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On the Mechanisms of Tear Trajectory for Cotton Fabrics at off -axis Angles

Ahmed Ramadan Abd El Hamid Mohammed El-Tantawi.
Faculty of Applied Arts, spinning weaving and knitting Department
Damietta University

Abstract:

The mechanical parameters of a fabric are frequently used to determine its utility parameters. Unidirectional tear strength and elongations characteristics are the most significant strength criteria while usage. In this work, the researcher describes in detail the tear force and crack trajectory of tear strength for cotton fabric. Laboratory measurement methods and the correlation relationships between the results obtained by different cutting angles for most common cotton fabric in Egypt markets, using tongue tear method. The measurements of tear strength were carried out for fabrics produced from most common cotton spun methods. In addition, the unidirectional tear force according to different weave structures with different off-axis angles was measured for the group of textiles mentioned above, and the correlation coefficients between the weave parameter and angle of tear strength were calculated. The results shown a prediction proficiency to transitions analysis of total tear path distribution for woven fabric would have to take into account variety of precise parameters between the relations of working circumstances, distortion conditions, direction of stress angle, slippage and tip of the incision for daily cotton woven fabrics statistically significant (0, 0001), and it would be necessary to know how these characteristics are related to cloth construction.

Key words: Tear

1. Introduction:

From underwear and daily apparel to protective, recreational, work garments, ornamental furniture, upholstery, high-tech, home textiles and locomotion daily clothing, woven fabrics have a wide variety of applications [24,39], the subjects can be stretched, torn and worn out in one direction or in many directions .Therefore, their vast range of applications, textiles is subjected to a variety of stresses and strains throughout their lives, depending on their destination and working circumstances.

In the textile industry, tearing is generally associated with *woven* fabrics; knitted fabrics are usually very difficult to tear and are therefore not subjected to tear

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testing. Not only, the most known failures of fabrics have been caused by tear propagation, but also its consider to be the most common failure mode for fabrics [29], which will typically terminate the useful life of the article. Whereas tensile strength may be seen as a minimum requirement that ensures quality. Moreover, tearing strength can be considered an assessment of the serviceability of a fabric or garment. The contrast between tensile and tearing strength is quite obvious tensile strength, many threads breaking simultaneously due to its requires for exertion force, whereas, to tear the cloth, the threads are subject to broken singly. The latter is therefore a much more and prominent effect of failure than the former. For this issue may be attention drawn by, manufactures to care that must be exercised to prevent a hole or slit which a result of an accident from developing into a tear; the stresses of normal use for daily woven fabric are quite capable of causing an extension of such damage [9].

Therefore, for the purpose of maximizing damage tolerance and preventing catastrophic tear propagation, it is imperative to investigate tearing force for most common producing in the world as *cotton fabrics* in various direction which used in the most articles at daily life's.

Fabric tearing can define as the consecutive bearing of yarns or collections of yarns laterally a stripe done a fabric [3]. It is the consecutive breaking of yarns or collections of yarns laterally a stripe done a fabric, considering one of the greatest communal kind of disappointment in textile materials and in many cases; it helps to sack their useful life [15]. Taylor [16] explain tearing strength dependent mainly on the spacing and strength of the threads being torn and the force required to make them slip over the crossing threads.

The study of tear behaviors of woven fabrics dates from1945 .For instance, Krook and Fox [6], then L. H. Turl [15] already discussed the fabric tongue tearing behavior and described the del-shaped opening observed in the tearing damage, as shown in Fig (1). For more explanation, to *tear phenomena*: during the test, the longitudinal load bearing threads (the threads gripped in the jaws of the instrument) lose crimp and slip across the transverse threads.

. In trajectory, Spun methods, Off-axis angles.

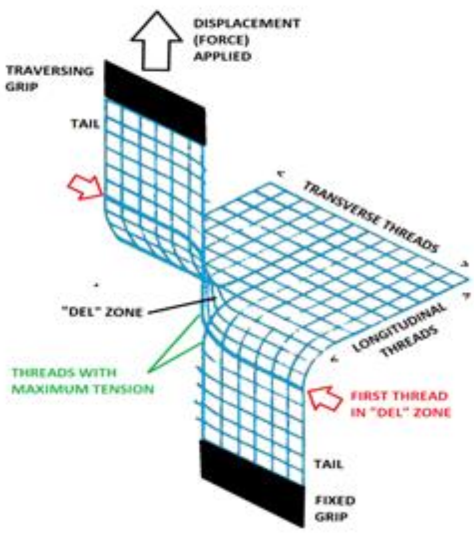

Fig. 1. Krook and Fox model for Del zone. tearing test

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The transverse threads cross a delta shaped zone in which there are no longitudinal threads. As the force increases, the longitudinal threads slip closer together increasing the size of the "del zone" and increasing the frictional contact, and force transfers from the longitudinal threads to the transverse threads. Longitudinal threads are drawn together towards the cut line and transverse threads are pulled into a near vertical plane increasing the size of the Del area.

Us army textiles designer has its roots in the work of studying textile material strength especially tear strength measurement. Since then, research has continued in the area of technical textiles, and finally has been adopted in industries manufacturing textiles for daily use [41].

