Mansoura Engineering Journal

Volume 34 | Issue 2 Article 11

11-28-2020

Determining Count of Yarn without Measuring its Length.

Hamdy Ahmed Ebraheem
Textile Engineering Department, Faculty of Engineering, Mansoura University., Mansoura., Egypt

Recommended Citation
Ebraheem, Hamdy Ahmed (2020) "Determining Count of Yarn without Measuring its Length.," *Mansoura Engineering Journal*: Vol. 34 : Iss. 2 , Article 11.
Available at: https://doi.org/10.21608/bfemu.2020.125911

DETERMINING COUNT OF YARN WITHOUT MEASURING ITS LENGTH

تحديد نمرة الخيط دون قياس طوله

Hamdy A. A. Ebraheem
Textile Engineering Department, Faculty of Engineering, Mansoura University,

خلاصة:

يقدم هذا العمل البحثي طريقة جديدة لقياس نمرة الخيط. وتعتمد هذه الطريقة علي قياسات الوزن، حيث يتم تجنب قياس الطول بسبب المشاكل المتعلقة به. وتبني هذه الطريقة الجديدة علي استبدال قياس طول الخيط بقياس وزنه، ثم حساب نمرة الخيط من خلال علاقات رياضية بحتة، حيث يتم التعبير عن نمرة الخيط كدالة في وزنه وقطر أسطوانة. ويمر الخيط بعملية تشكيل باستخدام أسطوانات ذات قطر معلوم للحصول علي شكل يمكن تقييمه رياضياً ، ثم يوزن جزء الخيط المشكل. و تكرر عمليتا التشكيل والوزن لجزء آخر من نفس الخيط ولكن مع أسطوانات ذات قطر آخر. ويستخدم البحث صيغة تم اشتقاقها وإثباتها لتحديد نمرة الخيط، كما يقدم طريقة التشكيل وكيفية توليد عدد كبير من القراءات من عدد محدود من القياسات.

ABSTRACT:

A new method for measuring yarn count is presented in this research work. This method depends on weight measurements. Yarn length measurement is avoided because of problems associated with it. The new test method is built on replacing yarn length measuring by weight measuring and then through pure mathematical relations yarn count can be calculated. Yarn count is expressed as a function of yarn weight and diameter of a cylinder. Before yarn is tested, it goes through a forming process using cylinders of a known diameter to get a new shape which can be mathematically assessed. Formed yarn is weighed. This procedure (forming and weighing) is repeated for another part of the same yarn after being formed using cylinders of another diameter. A proven formula is used to determine yarn count. The way of yarn forming and a way of generating a large number of readings from a small number of procedures are described.

1- Introduction:

Measuring yarn count was an early trial to assess or to give an idea about yarn thickness. It was expressed in different units to suit for different yarn sizes and different material types. It became one of the most important specifications of yarns and also fabrics made from them. It is used in determining machine adjustments. It is also used in estimating fabric properties such as fabric cover ratio and fabric weight. As yarn linear density (the reciprocal of yarn count) is proportional to yarn cross-sectional area, it is used in expressing yarn tensile stress (e.g. g/tex). There was no other solution as yarn volumetric density is difficult to be determined.

Many instruments were developed to measure yarn count. They all depended on measuring both yarn length and yarn weight. Some devices are calibrated and scaled in different count systems to give yarn count directly by weighing a specified length of yarn. Yarn length can not be measured without tension. Tension is accompanied by extension. So the measured yarn count was not accurate.

Requirements for the determination of the yarn number are an accurate value of the sample length, and an accurate value of its weight. It is usual to wind a number of skeins by means of a wrap reel. The reel girth and the skein length are chosen to suit the section of the trade concerned, 1 m reel girth for metric and tex systems, 36 in. for worsted, etc. Problems arise because of inaccurate or wrong reels.

Accepted June 8, 2009.

