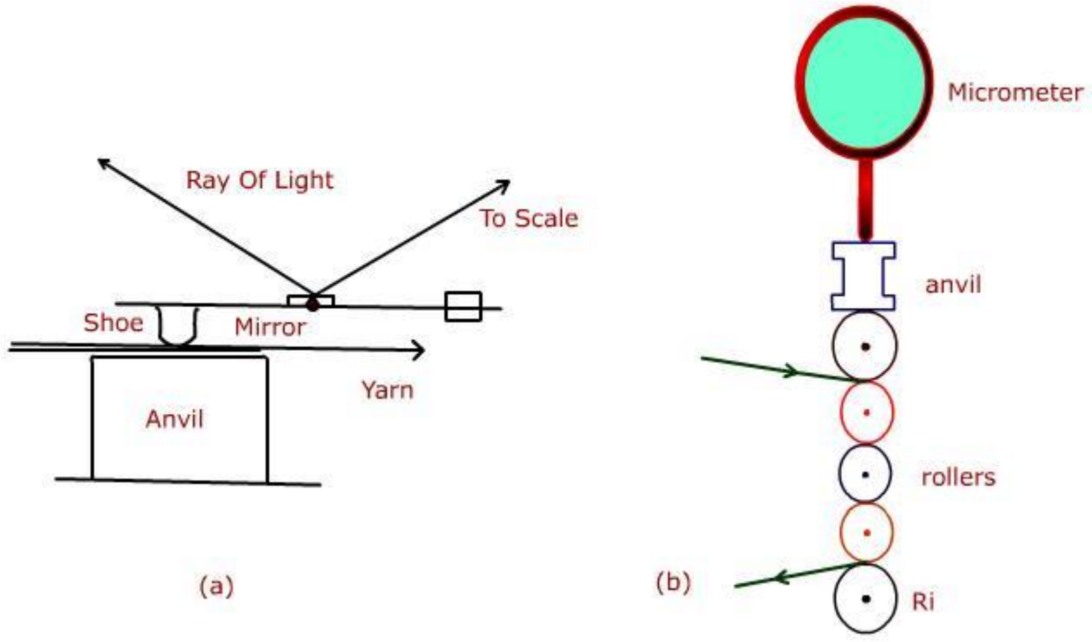
(a) *WIRA Roving levelness tester (sliver may also be used):*



b) Yarn testing by compression method:

i) Anderson yarn tester:

- The recording of yarn thickness variation taken from an optical arrangement.



Yarn testing by compression (a) Anderson yarn tester (b) the LINRA roller yarn diameter

- The reflected light beam falls on a strip of moving photographic paper and trace is generate

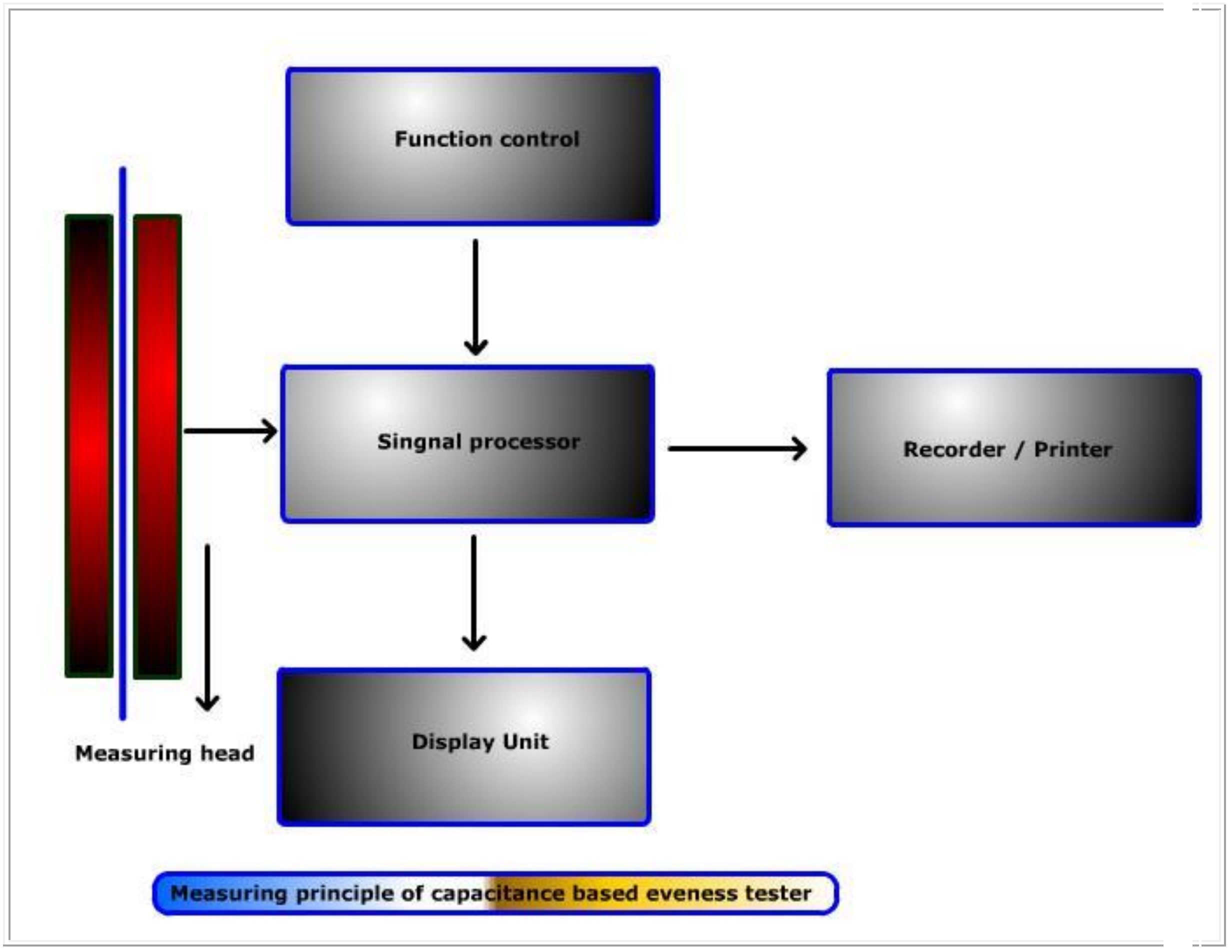
ii) Roller yarn diameter tester (LINRA):

- Four thicknesses so measured are equally spaced within 1''.

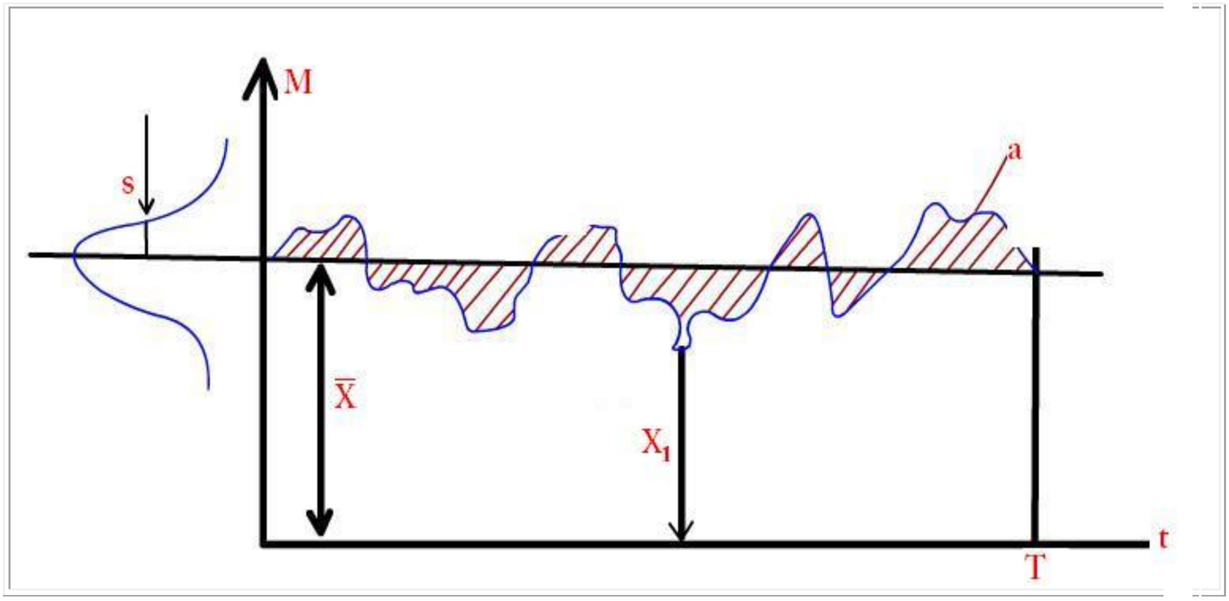
- The movement of top roller can also be measured by mechanical or electrical pen recorder.

