

THE COMMON CHARACTERISTICS OF COTTON FISHING NET TWINES—EXPERIMENT SERIES II*

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THE essentials to the economic well being of a developing national industry are the availability and the production of the basic raw materials within the concerned country. The Indian fishing industry, as the mainstay to ensure progress in exploitation, depends on fibres of vegetable origin. The majority of these fibres, cotton (*Gossipium* spp.) being the most important among them, are procured from indigenous sources. Notwithstanding the increasing demand from the Textile and other allied industries, a fair percentage of the country's annual production of cotton fibres, twisted in the form of threads, twines and ropes, is consumed by the fishing industry for fabrication of nets and other gear. Regardless of the importance as a net material, it must be admitted that very little information is available on record evaluating the dynamic characteristics of cotton twines. In an earlier communication (Kuriyan and Cecily, 1959) the authors presented an account of the preliminary studies conducted by them for the evaluation of the common characteristics of cotton fishing net twines. The present paper describes the Second Experiment Series in these investigations and embodies the results of analysis of a separate set of Indian machine-twisted twines. While the first set were 'Soft' twisted, the present series comprise of samples with 'Hard' twist.

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MATERIALS AND METHOD

Machine twisted cotton twines of the following specifications and manufactured by a twine twisting factory in Bombay were taken up for the present study:

Count No. 20 (Tex. No. 29.5); 3 strands (ply) 9, 12, 15, 18, 21, 24, 27, 30, 36, 42, 48, 54 and 60 threads (yarns).

* Contribution No. 20.

Mass of twine, diameter, outer and inner twists, breaking strength and stretch both in dry and wet (48 hours-immersion) conditions were recorded. Similar to the earlier experimental series, the effect of the trawl and reef knots on the strength of twines was also observed.

Mass, diameter and breaking strength and stretch of twines were determined on the basis of 100 tests, while the other characteristics were ascertained based on 30 tests. The conventional formulæ for grouped and ungrouped data were employed for calculation of the standard deviation (σ) and they are:

(a) For 100 tests (grouped data):

$$\sigma = Ci \sqrt{\frac{\sum (fd)^2}{N} - \left(\frac{\sum fd}{N}\right)^2},$$

where Ci is the class interval; d the class deviation; f the frequency and N the number of observations.

(b) For 30 tests (un-grouped data):

$$\sigma = \sqrt{\frac{\sum (x)^2}{N}}$$

where $\sum (x)^2$ is the summation of the squares of the deviation of each observation from the mean and N the number of observations.

RESULTS

The results are tabulated in Tables I to V. Mass is expressed in grams per metre length of twine, diameter in millimetres, breaking strength in kilograms and breaking stretch in percentage of the tested length.

DISCUSSION

(i) *Mass and diameter.*—It would be evident from Table I that the twines analysed are fairly uniform in regard to mass per unit length and diameter.

The relationship between mass and the number of threads in the twine and mass and the square of the diameter of the twine are indicated in Figs. 1 and 2. Mass is proportional to the number of threads and also to the square of the diameter of the twine. The formulæ propounded in the earlier communication (Kuriyan and Cecily, *op. cit.*) to depict these

TABLE I

The analysed data about mass and diameter of the twines

No. of threads	Mass in gm.				Diameter in millimetres			
	Upper limit	Lower limit	X	σ	Upper limit	Lower limit	X	σ
9	0.40	0.32	0.36	0.024	0.83	0.63	0.72	0.042
12	0.51	0.44	0.47	0.020	0.97	0.75	0.87	0.040
15	0.68	0.58	0.63	0.020	1.04	0.88	0.95	0.040
18	0.80	0.70	0.76	0.022	1.12	0.97	1.04	0.040
21	0.95	0.82	0.87	0.030	1.20	1.02	1.09	0.050
24	1.04	0.94	0.98	0.021	1.24	1.09	1.15	0.033
27	1.19	1.08	1.22	0.023	1.34	1.18	1.25	0.040
30	1.29	1.22	1.25	0.020	1.34	1.22	1.28	0.031
36	1.46	1.34	1.39	0.027	1.45	1.31	1.39	0.030
42	1.94	1.74	1.86	0.041	1.59	1.44	1.54	0.030
48	2.24	2.01	2.12	0.058	1.78	1.58	1.67	0.050
54	2.41	2.30	2.37	0.027	1.85	1.73	1.78	0.040
60	2.80	2.61	2.67	0.043	1.96	1.83	1.88	0.031

 X = Arithmetic mean; σ = Standard deviation.