The tension at which the skein is wrapped will affect the result- high tension gives low weight and fine count. A skein gauge can be used to check that the reeling tension is correct. Balances used in the determination of count must be accurate, well maintained, levelled before use, and checked. Weights must be to an accuracy of not less than 1 in 500. When yarn is wound onto a package a certain amount of tension is put on the yarn and, therefore, the yarn is in a state of strain. When the yarn is pulled freely off the package, some of this strain is recovered, i. e. the yarn relaxes and contracts. To counteract this source of error such yarns should first be wound into hank form, allowed to relax in the testing atmosphere for not less than 3 hr, and wrapped for count on the reel. The determination of the yarn count in the fabric is usually made on a comparatively short sample length. Yarn removed from fabric is crimped due to the interlacing of the threads, and it is necessary to estimate the straightened length of the threads. It must be accounted for the presence of moisture in the sample. A quadrant balance is used for indicating the counts of yarns and rovings. Direct reading count balances indicate the weight by digital read-out methods. Special balances such as Beesley balance were designed to furnish a quick estimate of the count, especially when only small samples are at hand. A number of simple formulae are available to estimate yarn diameter in terms of its count [1].

Yarn count must be measured not once but whenever conditions change with respect to moisture and length. Length can not be measured at zero tension and tension must, therefore, be more or less arbitrarily standardized. To measure yarn length wrapping tension was suggested not to exceed 0.1 $g/denier$. Reeling has its own problems as the length of yarn reeled doesn't depend only on reel speed and adjustments, but also on friction of yarn to reel parts. The problem becomes more difficult when it is dealt with yarns of different fibres and structures [2].

The effect of yarn count on fabric hand was studied. It was found that fabric hand is influenced by yarn count with other yarn specifications such as twist, CV%, hairiness, stiffness, and softness. These yarn quality parameters were used to predict softness of knitted T-shirts [3]. Statistical analysis of experimental data revealed the effect of yarn type, yarn linear density and tightness factor of fabric on the linear and area shrinkage behaviour of silk and cotton knitted fabrics [4]. Effect of yarn count on its tenacity was studied [5]. A family of five ring spun yarn sizes, each with five twist factors was tested by different tensile strength testers. Results were different from tester to tester and with the change in the time-to-break. Devices based on compression are of doubtful use in measuring thickness of a yarn because of the interaction of count and twist in determining yarn compressibility [6]. Peirce [7] used yarn count to calculate its diameter assuming its specific volume as 1.1 cm^3/g.

2- Theory of Test Method:

If a sheet of yarn ends (their number is N_1) is lapped at 180° around planer cylinders (their number is N_2) in an alternative manner such that cylinders jam, then length of yarn sheet lapped around cylinders will be

$$L_s = \frac{\pi}{2} N_2 (d + D) \qquad (1)$$

L_s : length of yarn sheet (mm)

d : yarn diameter (mm)

D : cylinder diameter (mm)

and length (mm) of yarn lapped around cylinders will be

$$L_y = \frac{\pi}{2} N_1 N_2 (d + D) \quad (2)$$

Weight of yarn lapped around cylinders can be expressed as follows

$$W = \frac{\pi N_1 N_2 (d + D)}{2000 N_m} \quad (3)$$

W : weight of yarn lapped around cylinders (g)

N_m : yarn count (m/g)

If cylinders of another diameter (D') are used (without changing number of cylinders) and another sheet of the same yarn is lapped (without changing number of ends) then weight of lapped yarn will change and become W' such that

$$W' = \frac{\pi N_1 N_2 (d + D')}{2000 N_m} \quad (4)$$

From (3)

$$\frac{2000 N_m}{\pi N_1 N_2} = \frac{d + D}{W} \quad (5)$$

From (4)

$$\frac{2000 N_m}{\pi N_1 N_2} = \frac{d + D'}{W'} \quad (6)$$

From (5) and (6)

$$\therefore \frac{2000 N_m}{\pi N_1 N_2} = \frac{d + D}{W} = \frac{d + D'}{W'} \quad (7)$$

Getting use of proportionality properties

$$\therefore \frac{2000 N_m}{\pi N_1 N_2} = \frac{D - D'}{W - W'} \quad (8)$$

$$\therefore N_m = \frac{\pi N_1 N_2}{2000} \left(\frac{D - D'}{W - W'} \right) \quad (9)$$

Looking at equation (9) it is shown that any error in the balance itself ,i.e. any offset in balance reading, will not affect our result as we take the difference between weights. It is preferred that the two diameters are highly different to obtain a considerable weight difference and to increase the accuracy of measuring and calculating.

3- Testing Procedure:

The following procedure is followed:

3.1- Preparing Yarn Sheet:

Yarn is withdrawn from its package and wound onto a reel. Yarn is distributed across the reel using a screw of a suitable pitch. Yarn sheet on the reel is then clamped in two positions separated by a distance equal to the length of yarn sheet required on the forming frame. Fig. (1) shows a sketch of the forming device. Number of ends in yarn sheet (N_1) is counted and registered. Fig. (2) shows a sketch of one pair of clamps.