4. Electronic capacitance method: (USTER Tester 3 or 4):

- Indirect method of measuring the change in mass per unit length
- The yarn is passed though a parallel plate condenser in a continuous fashion
- Change in capacity are monitored electronically
- A change in mass of the dielectric (non-conducting material) in the condenser changes its c acitance.
- Change in capacitance **'a'** mass of material



Measuring principle of capacitance based eveness tester



If the material is drawn at constant speed through the condenser continuously, the changes ı capacitance wil the variation in weight/unit length of the strand.

The unit length being the length of the capacitor (e.g. for Zellweger USTER it is 8 mm).

$$U\% = [a/(X \times T)] \times 100 \,]$$

$$= (100/X \times T) \times \int I x - x_i \, I. \, dt$$

$$CV\ \% = 100 \times \sigma / X = 100/X\, [1/T \int (x-x_i)^2 dt]^{0.5}$$

Larger deviation from mean in case CV% (as it is in squaring)

CV% values have greater impact of yarn appearance and their processing behavior, so CV% ꞩ a better measu unevenness than U%.

Diagram:

The graphical representation of mass per unit length variation along the length of sliver, r ing or yarn is ref diagram.

It indicates the nature of variability present in the material.

We get following information from diagram:

1. Long wavelength variations, even with periodic variation which spectrogram cannot confirm.

2. Extreme thick and thin places.

3. Slow changes and step changes in the mean value.

4. In many cases, it can confirm the numerical values of instrument.

Imperfections:

Staple fibre yarns, at a number of places along their length, contain large variations in mass per unit length which are referred to as "imperfections" - ***thick, thin, neps***

Causes:

Due to defective raw material or manufacturing process.

1. Thick places: +50% If the counter is actuated, the mass per unit length (cross section) at the thick place is 150% or more of yarn mean value (> 4 mm length)

(Ranges: +100%,+70%,+50%,+35%)

2. Thin places: -50% only 50% of yarn mean value or less.

(Ranges: -60%, -50%, -40%, -30%)

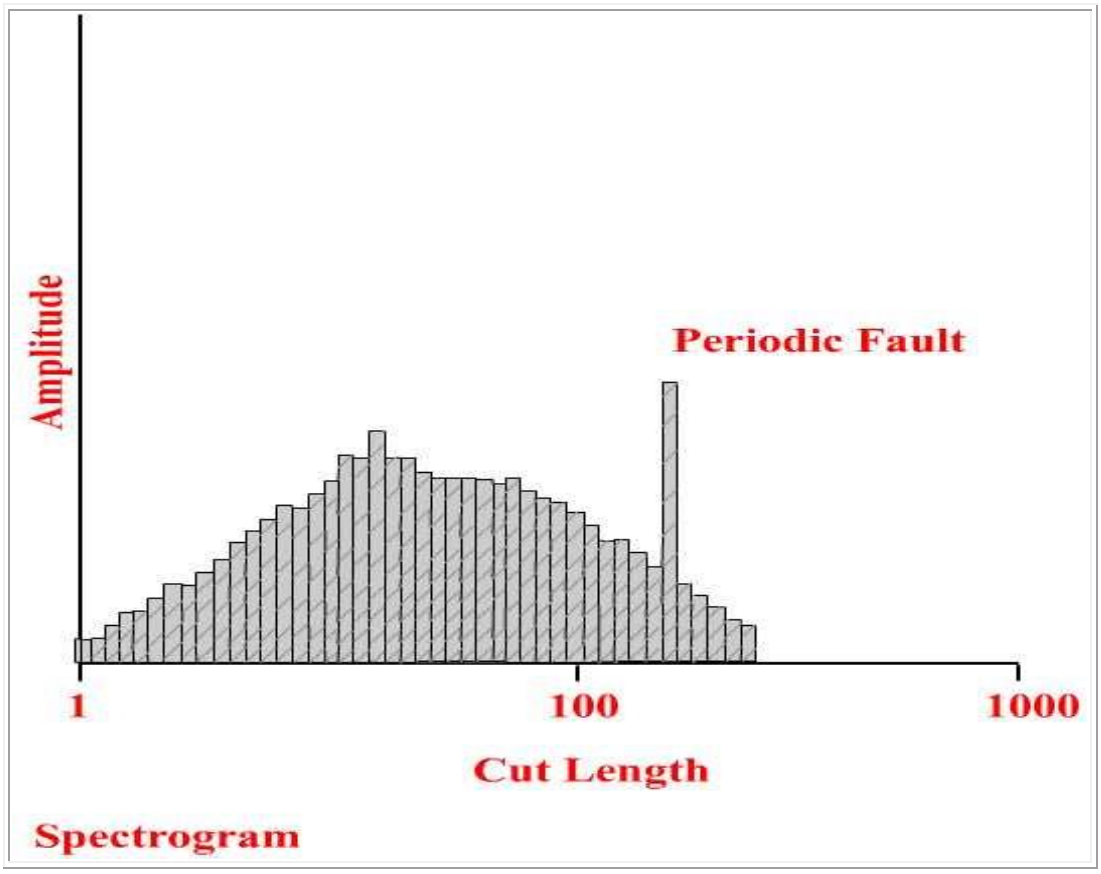
3. Neps: +200% The thick place based on 1 mm length, is 300% of the yarn mean value or more. Length shorter than 4 mm (however refers as a reference length of 1 mm)

(Ranges: +400%,+280%,+200%,+140%)

Spectrogram:

- Amplitude of periodic mass variation is plotted against the wavelength in a spectrogram.

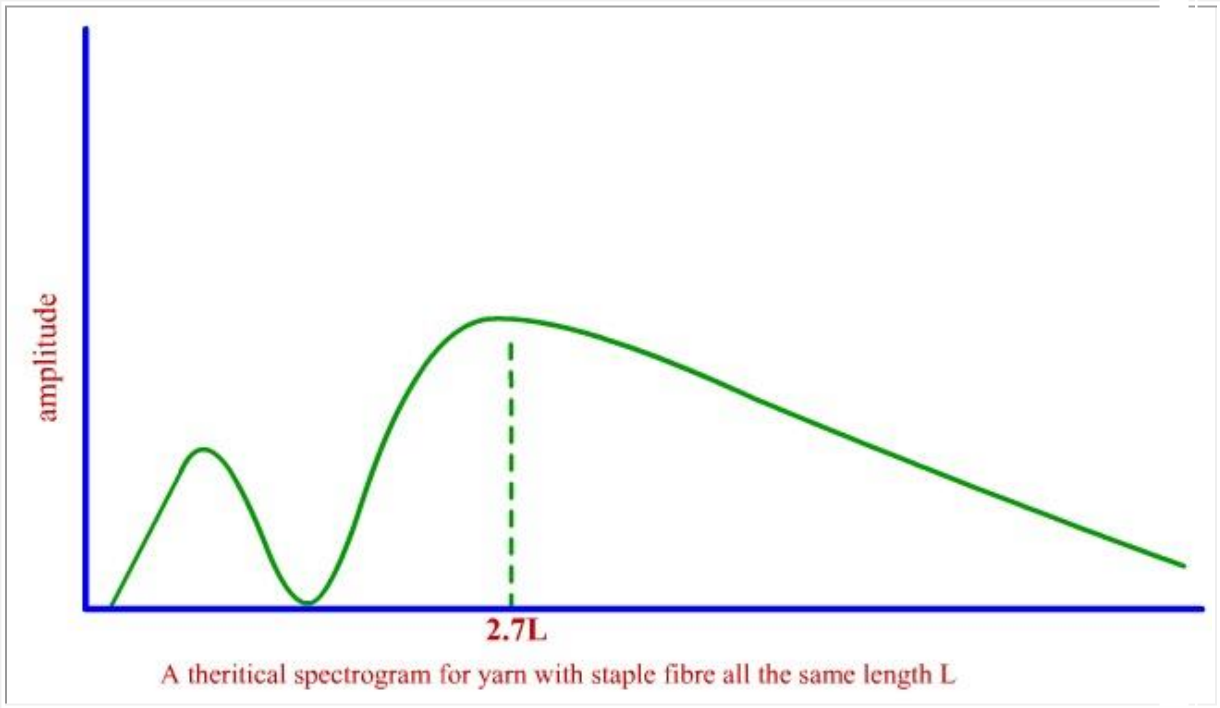
- From the speed at which the yarn is running (through capacitance type sensor) the frequenc s are converted to wavelengths and plotted into a finite number of discrete wavelength steps.



