A review on Classification and Structure of Fabrics

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1. Introduction:

The textile industry has spread all over the world of which fabric manufacture is the most important segment both in spread and variety. Efforts have been made to classify fabrics from different viewpoints, viz. consumer, Trader, Manufacturer, Technologist, Engineers and Standard.

From **consumer's viewpoint** fabrics were classified earlier as-

i. **Apparel**
ii. **Household**
iii. **Industrial**

This classification was subsequently modified as-

i. **Apparel**
ii. **Household – a)Bedding b) Home Textiles**
iii. **Technical Textiles, which include:**
   a) **Mobile Textiles**
   b) **Geo Textiles**
   c) **Construction Textiles**
   d) **Industrial Textiles**
   e) **Medical Textiles**
   f) **Safety Textiles**
   g) **Smart or Intelligent Textiles**

From trader's viewpoint, fabrics are classified according to specific Trade/Brand name.

From the **manufacturer's viewpoint**, fabrics are classified according to the method of manufacture as:

i. **Woven- a) Handloom b) Power loom c) Khadi**
ii. **Knitted- a) Warp knit b) Weft knit**
iii. **Embroidery**
iv. **Lace**
v. **Crochet etc.**

From the **technologist viewpoint**, fabrics are classified as –i) **Structure ii) Texture**

From the **engineer's viewpoint** classification is according to-

i. **Width/ Breadth**
ii. **Length**
iii. **Yarn Size**
iv. **Weight**
v. **Thickness**
vi. **Setting**
vii. **Face**

From **standard's viewpoint**-

i. **Set**
ii. **Weight**
iii. **Strength**
iv. **Condition**
v. **Application or end use**

Based on the above characteristics, it is possible to set up norms for the different characteristics under different groups.

2. Selection and Construction of Fabric for a Particular Application:

The production of textile fabrics to meet the requirements of industrial, household, and apparel uses is a threefold problem involving:

i. Selection and cultivation or manufacture of a base fibre possessing the properties desired in the end product.
ii. Construction of materials which enhance the characteristics of the fibres used through the medium of the form, or geometry of the yarn and fabric.
iii. Modification of the intrinsic fibre properties or the structural geometry of the textile by chemical treatments.

The second phase, which embodies the building of fabric structure to enhance available fibre characteristics or to create entirely new properties in the finished item, has been the subject of practical mill experimentation since the days of the hand weavers.

The geometry of a textile fabric is determined by the mechanical processing to which the material is subjected from fibre state to finished cloth.

The practical geometry of the cloth is described by form factors which are in common use throughout the textile industry. These include:

- Yarn count
- Yarn Twist
- Threads per inch
- Weave
- Crimp

Since each of the factors listed, with the exception of weave, may be varied in warp or filling directions, the problem of predicting the mechanical behavior of fabric structures becomes one involving up to nine variables, some of which are independent, while others are related either throughout their ranges or merely at their limits.

Many of the properties of textiles which govern their conformance to technical specifications are dependent for the most part on the yarn network; these include breaking strength, thickness and weight.

Large group of fabric qualities are more dependent upon the pore structure than upon the yarn network; these include resistance to flow of liquid, gases, and light.

A third set of attributes relies to a considerable degree upon an interchange in yarn and interstice geometry, and it is here that the textile differs from most other fabricated items; these include tear-resistance, fabric drape and sewability.

3. Important Fabric Properties: Factors affecting and selection Criteria for end use application-

Breaking Strength and Elongation:

The breaking strength of a fabric is enhanced by increase in the strength of its component yarns and in the number of such yarns gripped between the jaws of the testing machine.

Weave structure is a controlling factor in the determination of crimp, which in turn influences the extensibility of the fabric in a given direction. The degree of yarn twist affects the fabric elongation, for when tightly twisted yarns are woven in a close texture there is an apparent loss of extensibility.

There is no consistent difference in fabric properties as a result of change in yarn twist direction; however, as yarn twist is increased the corresponding directional breaking strength of the fabrics increase to a maximum point, then decrease with very high twist in manner similar to the behaviour of single yarns.

The investigators define fabric assistance as the difference between the strengths of skein yarns and the same yarns woven into a cloth structure, expressed as a percentage of skein

yarn strength. It is shown that the fabric assistance decreases in general with an increase in twist multiplier until a minimum is reached, whereupon further increase in twist is accompanied by greater fabric assistance.