KLA American Manufacture Instruments presented critical fracture energy from a tear test is known as tearing energy, which is deepened increasing in crack length. They presented mathematical formula for the work done during a tear test as equation (1): $\Delta W = 2F\Delta C$ where F is the tearing force and Δc is the tear distance, they ignored the changes in extension of the material between the tip of the tear and the legs are negligible. The tearing energy, or critical fracture energy, can be written as following equation (2): $T_c = \Delta W / B\Delta c$., where B is the thickness of the specimen. Hence, by combining Equations 1 and 2 they get the critical tearing energy in following equation (3): $T_C = 2F / B$, which independent of the initial sample geometry and crack length. The critical tearing energy could have also been calculated using equation 2, they advised that due to complicated crack length measurement it should be measured before and after the tear test to achieve good results.

Ppt group the England manufacturer of most of fabric testing instrument's illustrate in their webinar that : not only yarn Properties, fabric construction, fabric finishing, single end strength (breaking load), extensibility, twist, frictional properties and tear test procedure consider the main the factors affecting tear strength - in yarn ,but also yarn spacing, weave design, crimp, multiple fabric layers, fabric reinforcement and fabric finishing methods consider the main the factors affecting tear strength – in fabrics. Moreover , there are factors affecting tear strength for test procedure such as speed of tear propagation, gauge length and tear test method. So it can summarize as the tear strength (resistance) of a particular fabric determines the fabric strength under the static tearing action (static tearing), kinetic energy (dynamic tearing) and tearing on a 'nail' of the appropriate prepared specimen.

In the last several decades, due to the increasing use of textile materials especially composite, studying tear topic has received even more attention. For investigate how coated or dry materials tear, various types of tear procedures have been proposed [5, 8, 17, 33, 37].

Tongue tear method, was originally applied to characterize tearing properties of fabrics in the garments industry. Numerous researchers [20, 21] have also studied the tearing behaviors of woven fabrics through experimental and analytical methods. For instance, Teixeira et al[34],in their paper of studying the factors effect on the tear strength of woven fabrics; they were observed that some certain geometric properties of dry materials, such as weave pattern, yarn twist and yarn structure, had a significant effect on the tongue tear strength.W.A. Scelzo et al. [38] analyzed the subcomponents of tear, the isolated contributions of yarns pull-in to Del zone, yams towards the untorn fabric and yam tenacity. , to the tongue tearing resistance of cotton, woven fabrics and they established a predictive model based on a mechanical spring analogy to predict load-displacement responses of woven fabrics being torn**.** Wang et al. [22] investigated the tongue-tearing damage of woven fabrics from a Finite element modeling approach at the microstructure level. From their parametric study of the fabric tongue-tearing damage, they founded that there are factors influencing the tongue tearing strength and tearing load-displacement curves of woven fabrics. Such as friction coefficient, fabric construction, and weaving density.

For the topic of central slit tear method, several investigations [11] have been conducted on dry, coated, or laminated fabrics. One of the most important to revision is Chen et al. [14] tested central slit tearing behaviors of a laminated fabric with different slit lengths under uniaxial and biaxial tensile loads and proposed an analytical model as shown in Fig.2 to evaluate the uniaxial tearing strength of the laminated fabric with a slit oriented at 0 degree.

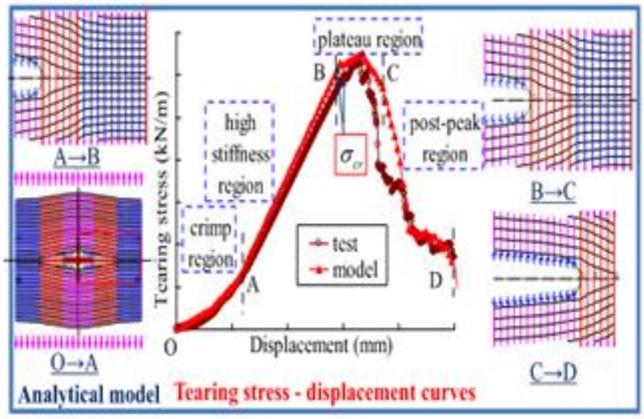

Fig .2. Hypothesis on the mechanism of failure in a tongue-tear test.

About measuring the *tearing performance* of fabrics with various parameters Fatemeh [9] studied the tearing performance of worsted fabrics with various common weave structures and weft yarns with different yarn spinning systems, their paper presented a smart mathematical equation elated to peak number of tear test as following in equation (4):

$TE = \sum_{i=0}^{n} (\frac{(F_{i\max}+F_{i\min})\times\Delta l_i}{2})$., where TE is the tearing energy, i is the peak number, $F_{\max}$ is the maximum tearing force in the i_{th} peak, $F_{\min}$ is the minimum tearing force in the i_{th} peak, and Δl_i is the movement of instrument jaws between $F_{\max}$ and , $F_{\min}$. Since the

number of peak points is not equal for various samples, the value of TE , which was calculated from equation was divided by " i " for each sample and in this manner the data were normalized and used
for the analysis and comparison of results., according to the study outcomes, it was founded that weave structures with the lower construction firmness had the higher tearing energy. In addition, two-ply ring yarns had the highest tearing energy among the studied yarns; while the solo yarns tearing energy was higher than Siro yarns, and the single ring yarns had the lowest tearing energy. Moreover, the finishing process negatively affected the tearing energy of worsted fabrics. J. Thanikai Vimal et.al. [35] studied the effect of weave parameter as (ring spun yarn) from cotton blending with different weave structure on the tear strength of woven fabrics; their results obtained that Fabrics with longer floats have higher tear strength in comparison of the fabric having no floats like plain weave. A. Mukhopadhyay et al. [19] explained that fabric made from ring spun yarn has more tearing strength than rotor spun yarn fabric. S. Dhamija et al. [27] observed that due to the smoothness of compact spun yarn and the better movement of yarns inside woven. Fabric produced from it, required higher load so, it's considering more tearing resistant fabrics. Similarly, due to easier yarn movement and the ability of yarns to group with each other at weave structures chosen in his paper with more floating yarns, show higher tear strength**.**