- Histogram is then plotted automatically.
- Amplitude is a measure of the number of times a fault of that repeat length occurs.
- Helps in locating the generating point of a periodic fault.
- Spreading of humps are due to periodic faults generated due to “drafting waves” and the wavelength due to drafting wave will be around 2.5 – 3.0 inch for cotton.

Theoretical spectrogram:

For yarn with its staple fiber all the same length L (but in actual practice it is different, due to fa t induced during processing)



$$S = f(\lambda) = (1/\sqrt{\pi n}) \times \sin(\pi l_0/\lambda) / \sqrt{(\pi l_0/\lambda)}$$

Where,

n = No. of fibers in cross section,

l_0 = Fiber length,

λ = Wavelength

For natural fiber with variable length (L = mean fiber length)

Deviation rate:

It indicates the ratio of the total length of yarn irregularities determined on the basis of the yarr regularity signals averaged over certain length (small reference length) which exceeds the preset level to e total measured yarn length.

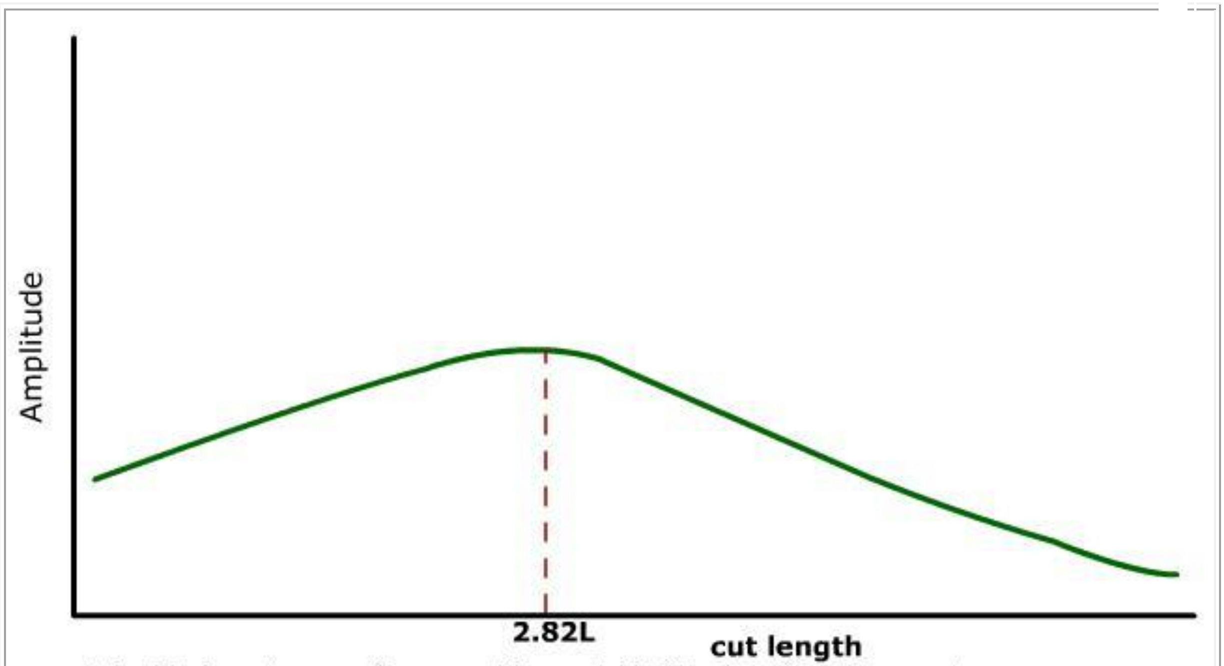
***DR % = [Σ d** / L] x 100*

It shows correlation with the evaluation by the naked eye of the appearance of fabric.

Uster statistics:

- A comprehensive data bank on quality parameters of yarns or fibres.

- Large number of samples are collected and tested for various parameters in a standard test g laboratory.



A theritical spectrogram for yarn with a variable fibre length in this case L is mean fibre length

- In 1997 Uster statistics total 5840 samples were collected

(8% from North America, 12% from South America 40% from West Europe, 5% from East Euro , 13% from Africa and Middle east and 22% from Asia Pacific zone)

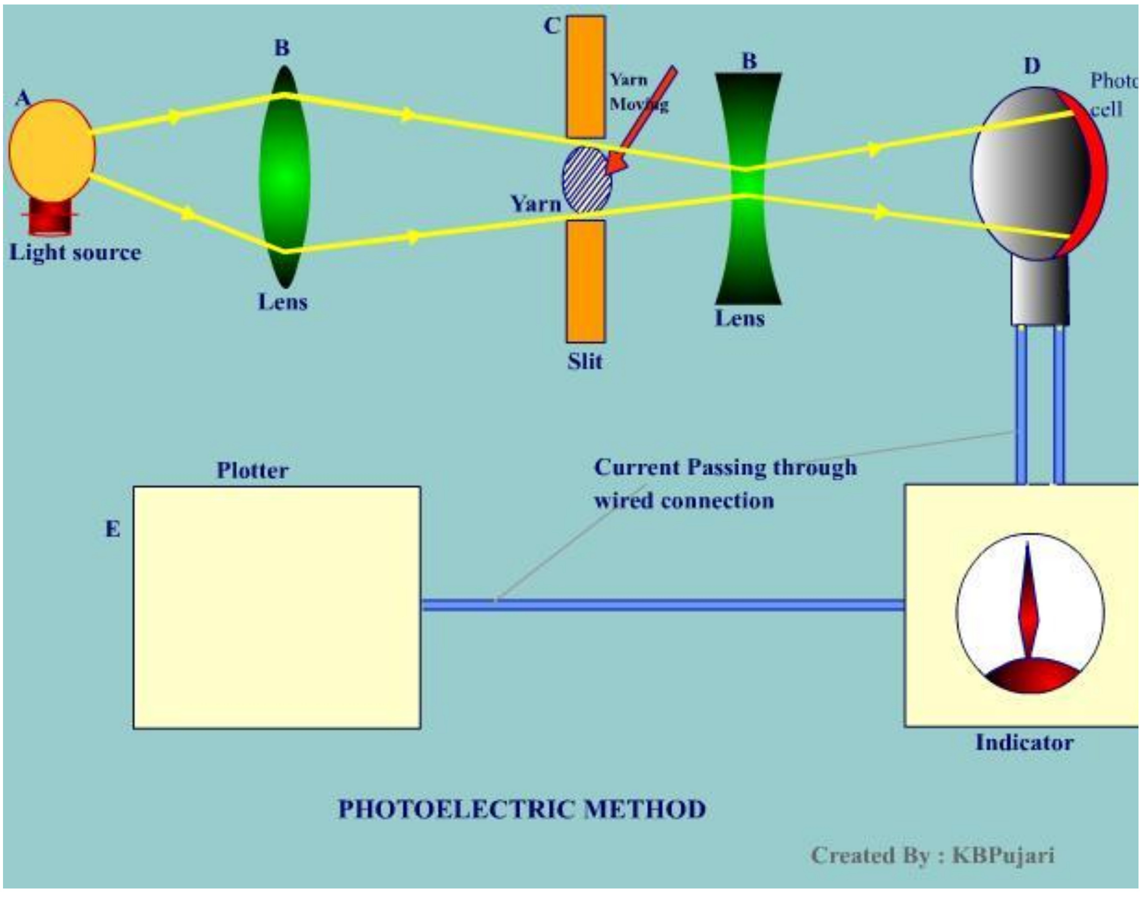
- All data are entered into data bank and with the help of application software the percentile rves are plotted.

- It helps in assessing the level of the quality of product with international standards.

- The Uster Statistics value changes in every 5 years.

5. Photoelectric method:

➔ When the beam of light is directed onto photoelectric cell, an electric current is produced.



➔ The magnitude of the current is proportional to theintensity of light falling.

➔ If path of light is cut off by the yarn /roving/ sliver, the current flowing will vary as thickness of light will varies.

