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Testing of Fibres, Yarns and Fabrics in Textiles and its Interpretations

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ABSTRACT:
Various testing instruments are used in textile industry for determining the quality. Among the textile instruments used different models, methods are available. The problem with traditional instruments are inaccuracy, time consuming, more labour work, high testing cost, very high calculations involved etc. These were overcome by the inventions of new instruments which are available worldwide. Institutions are equipped with old instruments. Modern instruments can be bought and kept in the institutions and training can be given in these instruments. Interpretation of results were not taught in institutions. These can also be done with available norms & data book in the world. The cost of the instrument is high for modern instruments. With mass production and usage by many industry. The cost of single piece will come down. The type of test to be used depends on the end use of the product. Appropriately test instruments can be used and results, conclusions can be done.

KEYWORDS: Instruments, fibres, yarns, fabrics, electronic, computer, modern, electrical

I. INTRODUCTION

Modern textile manufacturers employ progressively more sophisticated methods and use a variety of natural, man-made, and synthetic fibers. The quality and durability of fabrics are directly affected by the quality of fibers, correct choice of dyes and colorants, and the use of appropriate manufacturing processes.

QIMA offers inspections and laboratory tests for all modern textiles, including:

- Textile and canvas rolls
- Home textiles, carpeting, curtains, and upholstery
- Textile checks on finished products (garments, apparel, accessories, toys)

1.1 Textiles Testing Expertise

We offer the following physical and mechanical tests to assess the quality of your textiles:

- Performance: abrasion or piling (Martindale, ICI)
- Dimensional stability: torque, shrinkage, elongation, stretch and recovery
- Weather testing: waterproof, windproof, thermal, spray test
- Thermal and water vapor resistance / permeability
- Burn test (for 100% cotton textiles)
- Stiffness and bending
- Seam strength (for sewn articles)
- Tearing strength, penetration resistance
- Thickness, compression, and recovery (for floor coverings)
- Tensile properties
- Optical evaluation (appearance after the desired care treatment)

1.2 Textiles Lab Testing Expertise

General Lab Tests for Textiles

- APEO testing
- Fiber identification
- Eco-textile testing
- Banned azo dyes and colorants
- Color fastness check (CF to light, ozone, burnt gas fumes, phenolic yellowing perspiration, water, bleach, abrasion)
- Antibacterial and antimicrobial testing
- Formaldehyde testing

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- Pentachlorophenol (PCP) testing
- Polycyclic aromatic hydrocarbons (PAH) testing
- Dimensional stability and appearance evaluation after laundering cycles
- Heavy metals in surface coatings

These are given in reference [1].

II. TESTING OF TEXTILES

Fibre Testing

The various tests used for textile fibres are given below.

i. Moisture content, moisture regain using wet & dry bulb hygrometer, conditioning oven, Shirley moisture meter.
ii. Identification of fibres-cotton, wool, silk, viscose, rayon, nylon, polyester and acrylic fibres using solubility test, burning test, cross sectional and longitudinal view of fibres.
iii. Fibre length test. Hand stapling method, digital fibro graph, Baer sorter, uster stapler and fibro graph.
iv. Fibre fineness: Gravimetric method, micronaire, ATIRA fineness tester, Arealometer.
v. Fibre maturity: caustic soda swelling method, differential dyeing method, caustic caire method.
vi. Fibre strength: single fibre strength, bundle fibre strength, pressley tester, stelometer.
vii. Trash content of fibres: Shirley trash analyser.

Testing of yarns

The various tests used for textile yarns are given below.

i. Count of yarn – Analytical balance, Knowles balance, quadrant balance, beesley balance, stub yarn balance.
ii. Twist in yarn – straightened fibre method, Rock bank twist tester, continuous twist tester, twist to break method, optical method, twist contraction method, twist in doubled yarns, take up twist tester.
iii. Single yarn strength – Single thread strength tester, single thread strength tester based on inclined plane principle, uster single thread strength tester, Instron tester.
iv. Lea strength – Lea strength tester, Ballistic tester
v. Evenness of yarns – Visual examination method, cutting & weighing method, Electronic capacitance testers, Fielden walker evenness tester. Uster evenness tester, spectrogram analysis, Uster classimat, Shirley hairness tester, Tests for Textured yarns, Dynafil tester.