TABLE II

The analysed data about outer and inner twists of the twines

No. of threads	Outer twist per inch				Inner twist per inch			
	Upper limit	Lower limit	X	σ	Upper limit	Lower limit	X	σ
9	11.6	10.1	10.84	0.29	42.80	38.30	41.00	0.83
12	11.2	9.1	10.05	0.37	39.60	31.30	34.68	1.18
15	9.6	7.4	8.20	0.55	36.40	29.80	32.51	1.24
18	8.3	7.6	7.92	0.15	31.10	27.70	29.65	0.89
21	8.2	7.4	7.60	0.37	28.00	21.00	25.06	1.56
24	8.4	7.4	7.90	0.30	26.20	22.20	24.40	0.88
27	7.2	6.0	6.50	0.32	25.40	17.60	21.50	2.02
30	7.2	6.0	6.60	0.25	23.40	20.00	22.20	1.10
36	6.0	5.0	5.40	0.24	18.50	15.40	16.80	0.77
42	5.6	5.2	5.50	0.28	15.40	12.80	14.10	0.64
48	6.0	5.2	5.50	0.20	16.90	14.00	15.45	0.97
54	5.6	5.1	5.40	0.13	17.20	13.40	15.26	0.79
60	5.4	4.8	5.00	0.16	17.20	15.20	16.03	0.35

 X = Arithmetic mean; σ = Standard deviation.

TABLE III
The dry and wet breaking strength of twines

No. of threads	Dry breaking strength in kgm.				Wet breaking strength in kgm.			
	Upper limit	Lower limit	X	σ	Upper limit	Lower limit	X	σ
9	4.90	3.20	4.19	0.33	5.5	3.9	4.83	0.36
12	6.00	4.20	5.18	0.36	7.3	4.9	6.34	0.45
15	7.20	4.70	6.13	0.48	8.7	5.7	7.29	0.64
18	10.60	7.20	8.69	0.62	12.7	6.9	9.69	0.98
21	12.00	8.80	10.46	0.60	12.9	9.3	11.56	0.66
24	11.70	10.40	11.20	0.34	13.0	10.2	11.60	0.66
27	14.60	10.40	12.54	0.75	15.3	11.3	13.20	0.50
30	15.30	13.50	14.10	0.47	16.0	13.4	14.90	0.65
36	18.20	14.40	16.62	0.94	19.6	15.0	17.20	0.84
42	20.80	15.30	17.74	1.06	20.8	15.0	18.68	1.18
48	23.00	16.00	20.84	1.36	25.0	20.0	22.78	1.10
54	25.80	20.60	23.70	1.25	26.6	22.6	24.55	1.08
60	30.80	21.20	25.90	2.40	29.4	25.4	27.39	1.19

X = Arithmetic mean; σ = Standard deviation.

TABLE IV
The percentage breaking stretch of dry and wet twines

No. of threads	Dry breaking stretch in %				Wet breaking stretch in %			
	Upper limit	Lower limit	X	σ	Upper limit	Lower limit	X	σ
9	18.89	11.41	14.52	1.45	34.50	22.20	27.16	3.00
12	22.20	13.90	17.22	1.89	37.80	28.60	33.78	2.24
15	28.40	16.60	24.22	2.49	35.00	26.70	30.68	2.01
18	26.70	17.20	21.94	1.89	35.60	24.40	30.03	2.85
21	22.80	15.60	18.84	1.62	35.60	27.00	30.32	2.24
24	30.60	17.20	21.94	3.20	33.80	27.00	29.80	1.62
27	37.20	15.80	25.74	4.81	40.00	30.30	34.50	2.65
30	25.00	19.40	21.80	1.02	34.50	27.80	30.80	1.77
36	25.00	17.50	21.62	1.62	36.20	27.80	32.50	1.82
42	32.80	20.00	26.64	2.86	43.00	33.40	37.24	1.70
48	30.00	23.40	26.70	1.30	42.50	31.70	36.50	2.18
54	27.80	22.20	26.01	1.42	36.60	28.90	32.40	1.78
60	28.80	23.40	26.40	1.85	38.30	30.60	35.22	2.19

X = Arithmetic mean; σ = Standard deviation.