Morton& Williams examined the influence of varying warp tensions on the mechanical properties of plain weaves. An increased weaving tension, warpwise fabric elongation is considerably reduced. It is pointed out that breaking extension depends primarily on crimp in the longitudinal threads and on their extension properties. Cloth strength is affected by the degree of binding of the cross threads, which aids inter fibre frictional forces and contributes to the restriction of the region of breakdown. The degree of binding is dependent on the density of the weave.

Peirce comments on crimp distribution as a factor of prime importance in determining fabric strength and elongation. The straightening of longitudinal threads during the test applies compressive forces at the points of contact with the cross yarns. If the cross yarns jam before crimp exchange is complete reduction in fabric strength and extensibility will result.

Fabric Assistance:

Fabric assistance is defined as the percentage rise in the strength of a set of yarns when another set of yarns is inserted to form the fabric.

$$Fabric\ Assistakce = \frac{Fabric\ Strip\ Strength\ per\ yarn}{Corresponding\ Single\ Yarn\ Strength}$$

The difference between yarn strength ratios and fabric strength ratios is due to fabric assistance i.e. the effect of friction at cross-over points in fabrics.

It is influenced by yarn strength, count, yarn irregularity, fabric structure, crimp, weave, fabric finish and yarn structure.

The frictional forces between warp and weft, which are mainly dependent on the surface structure of yarns, influence the fabric strength to a greater extent.

A yarn with rough surface experiences more friction under sliding at low speeds. In this aspect, the presence of wrapper fibres on yarns surface assumes a significant role.

Fabric Made From	Warp Direction	Weft Direction
Ring Yarns	1.08	1.15
Rotor Yarns	1.29	1.41
Air Jet Yarns	1.43	1.57

Ring Warp/Rotor Weft	1.22	1.48

Table No.1. Ratio of Fabric Strip Strength per Yarn and S.Y.S.

Observations:

i. Ratios are significantly higher in weft direction compared to that in warp direction. This is due to more end density (Cross Yarns) than pick density in the fabric, providing more number of gripping points for weft yarns.

ii. Fabric made from Air Jet yarns has higher ratio followed by rotor and ring yarns, though the constructional parameters of these fabrics are identical. A higher ratio indicates that yarn strengths are exploited to a greater extent in fabrics.

iii. For a given yarn strength, the fabrics made from air jet and rotor yarns would be stronger by 35% and 21% respectively compared to ring yarn fabrics. This indicates that the yarn structure also plays a vital role in influencing the fabric strength.

iv. The strength utilization of open end and ring yarn combination is higher than that for ring & rotor yarn combination.

Tear Resistance: Fabric which is closely woven, firm, and has a large number of thread interlacings per unit area and short floats has lower tear –resistance than a cloth of the same weight which is loosely woven, sleazy, and has a small number of thread interlacings per unit area and long floats.

Increased tear resistance of the basket weave over the plain weave, attributed to the greater freedom of movement of yarns in the former pattern.

Increase in filling twist multiple is accompanied by higher tear values across the filling as a result of greater yarn elongation and more freedom of yarn movement due to the reduced yarn diameter.

The reduction in tear strength which follows is attributed to the facts –

i. The yarns in the pseudo jaws rupture progressively in the groups.

ii. The area of contacts, and therefore, the friction effect, decreases with higher textures.

iii. A number of the contact points do not contribute to the effective portion of the pseudo jaws.

Thermal Resistance:

So long as temperature differential exist between the skin and the surrounding air, transfer of body heat will take place, resulting in discomfort which is related to the rate of heat loss.

Low density materials, such as textiles, contain a large proportion of air within their total structures. Heat transmission through media of this type is, therefore, primarily dependent upon the resistivity of the air layer. The lower the proportion of fibre to air the higher will be the resistance to heat flow of the cloth.

The chief function of the cloth is to trap an air layer (with high resistance), thus preventing circulation of air currents around the subject.

Conclusion:

Fabric classification is crucial for selecting the right material for specific purposes, ensuring quality control, optimizing manufacturing processes, and managing costs. It also aids in proper care and maintenance, supports sustainable practices, enhances marketing strategies, and ensures compliance with regulations. Many of the fabric properties of fabric are governed by the structural properties of fabric and hence it is very much essential to understand the structural properties of fabric while selecting any fabric for particular end use application.

Ref:

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