Testing of Fabrics

The various tests used for textile fabrics are given below.

i. Quality particulars of fabric – Fabric length & width fabric thickness, threads per inch, fabric weight, yarn crimp using Shirley crimp tester.
ii. Fabric strength: Tensile strength, Ravtel strip, cut strip, Grab methods: Tearing strength, tongue tear test, double rip, Trapezoid tear, Ballistic tear, wing riptear; Elmendorf tear; Bursting strength.
iii. Fabric Abrasion Resistance, Handle: B.F.T abrasion testing machine, Martindale abrasion tester, I.C.I Pill box tester. Drapemeter, Shirley stiffness tester. Heart loop test, Crease recovery tester.
iv. Air and water permeability: Shirley air permeability tester, water permeability wetting time test, spray test, Drop penetration test, Bundesmann tester, Hydrostatic head test.

In addition to above tests the other tests carried out for quality are nep count, crimp rigidity tests, High volume Instrument, Advanced fibre information system, Autosorter, Uster Tensorapid, objective measurement using KES_F, FAST, sensory Handmatry or colorimetry. These were given in Reference [2].

III. APPLICATION OF MODERN DEVELOPMENTS IN TEXTILE TESTING

Electronic, Mechanical, Electrical and Computers

Testing of fibres modern development

The wet and dry bulb hygrometer have traditional one with different colours. Direct temperature and humidity in digital form is available. Anemometer which can measure Air velocity, Air flow, Temperature, Humidity is available. Metal hygrometer gauge which can be kept inside guitar & violin is available. Analog hygrometer can measure temperature and humidity is available. With these developments there is no need to look into the charts for humidity. Lab model conditioning oven have digital set up. Temperature can be set & time can be set. The weight can be directly read from the digital display. Shirley moisture meter is available to measure moisture content of fibres & yarns. Other textile materials can also be tested now with tables prepared.

Various fibre identification charts are available for structural, physical & chemical properties which can be displayed easily.

Fibre length can be easily tested using digital fibro graph instruments. The digital display & computer controlled machine is available. Uster

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stapler is used for checking the raw cotton quality. Computer model is available now. Fibrograph instrument produces length measurement for the test specimen. Servo-fibrograph instrument is available.

The fineness of fibres is measured using Shirley fineness tester, ATIRA fineness tester, speedar fineness meter, port-Ar fineness meter. The modern instruments are compact in design. Other fibre fineness instruments like light scattering method, vibration method (vibroscopes), Arealometer (Wheatstone bridge method), WIRA cotton fineness meter (like Shirley tester) are available in market.

Fibre maturity can be measured using polarized light method, air permeability method in modern development. Old methods require chemicals, water, drier for estimation. Now easy methods are developed. Caustic soda swelling method, differential dyeing method causticaire method requires chemicals which is costly & also it requires more time.

Fibre strength is determined using pressley tester or stelometer in traditional methods. Now the tensile strength can be determined using single small fibre test jig, micro fibre test jig with cardboard frame and glue gripping system, capstam grip system are available & perfect values are obtained quickly without much calculations.

The trash content of fibres is measured using Shirley trash analyser in olden days. Now Uster technologies introduced trashmeter for measuring trash content in cotton. This is quick in operations.

This determines trash using gravimetric method. It has operation area, separation, lint & trash collection, imaging system, auto-weigh systems. Sample balance, electronic box, feed plate are seen in the machine. This can determine trash content in bales & card sliver. So it is used now.

Testing of yarns modern development

The traditional method requires preparation of samples and calculation of data. But in Uster tester 6, sensor FA determines yarn count automatically. Together with yarn count other measurements such as evenness, imperfections and hairiness are given with greater precision. So other tests can be done immediately with less time.

The twist in yarn is measured traditionally with counters. But in modern methods the twist is given in digital format and it is motorised. Double yarn twist tester is also made motorised and digital. This requires less time & quick testing of samples.

Single yarn strength tester is used for testing strength of single yarn. The traditional method requires labour & heavy calculation is required to find it. But in modern instrument digitally all values are determined. 20 cops at the same time can be tested.

The lea strength testing of yarn is determined mechanically in old method. But in modern developments the load cell is employed and quick determination of lea strength is done. Digitally the values are available. Computerised lea strength tester is also available.

Evenness of yarns is previously done with capacitive method (Uster evenness tester). Now optical method of evenness determination has come (Zweigle G580). Optical method measures the variations in diameter of yarn. Infrared transmitter and two identical receivers are available in machine. The previous values are compared with measured value & correct evenness is obtained.

The automatic dynamic shrinkage, crimp, draw force tester in digital form is available. In addition to actual dynafil testing methods, friction measurements, entarglement tests, broken filament tests, yarn evenness tests and yarn count measurements using additional modules are done. These are some of the modern developments compared to dynafil traditional tester.