TABLE V
The breaking strength of twines with knot

No. of threads	Breaking strength in kgm. of twines with knot*							
	Trawl knot				Reef knot			
	Dry		Wet		Dry		Wet	
	Top mesh	Side mesh	Top mesh	Side mesh	Top mesh	Side mesh	Top mesh	Side mesh
9	3.30	3.30	3.55	3.68	3.50	2.98	4.10	3.28
12	4.07	4.60	4.80	5.30	4.55	4.00	5.35	4.30
15	4.75	5.35	5.32	6.65	5.49	4.51	5.98	5.08
18	6.75	6.83	7.05	7.55	6.95	6.15	7.35	6.40
21	7.10	7.55	8.05	8.35	7.65	6.70	9.15	6.85
24	7.60	8.44	9.10	10.00	9.88	7.45	9.50	8.52
27	8.92	10.37	10.10	11.33	10.60	9.30	11.30	9.70
30	10.28	10.67	10.70	11.80	10.42	9.35	11.83	10.86
36	11.60	11.78	12.05	13.00	11.75	10.35	13.35	11.75
42	13.05	14.10	15.35	15.53	14.20	12.71	16.20	14.70
48	13.81	14.51	16.26	17.38	15.47	12.95	16.82	15.92
54	14.46	15.93	16.76	17.45	15.59	15.41	20.05	17.38
60	17.32	18.81	18.35	19.10	19.66	18.31	22.60	18.20

* The figures represent the calculated arithmetic mean of 30 tests.

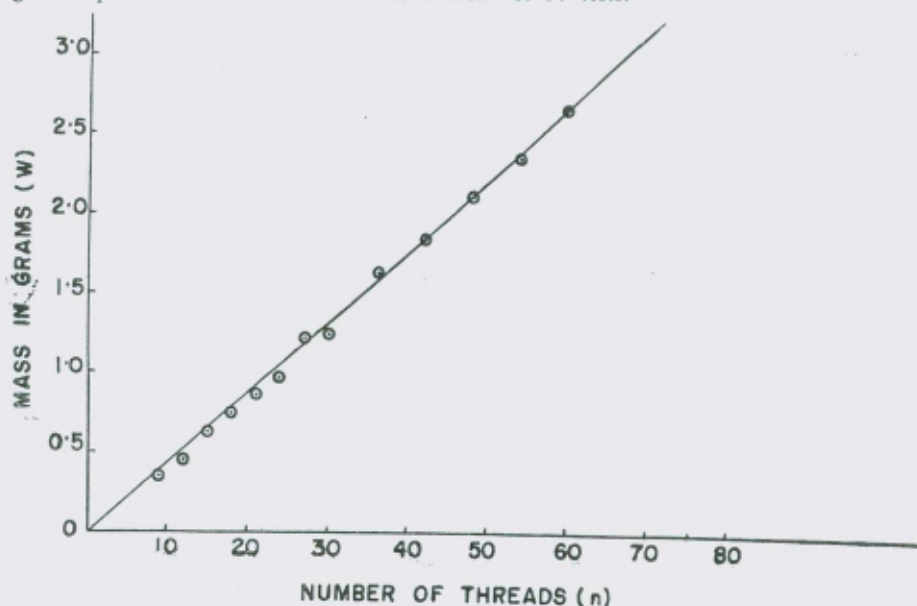


FIG. 1. Showing the relation between mass (W) in grams per metre length of twine and the number of threads (n).

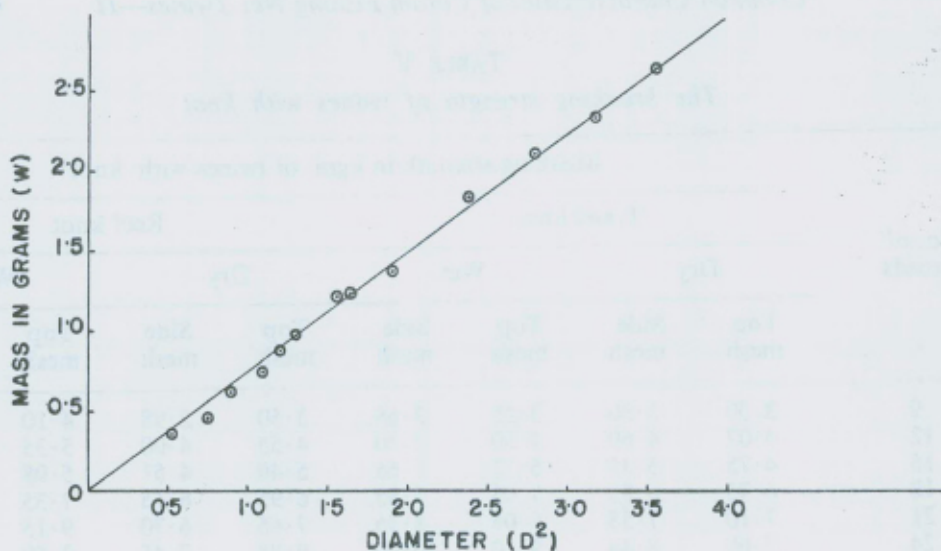


FIG. 2. Showing the relation between mass (W) in grams per metre length and the square of the diameter (D) of the twine.

relationships are:

$$W = Kn$$

and

$$W = KD^2,$$

where W is mass per unit length, n , number of threads, D , diameter and K , the constant in each relationship.