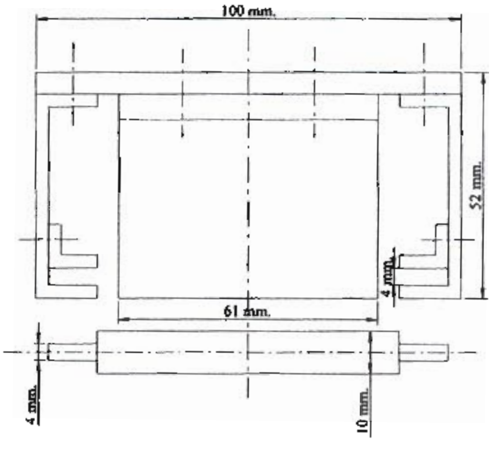


Fig. (1): A sketch of the device (a plan view) indicating the two vertical 4-mm slots, the 61-mm wide base plate, and one 10-mm diameter cylinder drawn separately

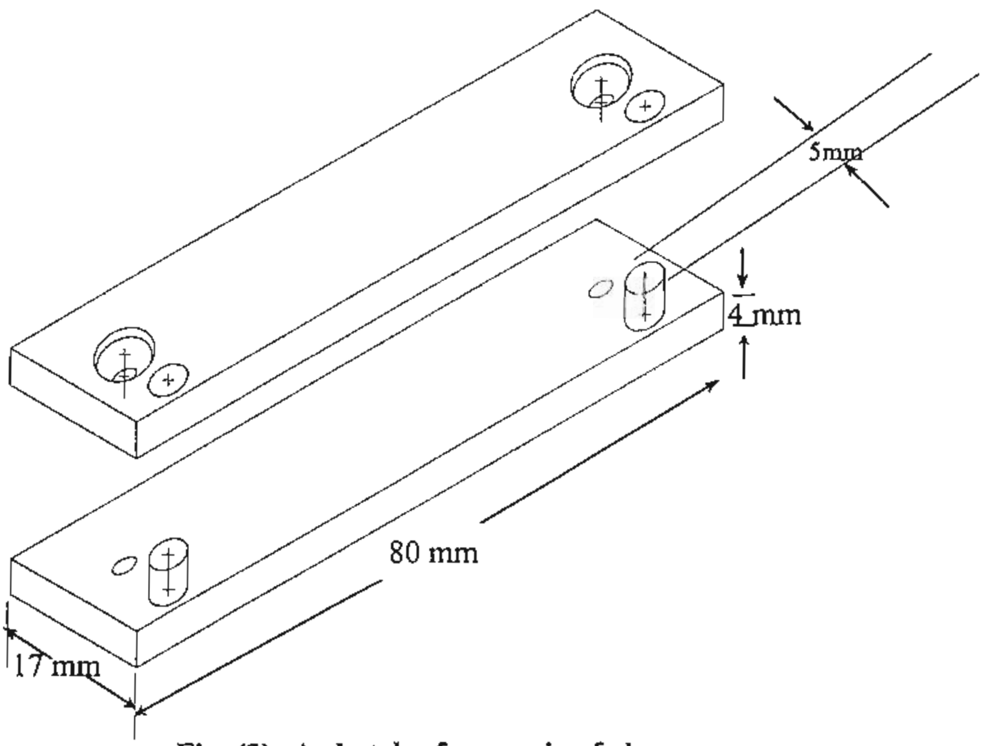
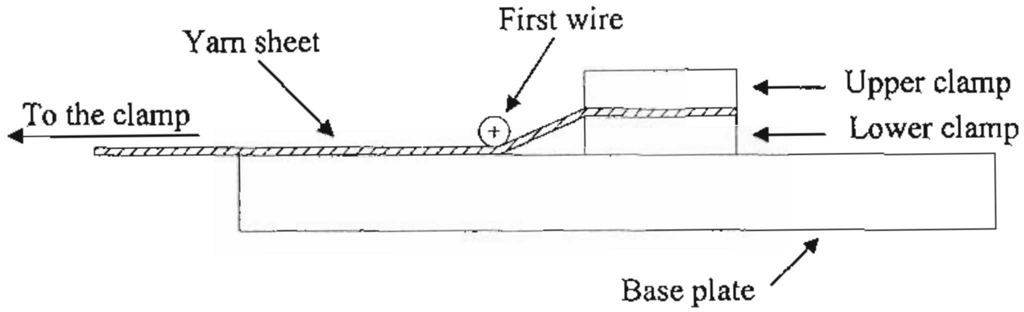