Testing of fabrics modern developments

Various fabric inspection machines are available for measuring the length and width of the fabric & also the defects in the fabric. For counting threads/inch, counting glass was used. Now counting glass with LED light facility and traverse thread counter are available in market. Fabric weight GSM was previously done with weighing piece of fabric and calculating the GSM using basic definitions. Now GSM cutter, weighing balance and direct reading is obtained without calculations. The crimp of yarn can be read digitally in crimp tester.

Fabric strength is calculated on the mechanical motorized machine in traditional one. Now load cell, touch screen monitor or LCD display or LED display machine are available for fabric tensile strength tester. Fibre strength tester with digital display is available. Automatic fibre bundle strength tester (stelometer) is also available. The strength of seam can also be done with seam strength tester. Fabric busting strength tester with digital display is available. The tearing strength of the fabric were previously available with mechanical types. Now digital tearing strength tester with elmendorf type is available. Touch screen system machine is available. Auto calculate, test & analyse result, print report are available. Other tear tests can be carried out in load cell machine with special attachments.

Traditional method of abrasion resistance of fabrics is done by martindale abrasion tester.

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Now Wyzenbeek (oscillatory cylinder) abrasion tester is available. In this fabric is rubbed against cotton duck fabric for testing purpose. Martindale with digital display is available now. 8 samples can be done at a time with new model abrasion tester. BFT abrasion tester for flex, ball and flat abrasion is available in market. I.C.I pill box tester is used for testing pilling in fabrics. Digital pilling tester is available. The drape of the fabric is determined using drapemeter. But now fabric drape tester with digital camera is used. Drape co-efficient and drape wave number & amplitude are obtained through computer image processing technology. So there is no waste of time & laborious work. The sample can also be rotated and (D_s) static and dynamic draping coefficient (D_m) is also obtained. Overchanging morphological change rate is also obtained. ($L=(D_s-D_m)/D_s$).

Fabric stiffness test is obtained using Shirley stiffness tester. But pneumatic stiffness tester is also available. Bending moment Vs curvature curve is obtained from the tester. Heart loop method of fabric stiffness tester is available in the FYI tester machine. Crease recovery tester is easy to use & hence not much change is done with machine. Original Shirley crease recovery tester can be used.

Air permeability tester is available in digital model. Many models of air permeability tester are available. Computerized air permeability tester is available. Bundesmann water repellency tester is available with various features. Varied water flow, automatic timer for switch off, drip tray, mechanical filter, optional centrifuge to remove surface water from samples are available. Other water penetration tests can be carried out in chemical labs.

The price of the instruments ranges from few hundred rupees to lakhs of rupees. The modern developments ensures correct value obtained and exhaustive human calculations are avoided. So in addition to the traditional methods the modern instruments can be taught in colleges and used in industries.

The high volume instrument gives details about cotton fibre properties. It is very costly (22 lakhs), but it can be used in industry. Advanced fibre information system was developed by Uster company. It is aeromechanical fibre processing method. Electro optical sensing & processing by computer. This gives lesser value than HVI instrument. But it is costlier than HVI (1 crore). Autosorter with latest model, count of fibre yarn and rovings can be tested in the instrument. It has also computer attachments. Uster tensorapid determines breaking load, elongation of single yarns, plied yarns & fabrics.

It is also a costly instrument. KES-F (1.5 crore) and FAS T (1.75 lakhs), colorimetry (Rs. 20,000) are also costly instruments. They are modern developed instruments. These are given in internet sales informations.

IV. SOME EXPERIMENTS FOR FIBRE, YARN AND FABRICS AND THEIR INTERPRETATIONS

Ex.No:-1 Fibre Fineness

Table 1: Readings of fibre fineness

S.No	Fibre Fineness micrograms in lint X	$(X-X_1)$	$(X-X_1)^2$
1	3.8	0.1	0.01
2	3.9	0	0
3	4.1	0.2	0.04
4	4.2	0.3	0.09
5	3.7	0.2	0.04
6	3.8	0.1	0.01
7	3.8	0.1	0.01
8	3.9	0	0
9	3.6	0.3	0.09
10	3.8	0.1	0.01
Average	3.9	0.14	0.3

S.D $= \sqrt{\frac{\sum(X-X1)2}{n-1}} = \sqrt{0.3/9} = \sqrt{0.03}$

S.D = 0.17

CV = (SD/X_1) x 100 = (0.17/3.9) x 100 = 4.4%

Result

Mean fibre fineness = 3.9
S.D = 0.17 CV% = 4.4%

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Conclusion

Fineness is less & hence the cotton may be of short staple. A Digvijay, L-147 or medium staple Laxmi, G.Agethi, 1007, MCU-7 or Long staple Sankar-4, JKHY-1, Sankar-6, Hybrid-4. Using other parameters testing the exact cotton type can be determined. Using the cotton 20s to 30s, 30s to 40s, yarn can be spun. The cotton is not suitable for other counts spinning.

