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A case study on fabric geometry and its applications

K Nirmaladevi [1], B Pooja[2], A Harini[3], M Naveenapriya[4]
[1] Assistant Professor, Department of Mathematics, Sri Krishna Arts and Science College, Coimbatore, Tamil Nadu, India
[2-4] UG Scholars, Department of Mathematics, Sri Krishna Arts and Science College, Coimbatore, Tamil Nadu, India

Abstract
The Main aim of the paper is to use fabric geometry to solve the problems related to evaluating the quality of fabrics. Geometry refers to the study of shapes, patterns, and sizes and their relations. Many textile designs use line organization in regular patterns which are defined by geometry. Fabric geometry influences the quality of fabrics. This paper deals how to relate fabric geometry and its quality evaluation problems.

Keywords: warp, weft, thickness, volum

Introduction

Woven fabric technology is deeply rooted in geometry. A fabric consists of immeasurable fibers assembled along in a very specific geometry. Mutual interlocking of sets of threads creates plain-woven material. The manner of the mutual interlocking of threads defines the ultimate fabric structure. The property of a cloth greatly plagued by its geometry.

Fabric construction refers to the fabric specification. The general format of fabric construction is given below: Warp count × Weft count / Ends per inch × Picks per inch Example: 20 × 16 / 128 × 60

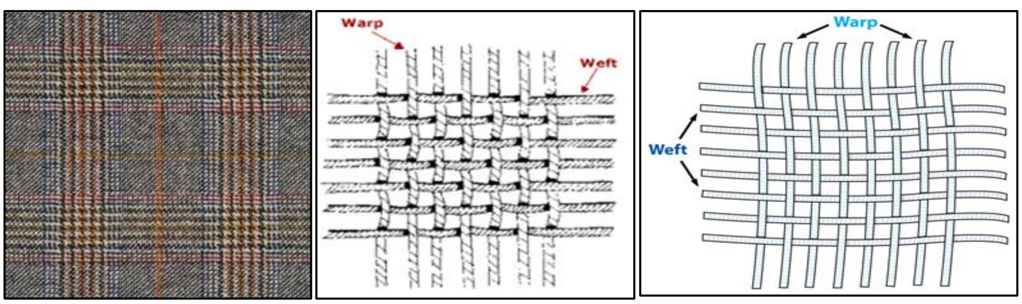

Fig 1: Fabric construction

Warp: Threads length wise in a fabric as woven.
Weft: Threads width wise in a fabric as woven.

2. Review of Literature

Geometry (geo- means earth and -metron means measurement) arose as the field of knowledge dealing with spatial relationships. Geometry was one in all the of the two fields of pre-modern arithmetic, the other being the study of numbers (arithmetic).
Classic pure mathematics was targeted in compass and hand tool constructions. Euclid, who presented mathematical rigor and the axiomatic method still being used today revolutionized Geometry.
In present day world, geometric ideas have been generalized to a high level of abstraction and complexity, and have been exposed to the techniques of calculus and abstract algebra, so that many fashionable branches of the sphere area unit barely recognizable because the descendants of early geometry.

3. Problems

Problem 1

A cotton fabric of plain weave has the following attributes:
Warp 26 tex, 29 ends/ cm; weft 16 tex, 30 picks/cm; density of yarn is 0.9 g/cm^3
Calculate the warp and weft fractional covers, fabric cover and effective weave density

Solution

Warp cover: $e_0 = \frac{P_0\sqrt{T_0}}{266}$

Where, P_0 = ends per cm, T_0 = warp count in tex

$$e_0 = \frac{29\sqrt{26}}{266} = 0.555$$

Weft cover: $e_y = \frac{P_y \sqrt{T_y}}{266}$

Where, P_y = picks per cm, T_y = weft count in Tex

Fig 2. Warp and weft

$e_y = \frac{30\sqrt{16}}{266} = 0.451$

Fabric cover: $e_f = e_0 + e_y - e_0 e_y$

= 0.555 + 0.451 - 0.555 (0.451) = 0.755

Warp density = $P_0 \times \sqrt{T_0 \times K}$

Where K = 1.00 for cotton fabric

$= 29 \times \sqrt{26 \times 1.00} = 147$

Filing density = $P_y \times \sqrt{T_0 \times K}$

$= 30 \times \sqrt{16 \times 1.00} = 120$

Weave density = $50 + \frac{(warp\ density - 100) \times FD - 100}{(weft\ density - 100) \times FD - 100}$