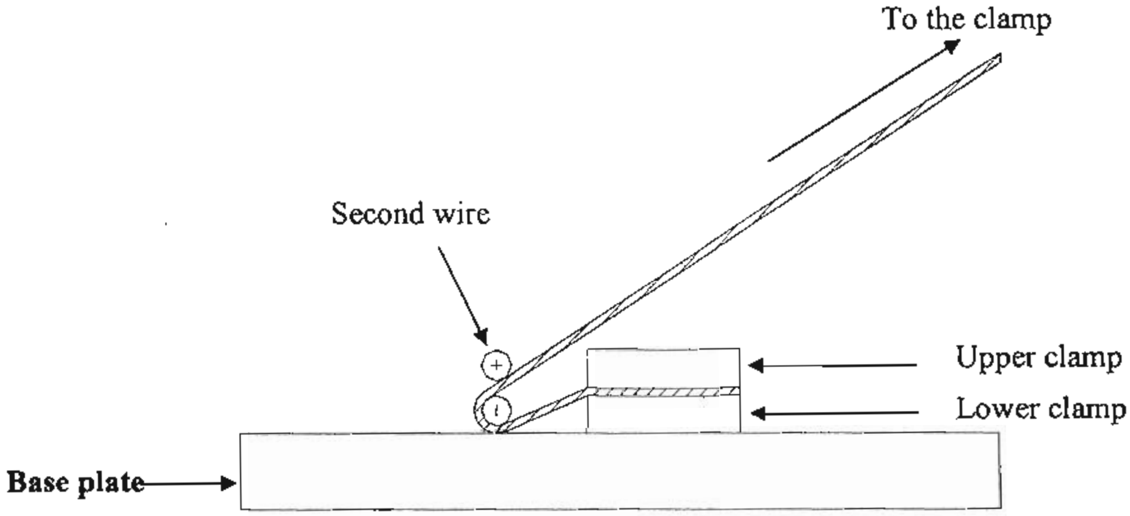
Fig. (2): A sketch of one pair of clamps.

3.2- Forming Yarn Sheet:

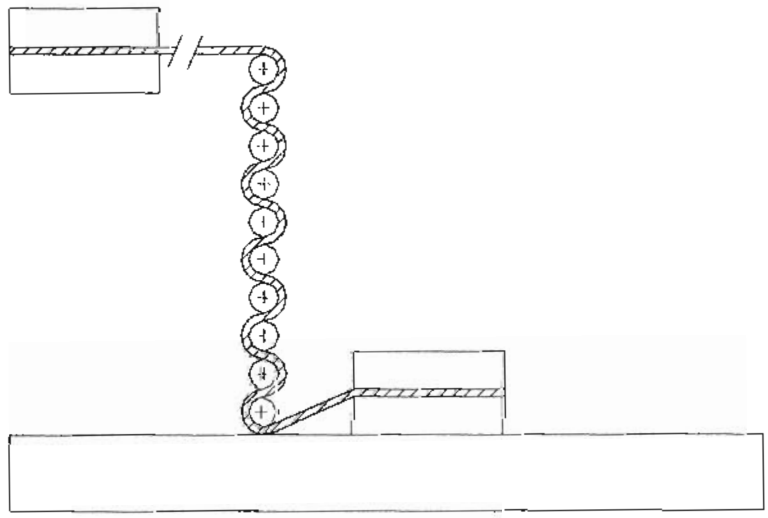
Yarn sheet is lapped manually and gently around wires or cylinders of a diameter D (mm) in an alternative manner such that lapping angle around each cylinder is $180°$ (this occurs at cylinder jamming state). Number of cylinders (N_2) is registered. Figure (3) shows how lapping or forming process is carried out.



3-a: Inserting first wire on yarn sheet



3-b: Inserting second wire on yarn sheet



3-c: Shape of yarn sheet after inserting a number of wires or cylinders

Fig. (3): How Lapping Process is Carried Out.

3.3- Separating Formed Yarn Sheet:

Yarn sheet is cut, using a sharp cutter, in two locations: just before the first cylinder and just after the last one such that complete lapping arcs are contained. Formed yarn sheet is then removed from the frame.