The standard deviation is 0.17 and CV% is 4.4%. The micronaire value have 67% - 3.9+0.17 (3.73 to 4.07). 95% - 3.9 + 0.17 x 2 (3.56 to 4.24), 99.7% - 3.9 ± 0.17 x 3 (3.39 to 4.41). The coefficient variation of 4.4% means micronaire value ranges from 3.9 x (100-4.4x3) to 3.9 x (100+4.4x3) = 3.3852 to 4.418 µg/inch.

The fibre sample may be laxmi. The tabulated value in norms is 3.8 µgm/inch.

Critical difference = ((3.9-3.8)/3.9) x 100 = (0.1/3.9) x 100

CD% = 2.56%

The acceptance norms is below 6%. Since 2.56% is below 6% the fibre is good and accepted.

Ex.No:-2 Count of roving & yarn

Table 2.1: Readings of count of yarn

Sample: yarn **Sample length: 120 yards**

S.No	Actual count		$(X-X_1)$	$(X-X_1)^2$
1	1.254	51.7	7.6	57.76
2	1.661	39.0	5.1	26.01
3	1.644	39.4	4.7	22.09
4	1.637	39.5	4.6	21.16
5	1.620	40	4.1	16.81
6	1.671	38.7	5.4	29.16
7	1.66	39	5.1	26.01
8	1.629	50.2	6.1	37.21
9	1.241	52.2	8.1	65.61
10	1.255	51.6	7.5	56.25
Average		44.1		358.07

Mean count X_1 = 44.1
Standard deviation SD = 6.30
Co-efficient of variation CV% = 14.285%
S.D $= \sqrt{\frac{\sum(X-X1)2}{n-1}} = \sqrt{2.167/(10-1)} = \sqrt{0.24}$
S.D = 0.49
CV = (SD/X_1) x 100 = (0.49/19.165) x 100 = 2.56%

Table 2.2: Readings of count of Rovings

Sample: Roving **Sample length: 15 yards**

S.No	Weight in grams	Actual Hank	$(X-X_1)$	$(X-X_1)^2$
1	6.692	1.21	0	0
2	6.731	1.20	0.01	0.0001
3	7.131	1.13	0.08	0.00064
4	6.437	1.25	0.04	0.0016
5	6.417	1.2	0.01	0.0001
6	7.278	1.11	0.1	0.01
7	6.486	1.24	0.03	0.0009
8	6.943	1.16	0.05	0.00025
9	6.233	1.29	0.08	0.00064
10	6.403	1.26	0.05	0.00025
Average	6.675	1.21		0.0144

Mean count X_1 = 1.21
Standard deviation SD 0.03
Co-efficient of variation CV% = 2.56%

S.D $= \sqrt{\frac{\sum(X-X1)2}{n-1}} = \sqrt{0.0144/(10-1)} = \sqrt{0.001}$
S.D = 0.03
CV = (SD/X_1) x 100 = (0.03/1.21) x 100 = 2.56%

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Result

The actual hank of roving is 1.2. The count spun can be 24-26s. The count yarn is 44.1s.

Conclusion

The standard diviation is 0.03. the roving hank can be 67% 1.17 to 1.23, 95% (1.2-2x0.03 to 1.2 + 2x0.03) i.e. 1.14 to 1.26 and 99.7% (1.2-3x0.03 to 1.2+3x0.03) i.e. 1.11 to 1.29. the CV% is 2.56%. The norms for CV% is good 3.0, Average 4.0 and poor 5.0 Here CV% is good.

The standard deviation of count is 6.3, 67% of count is (44.1-6.3 to 44.1+6.3) 37.8 to 50.4. 95% of count is (44.1-2x6.3 to 44.1 + 2x6.3). (31.5 to 56.7). 99.7% of count is (44.1-3x6.3 to 44.1 +3x6.3). i.e (25.2 to 63). The CV% is 14.285%. the norms is (40s & above) good 2.2, Average 3.0, Poor 4.0. Here the CV% is 14.285%. So the yarn is poor.