FABRIC HANDLE

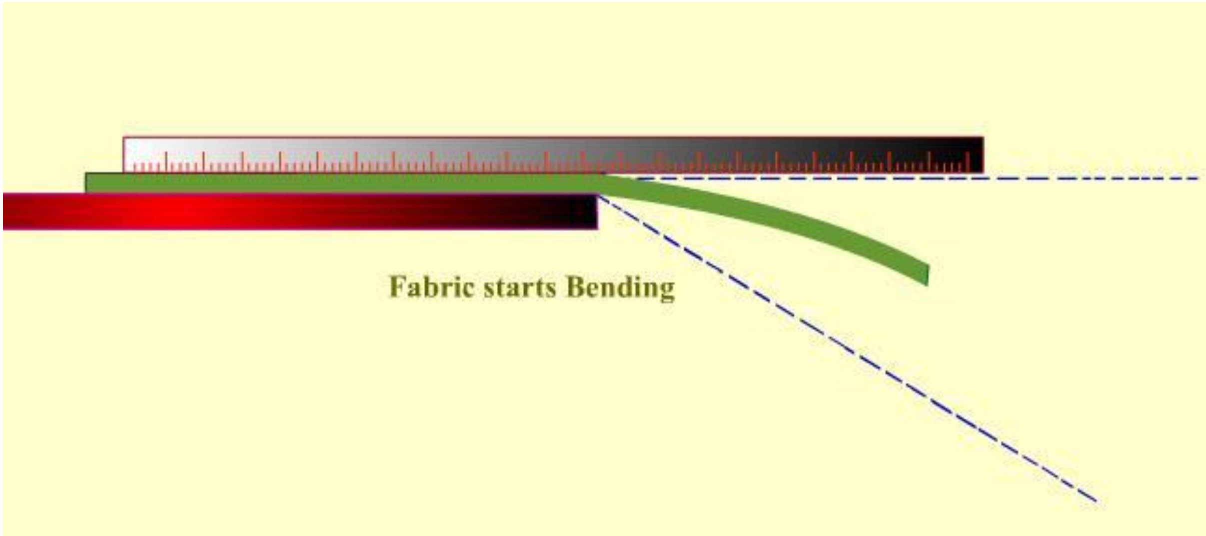
Bending:

For industrial fabrics performance characteristics are important like, smooth, rough, stiff or limp, draping, etc.

(1) Principle of measurement of bending characteristics:

Cantilever principle: (Shirley Stiffness Tester)

The horizontal strip of fabric is allowed to bend like cantilever, index its own weight.



Pierce empirical equation,

$$G = M\,L^3\left[\frac{\cos\theta/2}{8\tan\theta}\right]$$

$$C = L\left(\frac{\cos\theta/2}{8\tan\theta}\right)^{1/3}$$

Where,

M = Mass per unit area (g/m²)

G = Flexural rigidity.

C = Bending length (mm)

θ = Angle fabric bends

at θ = 7.1º, X = 1

Higher the bending length, stiffer is the fabric.

θ = 7.1º, C = L (mm)

So, pierce definition of bending length is "the length of rectangular strip of material which will bend under its own mass to an angle of 7.1º.

Shirley Stiffness factor:

- 200mm x 25mm specimen.
- Allowing this strip to bend to a fixed (41.5º) under its own weight.
- The over changing length is twice the bending length (C = L/2) at θ = 41.5º, X = 0.5.

(2) Hanging Loop Method:

- Fabrics that are too limp to give a satisfactory result by the cantilever method may have their stiffness measured by forming them into a loop and allowing it to hang under its own weight.
- L - strip length, lo = undistorted length of loop, i.e. the distance between grip to the farthest point.

- After hanging, due to their own weight the distance becomes "l"
- Stiffness is calculated from the difference 'd' = l – l_0

Ring loop: lo = 0.3183 L

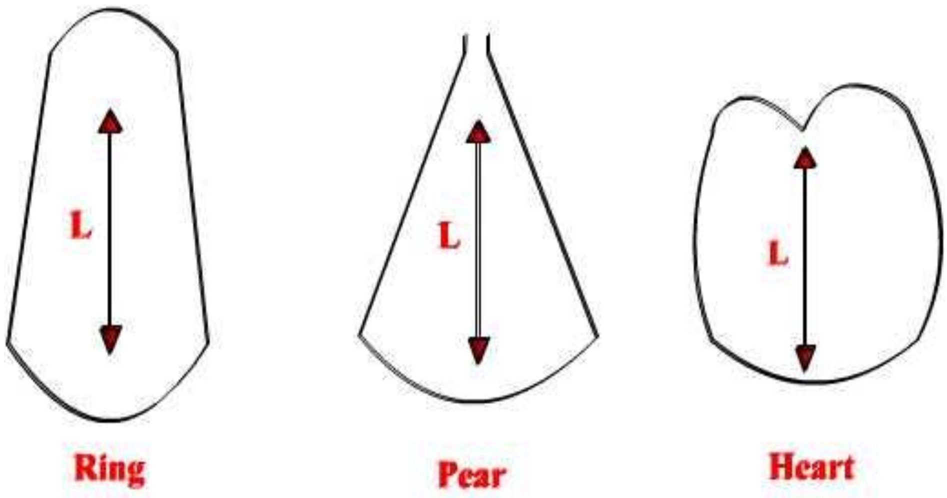
Bending length (C) = L × 0.133 × f(θ),

θ = 157º × d/lo,

Heart Loop: lo = 0.1337L, C = L x 0.1337 x f(θ)

θ = 32.85º x d/lo

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



Flexural Rigidity:

It is the ratio of the small change in bending moment per unit width of the material to the corresponding small change in curvature . Flexural Rigidity,

G = M x C^3 x 9.807 x 10^3 Micro N.m, where C = bending length in mm.

Bending Modulus:

The stiffness of a fabric in bending is very dependent on its thickness, the thicker the fabric, the stiffer if all other factors remain the same. The bending modulus is independent of the dimensions of the strip tested so that by analogy with solid materials it is a measure of 'intrinsic stiffness'.

Bending Modulus $= \frac{12 \times G \times 10^3}{T^3} N/m^2$ Where T = fabric thickness (mm)

FABRIC HANDLE

Drape:

The term used to describe the way a fabric hangs under its own weight determines how good a garment looks in use.

- It differs from fabric to fabric and depends on end use.
- A particular value cannot be classified as either good or bad.

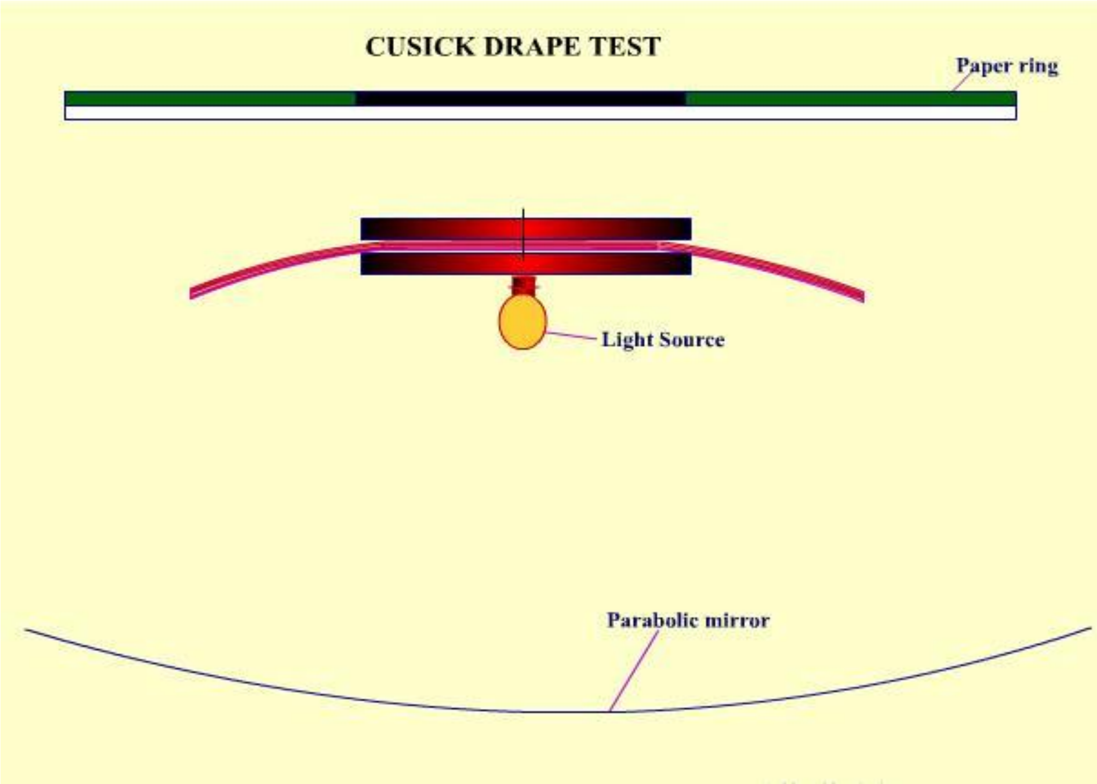
The multidirection curvature formed is dependent on shear property and bending stiffness.