P.wang,et.al [22] examine the fabric strength properties with respect to tensile, tear and bursting strength regarding the weft
yarn parameters and weft density using regression equations. His results show that the fabric with ring weft yarns had the higher tear strength compared to the fabric with rotor weft yarns. A. A. Almetwally, et al. [1] indicate that the characteristics of fabrics woven from both compact and ring spun yarns reflect their differences. His laboratory measurement revealed that there is no significant difference between both types of fabrics regarding the abrasion resistance and tear strength.

Moreover only limited studied founded for studying woven fabric performance with elastic constants[4, 42] of plain woven fabric as, cotton, wool, polyester and other blended from wool and lycra , as Željko Penava and et.al [43], shown in their paper with result that its need to respect tensile force measurements only in the warp, weft direction and at an angle of 45° .Although Shouhui Chen, et.al [31] in their investigation for studding tensile performance of coated woven fabrics under multiaxial loads is examined, illustrate that the tensile performances under bi- and multiaxial loads are much better than those under uniaxial loads for coated fabrics . Hynng S., et al. [11] presented a model by using A knife blade for evaluated the cut resistance of yarns under shear loading conditions. Their results can be taken into account, especially when testing technical yarns and fabrics.

Tear strength is a complex phenomenon, the character of which is difficult to explain in detail. The large number of tearing methods and the small number of theoretical models makes tear strength prediction difficult. The snagging of a garment and the resulting propagation of the hole is probably the most common example of a defect through the fabric structure. Therefore, it is necessary to select a suitable tear method to determine the tearing properties of the material [27], which should then be used for design purpose. Unfortunately, most of the common tear methods (the trapezoidal tear method, tongue tear method, and wing-shaped tear method) are typically intended for the garments industry rather than as appropriate methods for structural fabrics.

For term *tear energy*, several mechanics approaches indicate this term in different mathematical equations as R. S. Rivilan. , et.al. Indicate in three studied [10, 25, 36] the characteristic, strain concentration at an incision and the property of rubber tear . Their studies run on rubber; in particular, and mathematical relations were deduced based on the displacement of the sample, noting the magnitude of the large force for the occurrence of the crack. Thus, we can say that the magnitude of the displacement in the presented mathematical relations cannot be applied to woven fabrics, we will not elaborate on these equations here, and the special equations will be clarified for woven fabrics specifically in the above and following sections of this research.

Ennouri Triki,et.al. [32] In their study provided a simple criterion for the tearing energy of woven fabrics made from plain and twill woven fabrics made of cotton, polyester/cotton blend and polyester. Patricia.D, et. [23] Provided an equation for force–displacement curve in the tongue tear for the plain weave cotton fabric with a set value of *60 mm* for the maximum jaw displacement as shown in Fig..3 as following in equation (5).:

G= $-(\Delta W/\Delta A)\,L$., whereas: ΔW Is, expanded work, ΔA change in the tear surface area, *L* displacement. They mentioned that, different types of fabrics with different yarn material, weave structure and linear density were used to evaluate to the robustness of their approach.

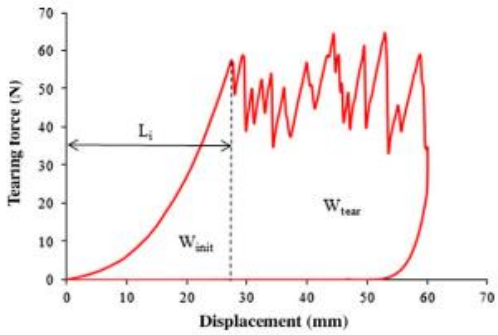

Fig .3. Schematic diagram for tongue tear test.

Even while laboratory simulations indicate a mechanism to quantitatively, compare samples that are somewhat similar, standard testing procedures frequently have little in common with actual failures that occur in use because they are meant to be quick, repeatable and at different directions or angles. Textile materials, in the case of apparel or garments daily use can fail in service for many reasons, the mechanics of failure are not so well defined., It can be said to fail or to become unserviceable because of excessive wear, serious fading, bursting of the seams, or tears caused by contact with sharp objects.

Not only , according to the aforementioned literatures; different types and sizes of notch sensitivity, damages, or tears have been found to produce different tearing strength or tearing force and characteristics, and tear propagation properties for different woven fabrics., But also considering to laboratory practice, there are several experimental investigation is the main way to determine fabric static tear strength measurement and tearing behaviors of the woven fabrics and the data are often used as a standard for verifying the calculated results of the corresponding analytical or fine element models. This measure has become just as significant in fabric statistical analysis as tensile strength.