Ex.No:-3 Single Yarn Twist Tester

Table 3: Readings of TPI
Sample length, Tension weight – 10", 8 gms

S.No	Actual TPI (X)	$(X-X_1)$	$(X-X_1)^2$
1	19.21	0.045	0.002
2	19.59	0.425	0.180
3	19.55	0.385	0.148
4	18.9	0.265	0.070
5	18.81	0.355	0.126
6	18.82	0.345	0.119
7	19.1	0.065	0.004
8	19.84	0.675	0.455
9	18.23	0.935	0.874
10	19.6	0.435	0.189
Average	19.165		2.167

Mean TPI = X_l = 19.165
Standard deviation SD = 0.49
Co-efficient of variation CV% = 2.56%
S.D $= \sqrt{\frac{\sum(X-X1)2}{n-1}} = \sqrt{2.167/(10-1)} = \sqrt{0.24}$
S.D = 0.49
CV = (SD/X_1) x 100 = (0.49/19.165) x 100 = 2.56%
(20^s or 30^s Hosiery) TPI = 20.81

Results & conclusions

TPI is found to be 19.165. the count is 20s or 30s H. Other counts may be 24s, 25s, 26s, 30s H combed & polyester blends. 32s, 40s, P/V also have this TPI. The twist inserted is 'Z' twist.

Ex.No:-4 Doubled yarn Twist tester

Table 4: Readings of TPI of doubled yarn
Sample length, Tension weight – 10", 8 gms

S.No	Actual TPI (X)	$(X-X_1)$	$(X-X_1)^2$
1	14.1	0.36	0.129
2	10.7	3.04	9.241
3	13.4	0.34	0.115
4	14	0.26	0.067
5	13.1	0.64	0.409
6	13.8	0.06	0.003
7	14.7	0.96	0.921
8	15	1.26	1.587
9	14.7	0.96	0.921
10	13.9	0.16	0.025
Average			13.418

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Mean TPI = X_1 = 13.74
Standard deviation SD = 1.22
Co-efficient of variation CV% = 8.87%
S.D $= \sqrt{\frac{\sum(X-X1)2}{n-1}} = \sqrt{13.418/(10-1)}$
S.D = 1.22
CV = (SD/X_1) x 100 = (1.22/13.74) x 100 = 8.87%

Results & conclusions

The TPI is 13.74. the count is 2/20s. The yarn twist is 'Z'. Doubled yarn twist is 'S' twist.

Ex.No:-5 Single yarn strength tester

Table 5: Readings of single yarn strength
Original length = 60 cm

S.No	Breaking Strength in grams (X)	Breaking Elongation in % Cm %		(X-X_1)	(X-X_1)^2
1	300	63	5	74	5476
2	320	64	6.7	54	2916
3	380	65	8.3	6	36
4	380	63	5	6	36
5	340	62	3.3	34	1156
6	400	61	0.02	26	676
7	400	63	5	26	676
8	400	64	6.7	26	676
9	400	63	5	26	676
10	420	62	3.3	46	2116
Average	374		4.83		14440

Standard deviation SD = 40.05
Co-efficient of variation CV% = 10.75%
S.D $= \sqrt{\frac{\sum(X-X1)2}{n-1}} = \sqrt{14440/(10-1)}$
S.D = 40.05
CV = (SD/X_1) x 100 = (40.05/374) x 100 = 10.7%
Tenacity RKM = (374/19.7) = 19
Tex = 590.5/30 = 19.7
RKM = $\frac{\text{Breaking strengt h in gms}}{\text{Tex}}$
Original length = 43 + 17 = 60cm
Elongated length = 46 +17 =63
Breaking strength of yarn = 374 gms, Elongation % = (63-60)/60 x 100

Single yarn strength is 374 gms. The count is 30s. The standard deviation is 40.05 CV% is 10.7%. 67% of thread is (374 – 40.05 to 374 + 40.05) i.e. 333.95 to 414.05 95% of thread is (374-2x40.05 to 374+2x40.05) i.e. 293.9 to 454.1. 99.7% of thread is (374-3x40.05 to 374 + 3x40.05). 253.85 to 494.15 CV% is 10.7%. the count of yarn is 30s. The norms for single yarn strength is Good-300, Average -275, poor-250. So the strength is good. CV% norms is good 10 Average 13, poor-16. So the CV% is good.
Breaking strength of yarn = 374 gms
Breaking elongation % = 4.83%
Tenacity = 19 gms/Tex

Result & Conclusions

Ex.No:-6 Lea strength tester

Table 6: Readings of lea strength tester

S.No	Lea weight gms	Count (a)	Lea strength (b)	CSP (X) (axb)	(X-X_1)	(X-X_1)^2
1	1.657	39	54	2106	174	30276
2	1.601	40	46	1840	92	8464
3	1.691	38	52	1976	44	1936
4	1.297	49	39	1911	21	441
5	1.601	40	50	2000	68	4624
6	1.603	40	45	1800	132	17424

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7	1.637	39	49	1911	21	441
8	1.647	39	49	1911	21	441
9	1.638	39	49	1911	21	441
10	1.639	39	50	1950	18	324
Average		40.2	48.3	1932		64812

S.D $= \sqrt{\frac{\sum(X-X1)2}{n-1}} = \sqrt{64812/(10-1)}$
S.D = 84.86
CV = (SD/X_1) x 100 = (84.86/1932) x 100 = 4.39%

Result & Conclusions

The lea strength of yarn is 48.3 lbs. (21.91 kg) The single yarn strength is 197. The count of yarn may be 40s c, which is correct. CSP is 1942. The SD% is 84.86. 67% is (48.3-84.86 to 48.3 + 84.86). 95% is (48.3-2x84.86 to 48.3 + 2x84.86). 99.7% is (48.3-3x84.86 to 48.3+3x84.86). (0 to 303lbs).