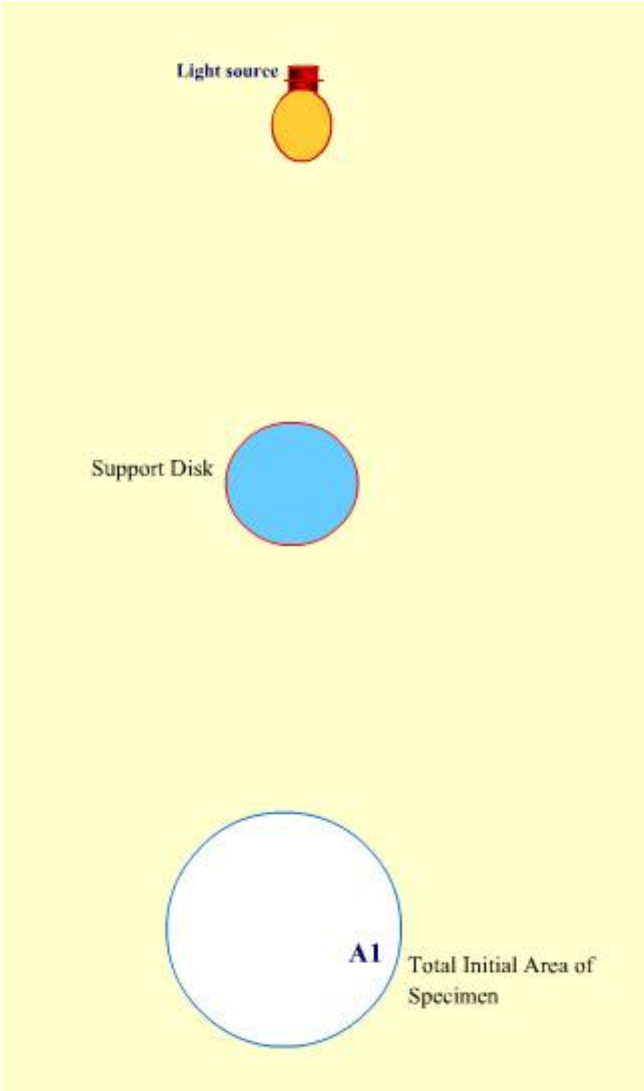
$$D = \frac{A_3 - A_2}{A_1 - A_2} \leq 1$$

Cusick Drape Test:

The shadow that the fabric casts, is traced onto an annular piece of paper. Paper mass per unit area is constant.

Click on Image to run the animation





Drape Co-efficient (D)= (Mass of shaded area / Total mass of paper ring) x 100

Mass of whole paper ring is taken and thin shadow part is cut and weighed

- Three different specimen diameter is recommended.

- 24 cm for very limpy fabric, D < 30%
- 30 cm is medium fabric
- 36 cm for stiff fabric, D > 85%.

- Drape coefficient has direct correlation with bending length and shear stiffness.
- For bending length (C) between 2 cm and 4 cm an almost linear relationship is predicted.
- D(%) = 30 C – 30
- 13-2

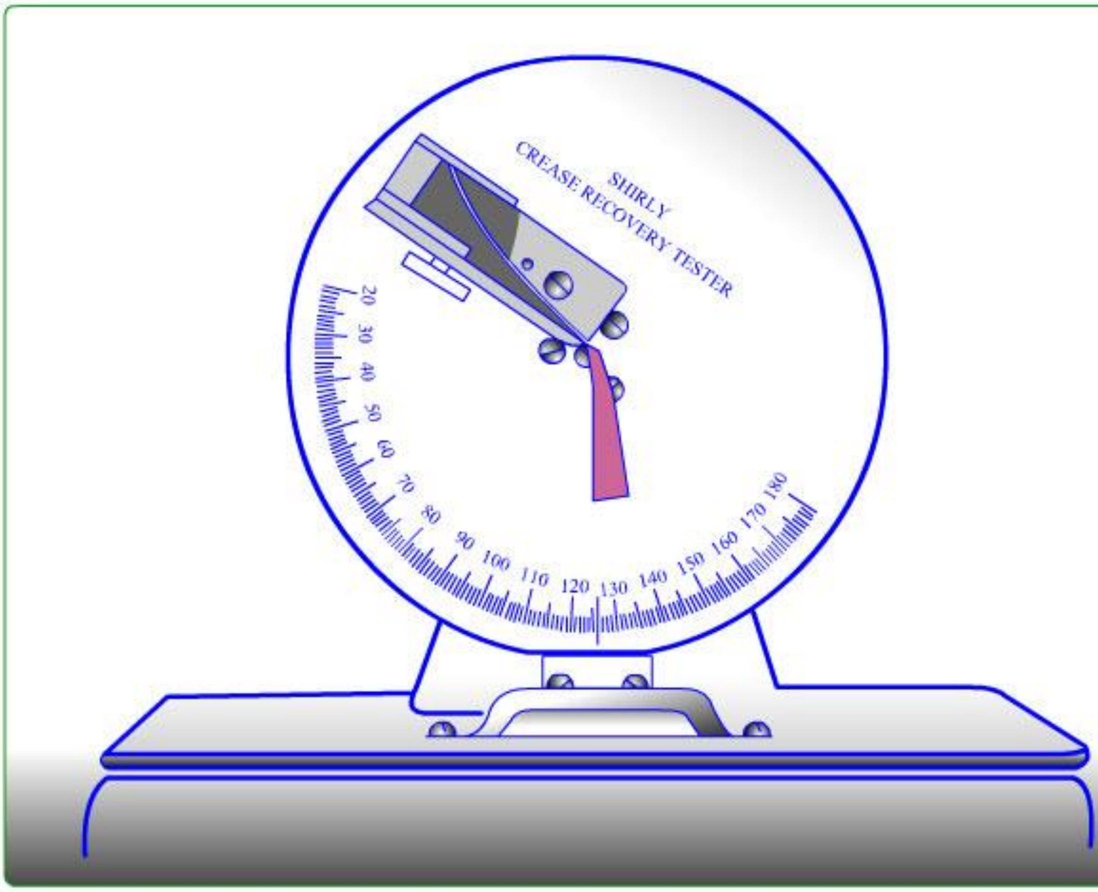
rease Recovery:

- Creasing of a fabric during wear is not change in appearance that is generally desired. The ability of a fabric to instance dependent on the type of fiber used in its construction.

- Wool and silk have a good resistance to creasing whereas cellulosic materials such as cotton, viscose, and linen creasing.

Shirley Crease Recovery test:

- The instrument consists of a circular dial which carries the clamp for holding specimen (see figure).



- Directly under the centre of the dial are a knife edge and an index line for measuring the recovery angle.
- The scale of the instrument is engraved on the dial.
- A specimen is cut from the fabric with a template, 2 inch long by 1 inch wide. It is carefully creased by folding i glass plates, and adding 2 kg weight.
- After one minute the weight is removed and the specimen is transferred to the fabric clamp on the instrument a the crease.
- As it recovers, the dial of the instrument is rotated to keep the free edge of the specimen in line with the knife
- At the end of the time period allowed for recovery, usually one minute, the recovery angle in degrees is read or
- Warp and weft way recovery are reported separately to the nearest degree from the mean values of ten tests i
- The load, time of creasing, and recovery time may be altered to suit particular cases.
- As for most cases, the specimens should be conditioned and tested in a standard testing atmosphere.
- A random sample should be taken but the selvedges, piece ends, and creased or folded regions should be avoid
- Higher recovery angle indicates fabric having good resistance against creasing.

- When fabric is creased the resulting deformation has two components

  One is the displacement of fibres and yarns relative to one another and

  Second is the stretching of the fibres on the outside of the curve.

- The relative importance of these two mechansims depends on the radius of the curve that the fabric is bent int
curvature, the more likely it is accomodated by fibre displacement.

- The unaided recovery of the fabric from creasing depends on the elastic recovery of the fibres, in particular whe
energy is sufficient to overcome the friction that resists the movement of the yarns and fibres.

Tensile Strength

To know the level of strength provided by fibers, yarns or fabric :

a) For Industrial and Technical products - It is very important to know the strength in products likes, industrial rope,conveyor belt, etc.

b) For household or apparel use - Merely need an adequate strength in order to withstand handling during production and use.