So that, the *main specific issues and purposes* of the study are as follows:

- Limited comprehensive studies founded in the subject of studying crack propagation in various directions of cotton fabric as (*Daily fabrics*), which are related to the crack trajectory of cotton fabrics which produced from different spinning technology.

- Whilst still taking into account the results of previous research studies, there is still a need to investigate of tear trajectory in different parameters and off- axes angles particularly. Therefore, more trails and experiments are necessary.

Moreover, the present *study objectives* has been probed to:

- Determine the mechanism of failure in the tongue tear test for cotton fabric to study the failure of cotton woven fabrics involve propagation of a defect through the fabric structure produced from different spinning technology in different angle with different common weave structure as cases of in end use applications of fabrics where the material may be holed in any directions.
- It is a relatively simple procedure to pre-pare tongue-tear specimens and test them in the specified manner, but only by a complete understanding of what takes place in the specimen during various angle of rupture will help manufactures to intelligently apply any changes in fabric structure that would result in improved tear resistance.

2. Materials and Methods:

As shown in Tables (one, two and three) respectively, the specification of weft yarn used, the specification of loom parameter, the specification of fabric parameter, and three weave structure (Plain1/1, Twill 1/3 and Stain ¼) are used, .Weft yarn 40Ne Combed , Carded and Open spun technology with 47 pick /inch .,.; Subsequently, nine woven fabrics were used. To maintain uniformity, same warp yarn- (30Ne Ring carded) was used, with warp density 60 yarns per inch.

Experimental Protocol shortly describes by equation (6) below:

3 Cotton spinning technology (Comb – Card-Open end) × **3** weave structures = **9** samples.

63 experimental are measured and the samples tests parameters given in Table .4.

Table 1. Weft yarn specification

Object/ Yarn	40/1 Ne Combed	40/1 Ne Carded	40/1 Ne Open End
Count Method ;Actual Yarn Count	40.10	40.20	39/3
Twist Method ; Mesdan Tester 2531C Twist (TPI) of single Yarn	26.35	26.65	32.15
B-force (g/f)	238.9	286.4	130.3
Strength Method; Tenso Rabid 4. Breaking Length(RKM)	19.23	19.40	8.82
Average Elongation %	5.45	5.64	4.59
CV %	4.7	5.8	11.7
Thin places *1000 km (-50%)	1	7.5	80.0
Thick places *1000 km (+50%)	25	155	122.5
Neps. *1000 km (+200%)	240	750	1265

Table 2.
The specification of loom parameter.

Loom parameter.	
Manufacture	Vamatex silver HS 2010.
Weft insertion system	Rapier.
Shed system	Negative dobby (Stäubli 2670)
Machine speed	450 RBM.
Machine width	190 cm
Let off system	Electronic
Take up system	Electronic
Warp stop motion	Electric
Initial Warp tension	(3) Kn
crossing angle (Shedding close time)	From (40 - 320)^o
Shed angle.	(24 ^{o})

Table 3.
The specification of fabric parameter.

Fabric Parameter.	
Weave structure	(1/1)-Twill(1/3)-Stain(1/4)
Warp count	30 Ne carded.
Warp density/Inch	60
Warping beam width /cm	167
Warp width in reed /cm	171,45
Drawing -In reed	2
Warp Yarns Total	3770
Pick / Inch.	47
Reed count / Cm.	13,7
Weft count/ spun method.	(40 Ne) Carded
	(40 Ne) Combed
	(40 Ne)Open end
Selvdages.	16 yarns each side
	Palin (2/2) weave structure.

2.1. Sample preparation, Testing Procedure and Data Acquisition

On the rapier weaving machine (and in the warp direction, tension is applied by the warp beam on one side and the cloth roll and loom temples on the other. In the filling direction, tension is applied by the loom temples and it is this tension, which prevents the filling yarn from crimping. After the fabric leaves the loom temple, it is free to contract and form filling crimp, the woven

fabric has no finishing process after weaving unless washing by fabric's through with helpful of simple cylinder machine with cistern at heat - 80 ° C, then fabric is drying and ironing at 125°c Evaporation water point by using *Ramallumin* drying tower cylinders.

The current study was carried out to robust investigation of tear behavior of woven fabrics in off axes angles of the specimen. In this regard, with taking into consideration that fabric is not an isotropic material, its behavior is affected by fabric direction., Therefore, the variation of fabric tear behavior, tear force, considering the direction of the specimen's has been traced.

As it is clear in Fig.4., the weft yarns were taken as the leading direction (0^0) for cutting speciesism's in different angle wanted, in relation to the warp location.

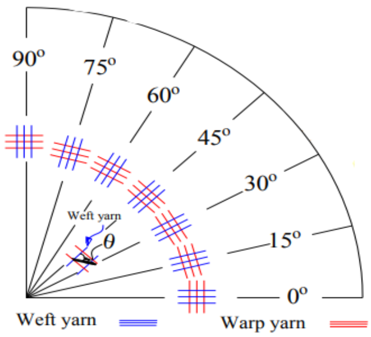

Fig.4. Tear Specimens cutting Trajectory

All tests were carried out in the weft direction after conditioning specimens in a standard atmosphere (temperature 20 ± 2 °C, 65 ± 2% relative humidity).

Tear behavior of fabrics was carried out on accordance with ASTM D2261 by the tongue (Single Rip) producer (Constant Rate of extension Titan 10 instrument) in various axis of 0^0 (weft), 30^0, 45^0, 60^0 and 90^0 (warp).