$= 50 + \frac{(147-100) \times 120 - 100}{(120-100) \times 120 - 100}$

= 52.35

Effective weave density = WD × K of loom width × K of design

= 52.35 × 0.99 × 1.00

= 51.82 %

Result

1. Warp fractional cover = 0.555
2. Weft fractional cover = 0.451
3. Fabric cover = 0.755 (i.e 75%)
4. Effective weave density= 51.82 %

Therefore, 75% of the total area of this cotton fabric is covered by yarn and effective weave density is 51.82 %

***Scope*:** To determine thickness of fabric.

Fig 3: AbraSmart

Problem 2

Scope: To determine the abrasion as well as pilling resistance of all kind of fabrics.

Table 1: Data of Abrasion Experiment

S.No	Sample wt before Abrasion (mg)	No. of Abrasion Cycle	Sample wt after Abrasion (mg)	Weight loss (mg)	Wear Index
1	5670	300	5630	40	12
2	5780	400	5720	60	24
3	5860	500	5780	80	40
4	5970	600	5840	130	78
5	6000	700	5390	170	119

Solution

Formula

Wear Index = $\frac{\boldsymbol{NO\ OF\ CYCLE \times WEIGHT\ LOSS}}{\mathbf{1000}}$

1. Wear Index for 300 cycle = $\frac{300 \times 40}{1000} = 12$
2. Wear Index for 400 cycle = $\frac{400 \times 60}{1000} = 24$
3. Wear Index for 500 cycle = $\frac{500 \times 80}{1000} = 40$
4. Wear Index for 600 cycle = $\frac{600 \times 130}{1000} = 78$
5. Wear Index for 700 cycle = $\frac{700 \times 170}{1000} = 119$

Result

It is observed that when there more no. of abrasion cycle then the weight loss of fabric is more. Based upon the end use, fabrics will loss its weight and servicibiliy. Hence we can say that the when wear index value is more the durability of the fabric is less.

Problem 3

***Scope*:** To determine GSM of fabric.

Fig 4: AnaThick

Determine fabric mass, thickness and specific volume of a circular yarn cross-section whose weight is 9.5 kgs length is 35m, breadth is 2m and radius is 8 cm.

Solution

Given data

Weight = 9.5 kgs = 95000 g
Length = 35m, Breadth = 2 m, Area = 70 m^2
Radius = 8 cm, diameter = 4 cm = 0.04 m

Calculation

1. Fabric thickness =$\frac{\pi d^2}{4}$ = $\frac{3.14 \times 0.04 \times 0.04}{4}$
 = 0.001256 m
2. Fabric mass = gsm = Grams / square meter
 = 95000 / 70 = 1357.1428 grams per sq.m
3. Fabric specific volume = $\frac{\text{fabric thickness}}{\text{fabric mass}}$ = $\frac{12.56\ cm}{13.57\ g/cm^2}$ = 0.925 cm^3

Result

1. Fabric thickness = 0.001256 m
2. Fabric mass i.e GSM = 1357.1428 grams per sq.m
3. Fabric specific volume = 0.925 cm^3

4. Conclusion

The benefits of proper application of test results include minimisation of the product cost. Knowing fabric geometry, with proper selection of fibres the yarn properties can be engineered, consistent yarn and fabric quality can be maintained. Textile testing is very important as it allows to make sure textiles are safe, of good quality. Textile testing involves mathematical calculations to predict the test results. They also help in choosing the best possible route to achieve the end product.

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