Fibre Strength:

- Fibre strength is generally considered to be next to fibre length and fineness in the order of importance amongst fibre properties.
- Fibre strength denotes the maximum tension the fibre is able to sustain before breaking.
- It can be expressed as breaking strength or load, tenacity etc.
- Elongation denotes elongation percentage of fibre at break.

Factors affecting the strength of fibres:

- Molecular structure
- No. and intensity of weak places
- Coarseness or fineness of fibre
- Relative humidity
- Elasticity

Fibre strength is determined by either testing individual fibres or group of fibres.

Manmade fibres are usually tested for their individual strength as there is very less variation in length and fineness the fibres. Natural fibres are tested for their bundle strength due to high variation in terms of length and fineness.

Bundle fibre strength testing:

A bunch of fibres are put in to two jaws. The jaws are moved until the fibres break. The breaking load and elongation at break are noted

$$\text{Tensile strength / Tenacity of the fibre in g/tex} = \frac{\text{Breaking load in kg} \times \text{Length of sample in mm}}{\text{mass of the fibres in mg}}$$

Bundle strength of cotton:

- The "Stelo"meter – the name coined from strength and elongation which functions on pendulum lever principle.
- Pressley fibre strength tester - functions on pivoted beam balance principle.
- Uster spin lab High Volume Instrument

TERMINOLOGY AND DEFINITIONS:

1) Load:

- The application of a load to a specimen in its axial direction causes a tension to be developed in the specimen.
- The load is usually expressed in *grams* or *pounds*.

2) Breaking Load/Breaking Strength:

- This is the load at which the specimen breaks.
- It is usually expressed in *grams* or *pounds*.

3) Stress: It is the ratio between the force and the area of cross-sectional of the specimen.

i.e., Stress = Force applied / Area of cross section

- But in case of textile material, only for circular materials, it can be measured.
- Cross section of yarns and fabrics, due to unknown packing characteristics the exact cross-sectional area is very difficult to measure.
- Also the cross-section of yarns, fibers or fabrics are irregular.

4) Specific/Mass Stress:

- In case of textile material the linear density is used instead of the cross sectional area.
- It also allows the strength of yarns of different linear densities to be compared.

Specific stress = Force/Linear density (initial)

The preferred units are *N/tex* or *mN/tex*, other units which are found in the industry are *gf/denier* and *cN/dtex.*

5) Tenacity or Specific Strength:

- The tenacity of material is the mass stress at break.
- It is defined as the specific stress corresponding with the maximum force on a force/extension curve.
- The nominal denier or tex of the yarn or fibre is the figure used in the calculation; no allowance is made for any thinning of the specimen as it elongates.
- Units are grams/denier or grams/tex.

6) Breaking Length:

- Breaking length is an older measure of tenacity.
- It is the theoretical length (in Km) of a specimen of yarn whose weight would exert a force sufficient to break the specimen.
- It is usually measured in kilometres.

e.g. 10 tex yarn breaks at a load of 150grams

∴ Breaking length would be = 15km (RKm)

The numerical value is equal to tenacity in **g/tex (150/10)**

7) Strain:

- When a load is applied to a specimen, a certain amount of stretching takes place.
- The elongation that a specimen undergoes is proportional to its initial length.
- Strain expresses the elongation as a fraction of the original length.

i.e., Strain = Elongation / Initial length

8) Extension percentage:

- This measure is the strain expressed as a percentage rather than a fraction.

i.e., Extension % = Elongation / Initial length

9) Breaking extension:

- Breaking extension is the extension percentage at the breaking point.

10) Gauge length:

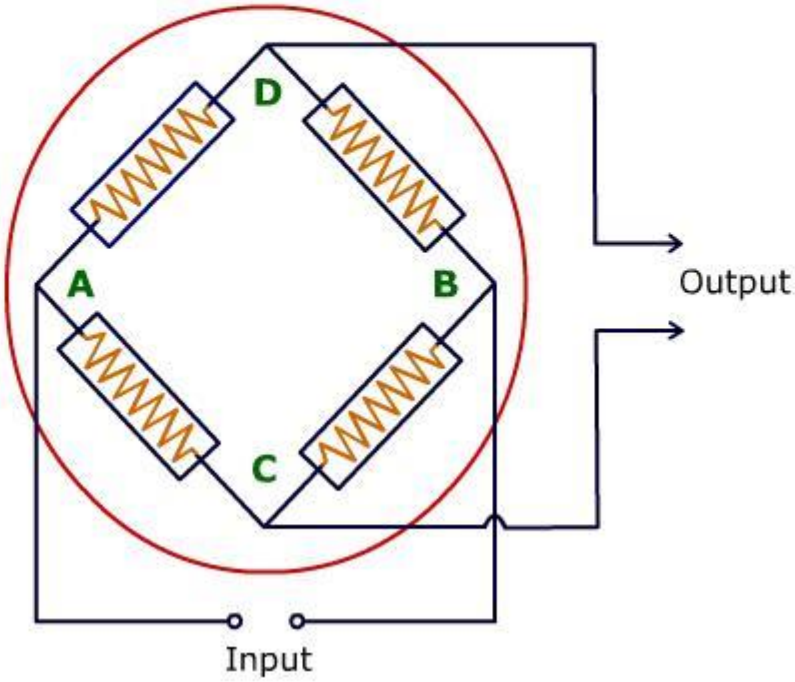
- The gauge length is the original length of that portion of the specimen over which the strain or change of length is determined.

When an external force is applied to any material it is balanced by the internal force developed in the molecular structure of the material.

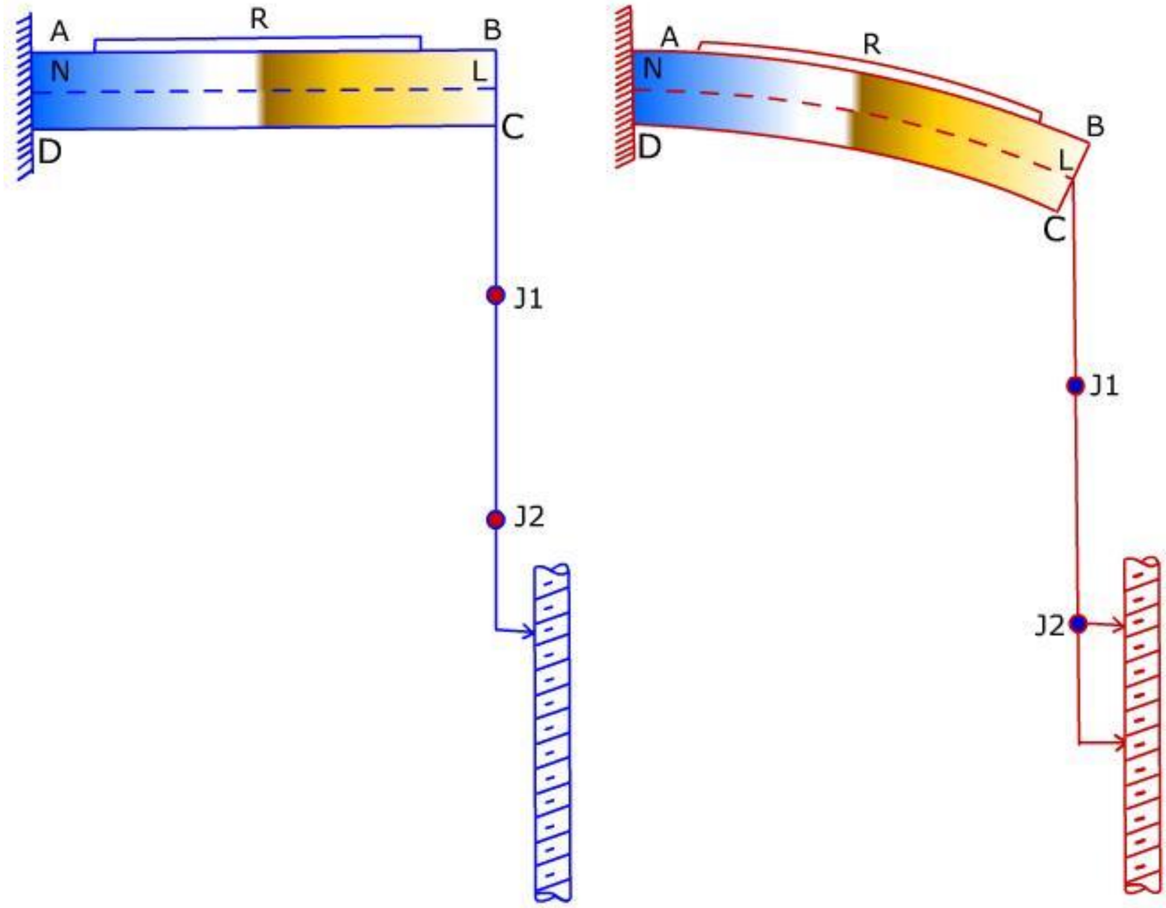
Strain gauge principle (Load Transducer):

Most of the modern tensile testers work on this principle.