Fabric samples were cut according to the standard method. After placing the sample in the jaws of the universal tensile strength tester, the jaws were moved at a constant rate of extension (150 mm), The values for fabric tear force was obtained using the mean of five samples for each axis and their average values were taken.

Table .4. Woven fabrics' specifications & Tongue Tear Tests result for woven specimens at off -axis angles.

Sample code	Spinning method	Weave	Weight (g/m^2)	Thickness (mm)	Tear Cutting angle	Average
P1	Ring Combed	Plain 1/1	93.9	0.42	15°	31.5
P2					30°	27.30
P3					45°	28.85
P4					60°	27.06
P5					75°	22.18
P6					Warp	22.02
P7					Weft	30.31
T1		Twill 1/3	94.3	0.48	15°	60.91
T2					30°	49.67
T3					45°	49.26
T4					60°	44.00
T5					75°	31.18
T6					Warp	39.52
T7					Weft	60.57
S1		Stain 1/4	92.1	0.45	15°	43.95
S2					30°	39.05
S3					45°	37.00
S4					60°	39.34
S5					75°	34.71
S6					Warp	39.30
S7					Weft	29.66
P8	Ring Carded	Plain 1/1	97.9	0.41	15°	34.43
P9					30°	32.98
P10					45°	29.75
P11					60°	27.74
P12					75°	25.83
P13					Warp	24.00
P14					Weft	28.7
T8		Twill 1/3	94.1	0.47	15°	53.33
T9					30°	40.85
T10					45°	44.86
T11					60°	43.27
T12					75°	34.82
T13					Warp	44.79
T14					Weft	52.15
S8		Stain 1/4	95.3	0.46	15°	50.50
S9					30°	41.27
S10					45°	39.64
S11					60°	37.87
S12					75°	33.38
S13					Warp	43.80
S14					Weft	54.13
P15	Open end	Plain 1/1	92.39	0.39	15°	13.94
P16					30°	13.6
P17					45°	10.86
P18					60°	11.23
P19					75°	9.98
P20					Warp	**8.13**
P21					Weft	18.8
T15		Twill 1/3	96.5	0.55	15°	20.74
T16					30°	17.00
T17					45°	16.72
T18					60°	15.76
T19					75°	15.70
T20					Warp	15.52
T21					Weft	29.76
S15		Stain 1/4	95.5	0.52	15°	16.86
S16					30°	23.79
S17					45°	13.58
S18					60°	17.45
S19					75°	15.76
S20					Warp	19.06
S21					Weft	20.07

3. Results and Discussion.

For presenting a single, exact, and complete analysis that could accurately depict the static tearing behavior of the woven specimens presented in this research , which the values of tearing force for different weft yarn types weave structures and specimens cutting angles show a special trend, so that the analyses of the concluded data statistically; SPSS software ,One-way and Three-way ANOVA were used to determine Mean & Standard Deviation ,also the least significant difference (LSD) to determine the relations between specimens groups (P_1-P_{21}) , (S_1-S_{21}) and (T_1-T_{21}) .

For the set of fabrics, which were used in this study, the value of TC (Tearing force) varies in the range of 8.13 N for the fabric with the lowest tearing resistance to 54.13N for the most resistant fabric during tearing as indicate in Table 4.The results revealed that at the confidence range of 98%, the effect of weft yarn type and weave structure is significant on the tearing energy of the cotton woven fabrics also cutting angle had high significant effect for tear mechanism.

It is also important to state that while observing the test during running a phenomenon known as "*pseudo jaws*" occurs as the crowding of the longitudinal threads forms a large number of frictional points of contact in the "del" zone. Along with this, jamming takes place in the untorn fabric ahead of the Del and slippage becomes difficult without incurring high local forces. When these forces develop, the transverse threads fail sequentially from the open edge of the "del" zone, it obsverd specially at when using (75^o) speciems tearing cutting angle when using open end weft yarn ., which occurrence of slippage of one set of threads over the other. The tearing force variation at different parameter during the test has a ficklely trend as indicate in following section and tables.

3.1.1. The effect of spinning methods on specimens' tear strength using different weave structures.

Table 5.A, D and G: Indicate the statistically significant differences of -effect- of different spinning technology on specimens tear strength while using different weave structures (plain (1/1/), Twill (1/3) and Stain (1/4), respectively. The analysis date indicate there are clear statistically significant differences in the values accordion laboratory tests which used at Significant value equal (0.0001) in all spinning technology.

Table 5.B, E and H: Indicate the Means, Standard deviations, and LSD results of spinning method impact on tear strength while using the three-weave structure mentioned above, respectively.

Table 5.C, F and K: Indicate the results of multiple comparisons (LSD) of spinning method impact on tear strength while using deferent weave structures plain (1/1/), Twill (1/3) and Stain (1/4), respectively. The outcomes are presented in fig. 5.

Table.5. Statistical analysis data for effect of different spinning technology while using different weave structures.

Table 5.A,B and C Indicate the effect of plain 1/1 weave structure on tear strength weaving by different spinning technology

Table 5.A.

Source	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	3508.70	2	1754.35	132.81	0.001***
Within Groups	792.57	60	13.21		
Total	4301.27	62			

Table 5.B.