3.4- Weighing:

Removed yarn sheet is weighed to obtain the value W (g).

3.5- Repeating Previous Steps:

Another sheet of the same yarn and with the same number of ends is lapped around the same previous number of cylinders but of a new diameter (D'). Formed sheet is separated and weighed to obtain the value W' (g).

Yarn count N_m (m/g) is determined by substituting for the test data in equation (9).

4- Number of Readings:

If test procedure is carried out m times with m different cylinder diameters, then m different weight values of yarn are obtained. Making computations of 2 between these m results a number of yarn count readings n is obtained. The relation between number of count readings and number of samples is as follows:

$$n={}^{m}C_2=\frac{m(m-1)}{2}$$

(10)

m: number of yarn sheets lapped or number of cylinder sets used.

n: number of yarn count readings.

It is clear from equation (10) that beginning from 4 cylinder sets, number of count readings will be more than number of test specimens. This is indicated in Table (1)

5- Statistical Data of Yarn Count:

Yarn count readings are statistically analysed to get means such as arithmetic mean and measures of dispersion such as coefficient of variation.

6- Experimental Work:

A yarn was tested by the previously mentioned method. Results of this test and the corresponding readings of yarn count determined by substituting in equation (9) are indicated in table (2).

7- Statistical Resuls:

According to yarn count readings shown in Table (2), mean yarn count = 84.8573 and coefficient of variation = 1.3996 %.

It is worth mentioning that nominal count written on yarn package is 50 s which is equivalent to a metric count of about 84.5.

8- Conclusion:

Yarn count can be determined without measuring yarn length. Avoiding yarn length measurements helps improve the accuracy of count measurement. The presented method generates a great number of count readings from a small number of tests. The amount of yarn needed to carry out the test is relatively less than that used in ordinary test methods.

Table (1): Number of Yarn Count Readings Obtained from Lapping and Weighing Procedures:

M	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
N	0	1	3	6	10	15	21	28	36	45	55	66	78	91	105
M	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
N	120	136	153	171	190	210	231	253	276	300	325	351	378	406	435

Table (2): Some Values of Yarn Count Readings Obtained by Substituting in Equation (9) :
[Number of Yarn Ends = 25 and Number of Cylinders = 29]

First Cylinder Diameter (mm)	First Yarn Weight * (mg)	Second Cylinder Diameter (mm)	Second Yarn Weight * (mg)	Estimated Yarn Count (Nm)
10	134.8	4	55.1	85.7335
10	133.8	4	54.8	86.4932
10	135.2	4	55.0	85.1990
10	134.8	4	55.4	86.0574
10	133.8	4	55.0	86.7127
10	133.8	8	107.5	86.6028
10	138.0	12	165.2	83.7373
4	56.3	10	137.5	84.1498
4	55.9	12	164.9	83.5836
10	138.0	12	165.2	83.7373
4	55.9	12	164.4	83.9688
8	110.4	4	56.3	84.2016
12	164.6	4	55.9	83.8143
12	165.4	8	110.9	83.5836
12	164.4	8	110.4	84.3575
8	108.5	4	55.4	85.7874

* at a temperature of 20 ^{o}C and a relative humidity of 72 %.

References:

[1] J. E. Booth, Principles of Textile Testing, Newness-Butterworths, 1968, 209-229.

[2] R. Meredith, and J. W. S. Hearle, Physical Methods of Investing Textiles, Textile Book Publishers, Inc., 1959, 194-194.

[3] Shahram Peykamian and Jon P. Rust, Yarn Quality Indexing Using a Mechanical Stylus, T. R. J., 69 (6), 1999, 394-400.

[4] Leticia Quaynor, Masaru Nakajima, and Masaoki Takahashi, Dimensional Changes in Knitted Silk and Cotton Fabrics with Laundering, T. R. J., 69 (4), 1999, 285-291.

[5] Lloyd B. De Luca and Devron P. Thibodeaux: Comparison of Yarn Tenacity Data Obtained Using the Uster Tensorapid, Dynamat II, and Scott Skein Testers, T. R. J., 62 (3), 1992,175-184.

[6] R. Meredith, and J. W. S. Hearle: Physical Methods of Investing Textiles, Textile Book Publishers, Inc., New York, 1959, 192-195.

[7] Peirce, F. T.: The Geometry of Cloth Structure, J. Textile Inst., 28, 1937, T45- T112.