- When the beam bends the length of upper face (AB) increases and lower face (CD) decreases and (NL) rema unchanged.
- Resistance wire (R) cemented on AB also expand and thus the value of resistance changes.
- ***Convert this value of change in resistance to load value (applied on specimen)***
- Two resistance wires are placed on upper and other two are on lower surface. (To form a *Wheatstone Bridge*



Four resistance in the load cell connected in the form of a wheatstone bridge



THE STRAIN GUAGE PRINCIPLE

- With the beam un-deflected, no voltage across CD, when a voltage is applied across AB. The bridge is ‘balan
- When load is applied, the deflection occurs and the values of the resistances change and a voltage is produc i.e., which is proportional to the load.

Advantages:

- Free from inertia errors and friction.
- The deflection of the end of the beam is very small, and thus it is tests under 'CRE' condition.
- Versatility in the type of instrument (yarn, fibre, fabrics, wide speed and load range, etc.)

Disadvantages:

- Expert technician is required for maintenance and repair.
- Chances of 'drift' in electronic circuits.
- High initial cost.

Instron tensile tester, UTM, Tensorapid, Zwick, Statimat and various other modern tensile testing instruments work in this principle.

h. Constant tension winding tests:

- It provides conditions somewhat similar to actual processing of yarn during winding, warping, sizing etc.
- The test is closer to actual running condition.
- A, B fixed pulleys and P movable pulley
- Under static conditions the tension of the loop will be 0.5L (uniform throughout the loop)
- The tension imposed on the yarn will cause it to stretch. "e" be the extension per unit length, v = u (1 + e)
- Necessary means are required to adjust the input and output velocity.
- The tension required to get the std. breakage rate

- Breakage rate and applied tension.

- Experimental data shows that

n_1 = Breaks/1000 yard

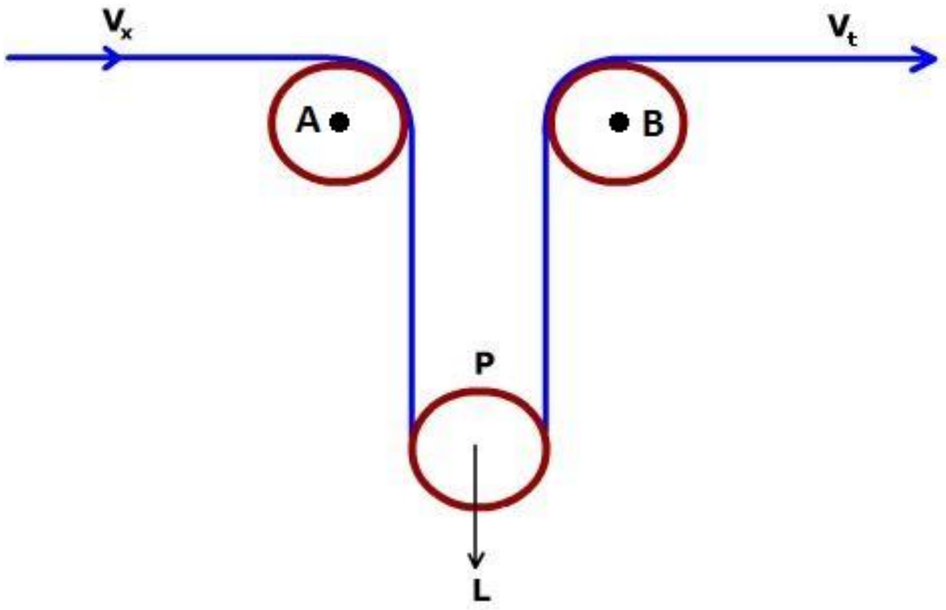
At t_1 tension imposed on the yarn will cause it to stretch "e" be the extension per unit length,

v = u (1 + e)

Necessary means are required to adjust the input and output velocity.

Standard breakage rate is "8 breaks per 1000yard of yarn".

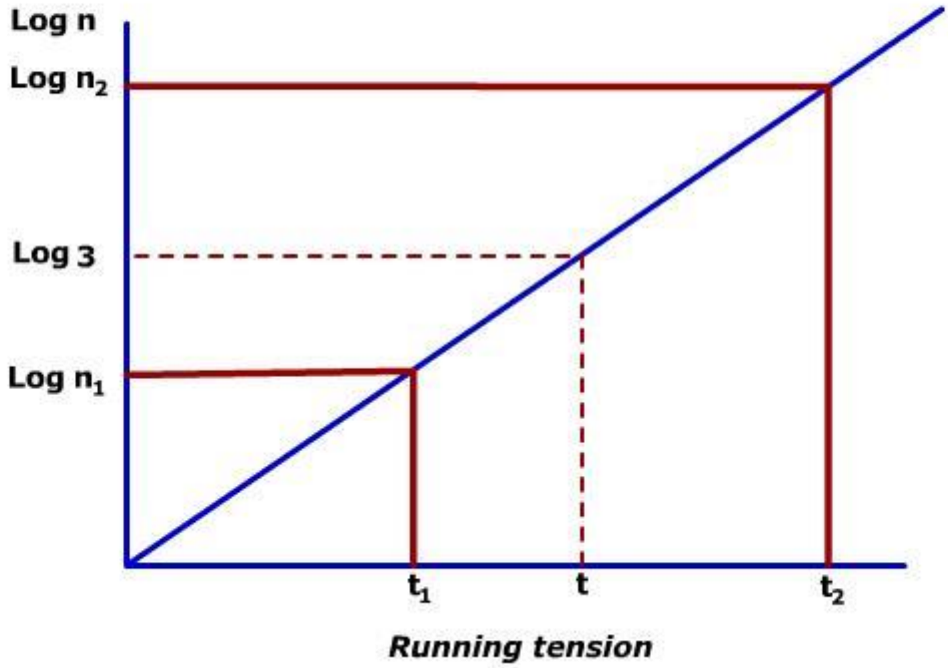
The tension required to get the standard break rate.



The constant-tension winding test principle

Breakage rate, applied tension and single thread strength:

Experimental data shows that



n_1= Bks/1000 yard at tension t_1, and

n_2= Bks/1000 yard at tension t_2.

Slope of the graph therefore, $\dfrac{\log n_2 - \log n_1}{t_2 - t_1}$ = constant (c)

If 't' tension required to produce 'x' Bks/1000 yds, then

Or, $t = t_1 + (t_2 - t_1)\left(\dfrac{\log x - \log n_1}{\log n_2 - \log n_1}\right)$

So, we can calculate the tension required (t) to have certain breakage rate and vice versa, if we know these values at certain level.

Breakage rate, applied tension and single thread strength:

Single thread strength:

Empirical equation

$$T = \bar{x} - K\sigma$$

Dynamic mode T = Tension required to produce “n” breaks/1000yard

Static mode = Mean single yearn strength

σ = S. D. of single yarn strength.

Factor ‘K’ depends on “n” and also change with test length of single thread tensile test.

In B.S. Handbook, the 1st estimate of tension required to produce 8 breaks/1000 yard is,

$$T = \text{Avg. Single yarn strength} \times \left(1 - \frac{CV\,\%\,of\,\sin gle\,yarn\,strength}{30}\right)$$

$$= \bar{X}\left(1 - \frac{6}{x} \times \frac{100}{30}\right) = \bar{X} - 3.30$$

K = 3.3., with 20” test length and 8 breaks/1000 yard.

Application of constant – tension winding test:

Results obtained may serve as a guide to the behaviour of yarn in subsequent processing i.e. forecast of probable end-breakage rates.

- Comparison of yarn quality

	Yarn A	Yarn B	Yarn C
Count	60.2	61.0	60.8
CSP	2255	2170	2216
Single Yarn Strength	150.5	147.3	148.5
Breaks/1000 yard	18.6	6.8	21.5

YARN STRENGTH:

(i) Single yarn strength:

Instron, Uster etc. 500mm gauge length and speed adjusted so that the time to break is 20 ± 3sec.

(ii) Skein Method (Lea Strength):

Advantages:

- It tests a long length of yarn in one test.
- Yarn is expected to break at its weak spots, so give more realistic strength values.
- Same hank can be used to measure yarn count.