Spinning method	N	Mean	SD
Ring Combed	21	27.01	3.85
Ring Carded	21	29.08	3.66
Open end	21	12.32	3.39

Table 5.C.

Spinning method	Ring Combed	Ring Carded	Open end
	M=27.01	M=29.08	M=12.32
Ring Combed	-	2.06	-14.70*
Ring Carded	-	-	-16.76*
Open end	-	-	-

* Significant at 0.05.

Table 5.D, E and F Indicate the effect of Twill 1/3weave structure on tear strength weaving by different spinning technology.

Table 5.D.

Source	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	10715.76	2	5357.88	87.76	0.001***
Within Groups	3663.19	60	61.05		
Total	14378.96	62			

Table 5. E.

Spinning method	N	Mean	SD
Ring Combed	21	47.46	10.31
Ring Carded	21	44.87	6.79
Open end	21	18.59	5.54

Table 5. F.

Spinning method	Ring Combed	Ring Carded	Open end
	M=47.46	M=44.87	M=18.59
Ring Combed	-	-2.59	-28.87*
Ring Carded	-	-	-26.28*
Open end	-	-	-

* Significant at 0.05.

Table 5.G, H and K Indicate the effect of satin ¼ weave structure on tear strength weaving by different spinning technology .

Table 5.G.

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7176.63	2	3588.31	114.90	0.001***
Within Groups	1873.86	60	31.23		
Total	9050.48	62			

Table 5. H.

Spinning method	N	Mean	SD
Ring Combed	21	37.57	4.94
Ring Carded	21	42.91	7.35
Open end	21	18.08	3.90

Table K.

Spinning method	N	Mean	SD
Ring Combed	21	37.57	4.94
Ring Carded	21	42.91	7.35
Open end	21	18.08	3.90

* Significant at 0.05.

According to Fig.5. Which displays the variation of the tearing strength with the different spinning technology for the three types of weave structures . The observed increase in tearing strength with the ring combed yarn which high value when using plain (1/1) can be attributed to an two points, not only the first one is the construction of plain weave with small spacing between yarns but also the second reason due to the agglutination method in comb spinning method ., so the woven sample in this case tolerate the load more and require more tearing force before the rupture.

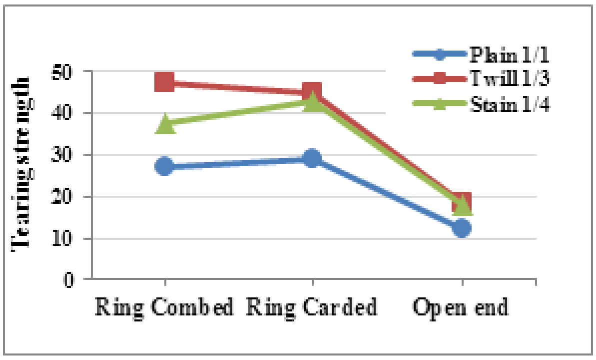

Fig.5.displays the variation of the tearing strength with the different spinning technology for the three types of weave structures

3.1.3. The effect of weave structures& spinning methods on specimens' tear strength.

Table.6. Statistical analysis data for effect of weave structures& spinning methods on specimens' tear strength.

Table. 6.A,B and C Indicate the effect of spinning technology on specimens' tear strength.

Table. 6. A.

Source	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	20082.75	2	10041.38	130.23	0.001***
Within Groups	14341.74	186	77.11		
Total	34424.50	188			

*** Significant at 0.001

Table. 6. B.

Spinning method	N	Mean	SD
Ring Combed	63	37.35	10.85
Ring Carded	63	38.95	9.32
Open end	63	16.33	5.17

Table. 6. C.

Spinning method	Ring Combed M=37.35	Ring Carded M=38.95	Open end M=16.33
Ring Combed	-	1.61	-21.02*
Ring Carded	-	-	-22.63*
Open end	-	-	-

* Significant at 0.05

Table 6.D, E and F Indicate the effect of weave structures on specimens' tear strength.

Table 6.D.

Source	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	6693.79	2	3346.89	22.45	0.001***
Within Groups	27730.71	186	149.09		
Total	34424.50	188			

*** Significant at 0.001

Table 6.E.

Weave	N	Mean	SD
Plain 1/1	63	22.80	8.33
Twill 1/3	63	36.97	15.23
Stain 1/4	63	32.85	12.08

Table 6.F.

Weave	Plain 1/1 M=22.80	Twill 1/3 M=36.97	Stain 1/4 M=32.85
Plain 1/1	-	14.17*	10.05*
Twill 1/3	-	-	-4.12
Stain 1/4	-	-	-

* Significant at 0.05

Table 6.A, B and C: Indicate the statistically significant differences, Means, Standard deviations, and LSD results of effect- *spinning technology* on specimens' tear strength. The analysis date indicate there are clear statistically significant differences in the values accordion laboratory tests, which used at (0.0001) in all spinning, technology without taking into consideration the type weave structures, which used.

Table 6. D, E and F.: Indicate the statistically significant differences, Means, Standard deviations, and LSD results of effect- *weave structures* on specimens' tear strength. The analysis date indicate there are clear

statistically significant differences in the values accordion laboratory tests, which used at (0.0001) in all spinning, technology without taking into consideration the type spinning technology, which used.