The CV% is 4.39%. the CV% for strength for 40s above is Good-4.5, Average-5.5, Poor-7.0. So the yarn strength CV% is good.

Ex.No:-7 Yarn appearance board winder

Table 7.1: Readings of yarn appearance

S.No	Yarn appearance	Index
1	A	130
2	B	110
3	B	110
4	A	130
5	A	130
	Total	610

Table 7.2: Yarn appearance Index values
Mean= 122, B+ = 120

Yarn appearance	Index
A	130
B+	120
B	110
C+	100
C	90
D+	80
D	70
BELOW GRADE BG	60

Table 7.3: Yarn Classimat faults classification

+400%	A4	B4	C4	D4		
+250%	A3	B3	C3	D3		
+150%	A2	B2	C2	D2		
+100%	A1	B1	C1	D1	E	
+45%				-30%	F	G
				-45%	H1	I1
				-75%	H2	I2
0.1	1	2	4	8	32	(cm)

Results & Conclusions

Yarn appearance grade = B+
Length = 23 cm width = 11.5cm
Wraps/cm = 20
Neps/Km == (48/52.9) x 1000 = 907 perKm
Slubs/Km = (8/52.9) x 1000 = 151 per Km
Thick places /Km = (40/52.9) x 1000 = 756
Thin places/Km = (8/52.9) x 1000 = 151

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The neps, slubs, thin, thick places are below the norms, value. So the yarn is good.

Ex.No:-8 Fabric Tensile strength tester

Table 8.1: Readings of warp load & Elongation
Tensile Strength Tester

S.No	Warp load (Kg)	Elongation (inches)
1	23	2
2	24	2.5
3	22	1.5
4	23	2
5	23	2
Average	23	2

Table 8.2: Readings of weft load & Elongation

S.No	Weft load (Kg)	Elongation (inches)
1	15.1	4.5
2	13.0	4
3	14.0	5
4	12.2	4.5
5	13.6	4.5
Average	13.6	4.5

Count of yarn = 30^s
Thickness in inches = $1/28\sqrt{Ne}$ = $1/28\sqrt{30}$ = 1/153.36 = 0.00652”
Total thickness = 2x0.00652 = 0.01304”
Area of cross section = 2”x0.01304” = 0.02608”

Warp
Stress = Load / area of cross section = (23/0.02608) x (1/2.54) x (1/2.54)
= 23/0.1683 = 136.66 kg/cm^2
Strain % = 2/8 x 100 = 25%
Modulus = 136.66/25 = 5.4664 kg/cm^2

Weft
Stress = Load / area of cross section = (13.6/0.02608) x (1/2.54) x (1/2.54)
= 13.6/0.1683 = 80.8 kg/cm^2
Strain % = 4.5/8 x 100 = 56.25 kg/cm^2
Modulus = 80.8/56.25 = 1.44 kg/cm^2
*count of yarn = 30^s
EPI = 50
PPI = 33
Single yarn strength =250gms
Theoretical tensile strength warp (2”) = 250x100 gms =25 kg
Theoretical tensile strength weft (2”) = 250 x 66 gms =16.5 kg

Result
1. Mean value of tensile strength in warp = 23 kg
2. Mean value of tensile strength in weft = 13.6 kg
3. Elongation % in warp = 2”
4. Elongation % in weft = 4.5”
5. Modulus of warp = 5.4664 kg/cm2
6. Modulus of weft = 1.44 kg/cm2
7. Theoretical tensile strength warp = 25 kg
8. Theoretical tensile strength weft = 16.5 kg
9. Conclusion of fabric = Good fabric

Ex.No:-9 Fabric Tearing Strength Tester
Tearing of ends = 124 x 250 = 31,000 gms = 31kg
Tearing of picks = 82 x 250 = 20,500 gms
= 20.5 kg
EPI = 50PPI = 33
Ends teared = (50/25.4) x 63 = 124
picks teared = (330/25.4) x 63 = 82