Disadvantages:

- Result depends on friction between yarn and also between yarn and hook.
- No measure of strength variability.

FABRIC TENSILE STRENGTH

Fabric tensile strength depends upon

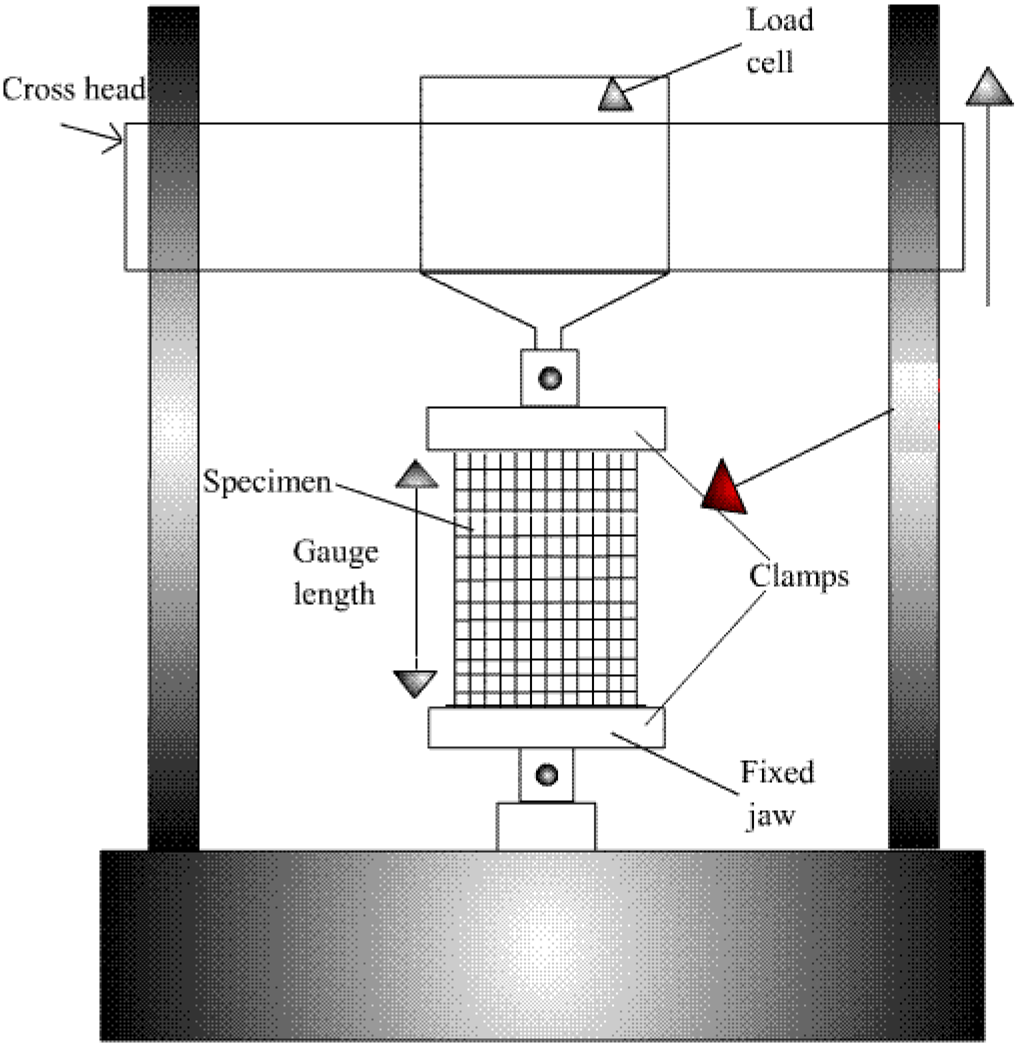
- Raw material.
- Yarn strength (twist: more twist for more strength)
- Fabric construction (*weave*: plane weave is stronger than floats-satin, sateen which are weaker, *Density:* low density cause weave slippage which result in seam slippage).
- Finish applied (resin finish improves weave slippage).
- Adverse of "finishing" process.

Measurement of fabric tensile strength

1. 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 samples both in warp and weft direction are prepared with each not containing the same longitudinal threads.
- Samples are prepared 60mm x 300mm and then frayed to get 50mm wide specimen.
- The rate of extension is set to 50mm/min and gauge length is 200mm. pretension is 1% of the probable breaking load.

Click on Image to run the animation-1

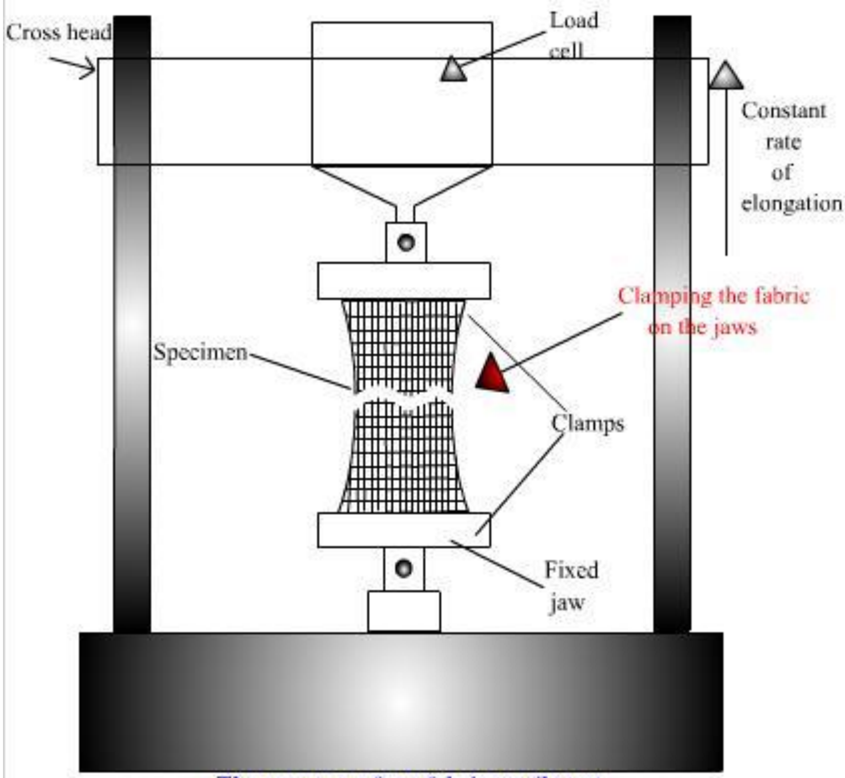


The apparatus for a fabric tensile test

- 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 x 300mm) parallel to warp/weft.
- Frayed the threads from both sides of the width to bring down to 50mm wide.
- For heavily milled fabrics, no fraying is done (50mm x 300mm).

2. Grab Test: (U.S) ASTM D1682:

- The grab test uses jaw faces which are considerably narrower than the fabric, so avoiding the need to fray the fabric to width and hence making it a simpler and quicker test to carry out.
- The sample used is 100mm x 150mm jaws are 25mm square which stress only the central 25mm of the fabric.
- A line is drawn 37.5mm from the edge of fabric to assist it in clamping so the same set of threads are clamped in both jaws.
- The gauge length is 75mm and speed is adjusted so that the sample is broken in 20±3s.



The apparatus for a fabric tensile test

- In this test, there is a certain amount of assistance from yarns adjacent to the central stressed area so that the strength measured is higher than for a 25mm frayed strip test.
- Fundamentally different from strip test.
- Jaw faces are considerably narrower than fabric. No need to fray the fabric.
- Simpler and quicker method.

3. USTER TENSORAPID (CRE Principle):

- For tensile testing of single and ply yarn.
- Testing of slivers, leas and fabrics is also possible.
- Force measurements up to 1000N without exchanging the force transducer.
- The *clamping force*, the yarn tensioners and the suction-off of the yarn can be programmed.
- All numerical and graphical results are displayed on a video screen. (Histogram, L-E curve, tables, etc.)

- Package creel for the automatic measurement up to 20 packages.
- Calling-up of test parameters of frequently tested yarn types from the memory (up to 40).
- *Pneumatically-actuated yarn clamps* ; the clamp pressure is programmable.
- Electronic elongation measurement.
- Test speed – Continuously adjustable between 50 and 5000mm/min.
- Test length.

  ----> With horizontal position of clamps, continuously adjustable between 200 and 1000mm.

  ----> With vertical position of clamps, continuously adjustable between 100 and 1000mm.
- Self test - Automatic calibration check for accuracy through inspection.