AS it is clear in Fig.7 and Fig.8 for all woven specimens that were investigated in this study, not only the open end spinning technology had lowest value on tearing strength resistance , but also twill (1/3) high the high rang value for tear resistance for all values of woven specimens' .

The estimated tearing resistance for open end spinning had the lowest value of tearing energy and as it turns out that there is not much difference in the value of tear resistance between combed method and carded method , thanks to the utilization of the long fibers for open end spinning technology , the fibers which had has an extremely flat structure, softer with cooperation in the yarn structure increases which leads to the improvement of the yarn's evenness then yarns inside woven fabrics can participate to the higher effective length in the yarn structure and more tearing load is required.

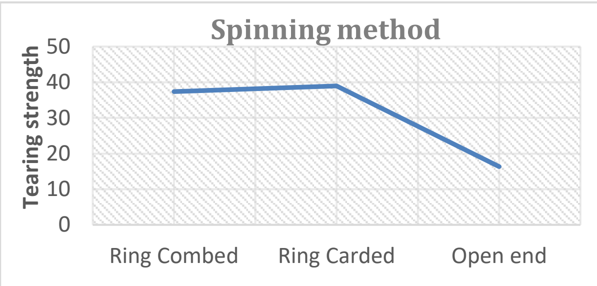

Fig.7. Effect of spinning method on tear resistance.

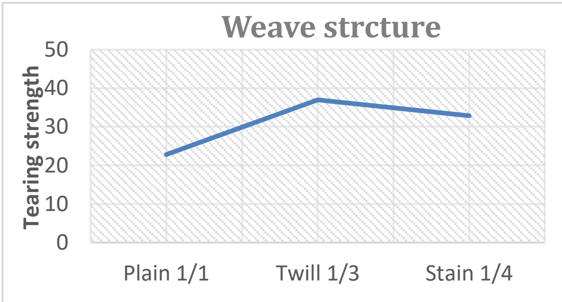

Fig.8. Effect of weave structures on tear resistance.

As shown in Fig. 8, which indicate that plain (1/1), high the lowest rang value for tear resistance for all values of woven specimens'. It was determined that the fabric structure's firmness plays a role in explaining this trend. The firmness or (average float) of structure can be defined by calculation by the following equation (7).

$$(AF)=\frac{\text{number of crossing over lines in the complete repeat.}}{\text{number of interlacing points in the complete repeat.}} \quad (7).$$

By employing this equation, the value for plain (1/1), twill 1/3and stain (1/4), were (one, 0.83 and 0.83) respectively. By increasing the value of AF, the firmness of the fabric increases, thus the ability of yarns to move and change their position in the fabric structure diminishes.

During the exertion of tearing force, the yarns in twill (1/3) fabric structure can easily move and gather with the yarns due to the mechanism of interlacing between yarn had more distance comparing stain (1/4) ,So that the yarn had an ability to vicinity; and therefore, make new groups consisting of more than one yarn. In this case, the applied tearing force should overcome the breaking strength of the group of yarns, so the value of tearing resistance decrease

3.1.2. The effect of Specimens cutting angle on tear strength using different weave structure and spinning methods.

Table .7.A, B and C. Statistical analysis data for effect of Specimens cutting angle on tear strength while using different both spinning methods and weave structures.

Table. 7. A.

Source	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	2623.15	6	437.19	2.50	0.024*
Within Groups	31820.74	182	174.84		
Total	34443.89	188			

Table. 7. B.

Cutting angle	N	Mean	SD
15	27	36.27	16.45
30	27	31.72	12.02
45	27	30.02	13.42
60	27	28.97	12.31
75	27	25.02	9.28
Warp	27	28.47	13.16
Weft	27	35.66	14.75

Table. 7. C.

Cutting angle	15^{O} M=36.27	30^{O} M=31.72	45^{O} M=30.02	60^{O} M=28.97	75^{O} M=25.02	Warp M=28.47	Weft M=35.66
15	-	-4.55	6.25	7.30*	11.25*	7.80*	0.61
30	-	-	1.70	2.75	6.70	3.25	-3.94
45	-	-	-	1.05	5.00	1.55	-5.64
60	-	-	-	-	3.95	0.50	-6.69
75	-	-	-	-	-	-3.45	-10.64*
Warp	-	-	-	-	-	-	-7.19*
Weft	-	-	-	-	-	-	-

* Significant at 0.05.

It is evident from Table .7.A, B and C. that there are significant differences in the tear strength property according to Specimens cutting angle, where the value of "F" was (2.50) and the level of significance (0.05).

Fig.5. indicate the outcome variations, it was observed that the tip of the incision when occur in cross direction of the fabric at angles (15^{o}, 30^{o}, weft (0^{o})) give high value of tear resistance. Concerning the tearing force direction or tip of the incision and the highest breaking force was recorded at angles (15^{o}, 30^{o}, weft (0^{o})).

Fig.5. indicate the variation of the tearing strength according to the angle of specimens cutting

By decreasing the angle and deviating from the warp direction, the tearing force increased and the lowest force was recorded for the 15^0 angle and after a point an increase in the value of tearing force was seen in the angle 75^0.Due to non-stacked straight for filling yarn inside woven fabrics .,in other side the angles which at longitudinal direction of fabric as(60,70 , 90 (warp))give low level of tear resistance ;this is due to the spacing and strength of the threads being torn and the force required to make them slip over the crossing threads with attention for a hole or slit angle that is a result of specimens cutting trajectory as a result of an accident may be happened while wearing fabrics in daily use which such this stresses of normal use are quite capable of causing an extension of such damage.