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Table 9: Readings of tearing strength
Elmendorf of Tearing Strength Tester

	Tearing strength inch	
S.No	**Warp way**	**Weft way**
1	42	30
2	40	28
3	38	32
4	45	30
5	40	33
Total	205	153
Mean	41	30.6

Tearing strength (warp) (gms) = (41 x 6400) / 100 = 2624 gms
Tearing strength (weft) (gms) = (30.6/100) / 6400 = 1958.4 gms
Count of yarn = 30^s
EPI = 50PPI = 33
Ends teared = (50/25.4) x 43 = 84
Picks teared = (33/25.4) x 43 = 56
Single yarn strength norms = 250 gms
Theoretical strength of ends (warp) = 124 x 250 gms = 21.16 kg
Theoretical strength of picks (weft) = 82 x 250 gms = 14 kg
Theoretical lea strength of ends (warp) = 60 x 453.6 / 1000 = 27.216 kg
30s CSPs = 1800
Theoretical lea strength of picks (weft) = 60 x 453.6 / 1000 = 27.216 kg

Warp way
CSP = Single yarn strength + 2 x Tearing strength
27.216 = (80x 250)/1000 + 2 x Tearing strength
Tearing strength of 80 threads = ½ (27.216 – 80 x 0.25) = ½ (7.216)
= 3.608 Kg
Tearing strength of 84 threads = (84/80) x 3.608 = 3.79 Kg

Weft way
27.216 = (80x 250)/1000 + 2 x Tearing strength
Tearing strength of 80 threads = ½ (27.216 – 80 x 0.25) = ½ (7.216)
= 3.608 Kg
Tearing strength of 56 threads = (56/80) x 3.608 = 2.5256 Kg

Result
1. Tearing strength of fabric warp= 2624 gms
2. Tearing strength in fabric weft = 1958.4 gms
3. Theoretical tearing strength of fabric warp = 3.79 kg
4. Theoretical tearing strength of fabric weft = 2.5256 kg
5. Conclusion of fabric = Good fabric

Ex.No:- 10

Table 10.1: Thickness of fabric

Thickness measurement

Thickness measurement reading (cm)							**Average**
0.24	0.24	0.25	0.24	0.23	0.22	0.24	0.24

Fabric thickness (by using thickness gauge) = 0.24 cm
Fabric weight/5 sq cm (by using digital balance) = 0.281 gm/5 sq.cm = 0.281/25 g/cm^2 = 0.01124 g/cm^2

Table 10.2: Bending length of fabric

	Bending length in cm	
S.No	**Warp way**	**Weft way**
1	2.3	1.5
2	2.7	1.8
3	2.5	1.9
4	2.4	1.5
Mean	2.47	1.68

Flexural rigidity warp = 2.47 x 0.01124^3 x 10^3 = 0.003507 gm.cm
Flexural rigidity weft = 1.68 x 0.01124^3 x 10^3 = 0.002386 gm.cm

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Overall Flexural rigidity = $\sqrt{\text{Gwarp x G weft}}$ = $\sqrt{8.3637x10-6}$ = 0.002892 mgm.cm
G – Flexural rigidity Max G = 8 x 0.03^{3} x 10^{3} =0.213 mgmcm
Bending modulus q = (12 x G x 10^{-6})/ g_2^3 kg/cm^2
g_2 – fabric thickness in cm warp q = (12 x 0.003507 x 10^{-6})/ 0.24^3 kg/cm^2
= 3.0442 x 10^{-6} kg/cm^2
weft q = (12 x 0.002386 x 10^{-6})/ 0.24^3 kg/cm^2
= 2.0712 x 10^{-6} kg/cm^2
overall q = (12 x 0.002892 x 10^{-6})/ 0.24^3 kg/cm^2
= 2.5104 x 10^{-6} kg/cm^2
Max q = (12 x 0.216 x 10^{-6})/ $(0.24x3)^3$ kg/cm^2
= 6.94 x 10^{-6} kg/cm^2

Results

1. Mean bending length (Warp way sample) = 2.47
2. Mean bending length (Weft way sample) = 1.68
3. Flexural rigidity (Warp way) = 0.003507 mgm.cm
4. Flexural rigidity (Weft way) = 0.002386 mgm.cm
5. Overall flexural rigidity (Warp way) = 0.002892 mgm.cm
6. Bending Modulus (Warp way) = 3.0442x10-6 kg/cm^2
7. Bending Modulus (Weft way) = 2.0712x10-6 kg/cm^2
8. Overall Bending Modulus = 2.5104x10-6 kg/cm^2

Conclusion

Bending length is lesser value & hence cloth is somewhat stiff. Flexural rigidity maximum is 0.216 mgm.cm. here it is very less. So the fabric flexes easily. Bending modulus maximum value is $6.94x10^{-6}$ kg/cm^2. Here it is half the value & hence bending modulus is average. Overall the bending property is good.

Ex.No:-11 Fabric Creasy Recover Tester

Table 11: Readings of Warp & Weft recovery angle

	Crease recovery angle (degrees)	
S.No	**Warp way**	**Weft way**
1	38	48
2	37	51
3	35	60
4	38	52
5	38	52
Total	186	263
Mean	37.2	52.6

Loading Weight = 2 kg
Creasing Time = 3 min
Recovery Time = 3 min

Result

1. Mean crease recovery angle for warp way specimen = 37.2
2. Mean crease recovery angle for weft way specimen = 52.6

Conclusion

The crease recovery angle is very less. So the fabric requires ironing for wearing as garments.

Ex.No:-12 Crimp tester for yarn in Woven Fabric

Table 12: Tension weight of crimp

Yarn	Count	Tension (gm)
Cotton	Finer than 7 tex	0.75 tex
	Coarser than 7 tex	0.2 tex + 4

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Tex = 590.5/count
Count = 30^s
Tex = 19.68
Tension = 4 + 0.2 x tex = 4 + 0.2 x 19.68 = 8 gms
Weft crimp % = (5.5-5)/5 x 100 = 0.5 x 20 = 10 %
Warp crimp % = (5.4-5)/5 x 100 = 0.4 x 20 = 8 %

Result

1. Warp yarn count = 30^s
2. Weft yarn count = 30s
3. Mean value of warp yarn crimp % = 8%
4. Mean value of weft yarn crimp % = 10%

Conclusion

The weft yarn crimp is more than warp yarn crimp. 110 m of yarn is required in weft for 1m of fabric. 1.08m yarn length is required for warp for 1m of fabric.
C.F – conversion factor values
Warp weight g/m^2 = (EPI/count) x ((100+C%)/100) x C.F
= (50/20) X ((100+8)/100) x ((100x453.6)/(2.24 x 840 x 0.91)) = 63 g/m^2
Weft weight g/m^2 = (PPI/count) x ((100+C%)/100) x C.F
= (33/20) X ((100+10)/100) x ((100x453.6)/(2.24 x 840 x 0.91)) = 42 g/m^2
Fabric weight = 105 g/m^2
With crimp % fabric gsm can be calculated.
5x5 cm sample weight = 0.28 gm
Actual gsm = 0.28/25 x 10000 = 112 g/m^2
The above experiments results were analyzed using sitra norms. This is given in reference [3].

V. DISCUSSIONS

The detailed experiment work are given in literature and also given by instrument supplier. It is not possible to do all experiments and interpret in this paper. Some experiments for fibres, yarns and fabrics were done and conclusions were done. Ex.No:-1 deals with the determination of fibre fineness. Easy methods of modern instruments will shorten the work. Ex.No:-2 deals with determination of roving and yarn count. The easy methods are available with Uster tester 6. Ex.No:-3 deals with determination of single yarn twist. With motorised & digital display in modern instruments the work is much easier to carry out. Ex.No:-4 deals with determination of ply yarn twist. The motorised instruments gives quick values. Ex.No:-5 deals with single yarn strength. With modern instruments like tensorapid it is possible to finish experiments very quickly. Ex.No:-6 deals with determination of lea strength and CSP. Modern instruments shows digital values & with computer easy method of CSP values are found out. Ex.No:-7 deals with determination of yarn appearance grade. With modern instruments, quick winding is carried out with motor & results obtained quickly. Ex.No:-8 deals with determination of fabric tensile strength. This is modern instrument used. So quick result is obtained. Ex.No:-9 deals with determination of fabric tear strength. This can be easily done with digitalised tear strength tester. Ex.No:-10 deals with determination of fabric stiffness tester. Modern instrument with pneumatic tester & easy computer calculations program give quicker values. Ex.No:-11 deals with determination of crease recovery tester. This has no development & hence old type can also be used. Ex.No:-12 deals with determination of crimp. With modern instruments crimp is determined digitally. It is accurate & easy.

Traditional methods are taught in institutions. Modern developed instruments are used in industry. So there is a big gap between educated youth in institution & industry. To have better knowledge brief study of traditional method basics can be taught & full training can be given in modern instruments in institutions. This will reduce training time incurred in industry. Also the interpretations done are given here with limited experiments. All experiments can be done with modern instruments and interpretation methods can be determined. Also the poor quality products can be utilised for other applications in life. Coarse count spinning, bedsheets, pillow filling etc. can be suggested and it can be done.

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