3.1.2. The effect of different parameters on tear strength of tear woven specimens.

Table .8. Statistical analysis data for mutual effecting of study parameters.

Source	Sum of Squares	DF	Mean Square	F	Sig.
Model	213577.92	63	3390.13	415.65	0.001***
Spinning method	20082.75	2	10041.38	1231.15	0.001***
Weave Structure.	6693.79	2	3346.89	410.35	0.001***
Cutting angle	2621.25	6	436.88	53.56	0.001***
Spinning method & Weave Structure.	1318.34	4	329.58	40.41	0.001***
Spinning method & Cutting angle	671.04	12	55.92	6.86	0.001***
Weave & Cutting angle	906.12	12	75.51	9.26	0.001***
Spinning method & Weave &Cutting angle.	1103.53	24	45.98	5.64	0.001***
Error	1027.67	126	8.16		
Total	214605.59	189			

*** Significant at 0.001

Table .8. Indicate the mutual effecting of (Spinning technology – Weave structures-Specimens Cutting angle) on tear strength of woven samples produced in current study. It was observed that there are clear statistically significant differences in the values at (0.001).

Conclusions:

- In this work, a new tearing criterion based on the off-axis tearing force has been used to study the effect of different spinning for cotton yarn on the tearing resistance of plain weave, twill, and stain fabrics. From tables 5, 6, 7 and 8. The reach results can be shorten in the following points:
- The tear resistance of woven fabric to failure in an off-axis tear test can be measured reliably and reproducibly in a simple transverse load test. To prevent slippage at the grips, caution should be taken when clamping the specimens. The pre-tension in the instrument also has an effect on measurement values.
- Cotton woven fabric tear force depends on test variables. Proper evaluation of the tear resistance for woven fabric at off-axis requires a well-defined of cutting specimens regards to warp or weft direction alignment.
- The inter-yarn forces for warp and weft yarn of each spinning technology used in this research had an effect on the tear trajectory of woven specimens, as well as weave structure, had a large impact on the effect of tear resistance due to the cover factor for each weave.
- One of a large number of hypotheses of modelling of the tear strength or initiation and propagation of fracture of cotton woven
- fabric is; the angle of the tip of the incision when occurring in fabric cross

direction, which will increase in proportion to its area of cross-section, and its elongation will increase in proportion to its length. Moreover, it is essential to propose a single, comprehensive, and precise parameter for quantifying the tearing performance of the cotton fabrics along the total tear path.

So that, in this study, it may be asserted that the role of tearing strength is directly involved in the assessment of serviceability and performance of daily cotton woven fabrics. These results pave the way towards developing a model for the tearing energy of woven textile structures.

Further research trends:

With in -depth understanding variables including the design experimental of fabric testing principles with complete analysis of stress distribution as (tear trajectory) for woven fabrics would have to take into account the relations between the different parameters such as yarn spinning methods, weave structures, stress, slippage distortion, and angle of the tip of the incision. It would be necessary to know how these characteristics are related to cloth construction and finish. It should be possible to get higher, better-balanced tearing strengths in cotton fabrics for daily use, for which these conclusions hold. In fact, only such information, gathered with similar information over a much wider field, will give any reality to the term "*Tearing cloth engineering*." Which will have a consequential in real markets.

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حول آليات مسار التمزق للأقمشة القطنية بزوايا غير محورية.

ملخص البحث :

كثيرًا ما تُستخدم الخصائص الميكانيكية لتحديد الوظائف المرادة من الأقمشة المنسوجه ،حيث تعتبر قوة التمزق أحد أهم معايير تقييم العمر الإستهلاكى للأقمشة خاصة أثناء الإستخدام اليومى .و يصف الباحث في هذا العمل بالتفصيل قوة التمزق ومسار الشق التى تتعرض له الأقمشة القطنية المنتجة بثلاثة اساليب غزل القطن المختلفة من (المسرح- الممشط – الطرف المفتوح). حيث أن طرق القياس المعملية وعلاقات الارتباط بين النتائج التي تم الحصول عليها من زوايا القطع المختلفة لمعظم الأقمشة القطنية الشائعة في الأسواق المصرية إستخدم فيها طريقة تمزق اللسان، بالإضافة إلى ذلك ، تم قياس قوة التمزق فى الزاويا المختلفة من القطع للعينات محل الدراسة مع الأخذ فى الاعتبار التراكيب النسجية المستخدمة من (السادة – المبرد – الأطلس)، وتم حساب معاملات الارتباط بين الخصائص المختلفة لكل عينة ومقدار مقاومتها لقوة التمزق ، حيث أظهرت النتائج ان هناك علاقة معنوية ذات الصلة بخصائص الاقمشة محل الدراسة تباعا للمنهجية المستخدمة من حيث نوع الغزل المستخدم والتركيب النسجى وكذلك مقدار زاوية الشق لتمزق العينة وذلك بدلالة إحصائية (٠,٠٠٠١) لكافة المتغيرات محل الدراسة .

الكلمات الدالة:

مسار التمزق، طرق الغزل، الزوايا الغير محورية .