Figures 1 and 2 also support the above indicated relationships. The constants K when worked out by the 'method of least squares' are:

$$K = 0.044 \text{ (in the mass g./m. and number of threads)}$$

and

$$K = 0.75 \text{ (in the mass g./m. and square of the diameter in mm.)}$$

The similar constants for soft twisted twines analysed earlier were 0.036 and 0.55 respectively (Kuriyan and Cecily, *op. cit.*). The differences in the values of K are attributable to the difference in the degree of twist in the two sets of samples.

(ii) *Twists*.—As indicated earlier in this communication, the twines used for the present experimental series were hard twisted. Figure 3 depicts the relationship between inner and outer twists.

The chief difficulty in twisting twines is to give the appropriate outer twist in relation to the inner twist of the strands. Since the outer

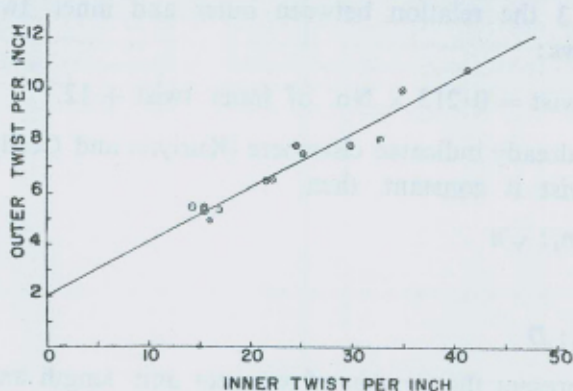


FIG. 3. Showing the relation between inner and outer twists of twines.

twist is invariably opposite in direction to the inner twist, a twine which is not given the correct outer twist will always be unstable and is susceptible to twist in the direction of the outer or inner twist, which is more than the optimum. The samples studied in the earlier experimental series were extremely badly twisted from this standpoint, while the present series appear to comprise comparatively of evenly twisted twines as would be evident from Fig. 3.

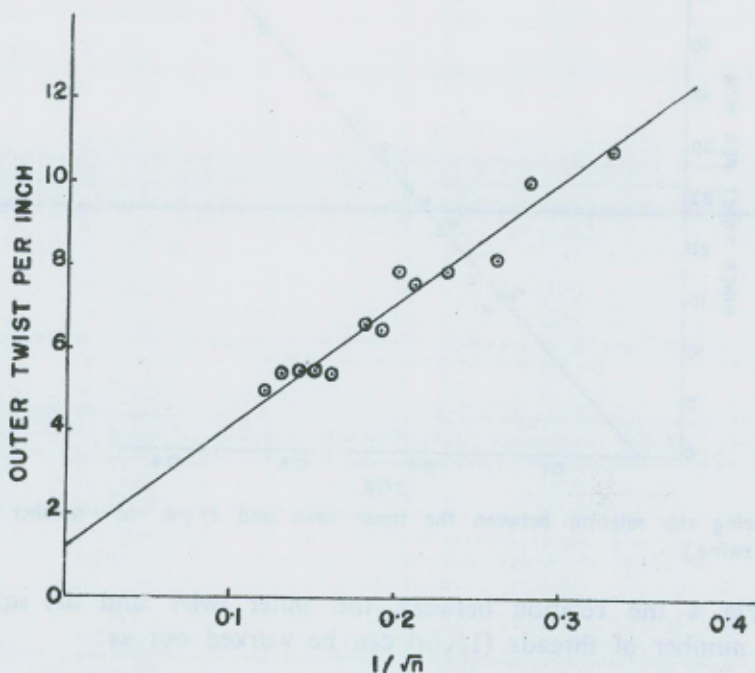


FIG. 4. Showing the relation between outer twist and $1/\sqrt{n}$, (n = number of thread in the twine.)

Based on Fig. 3 the relation between outer and inner twist can be represented as follows:

$$\text{No. of outer twist} = 0.213 \times \text{No. of inner twist} + 12.$$

As the authors already indicated elsewhere (Kuriyan and Cecily, *op. cit.*), if the degree of twist is constant, then,

$$T : T_1 = \sqrt{n_1} : \sqrt{n}$$

and

$$T : T_1 = D_1 : D$$

where, T and T_1 represent the number of twist per unit length and n and n_1 the number of threads in the twines and D and D_1 the respective diameters.

The number of twist is, therefore, inversely proportional to the square-root of the number of threads and the diameter of the twine.

Figures 4 and 5 show the relation between the outer and inner twists and the square root of the number of threads ($1/\sqrt{n}$). The Figures also substantiate the above hypothesis.

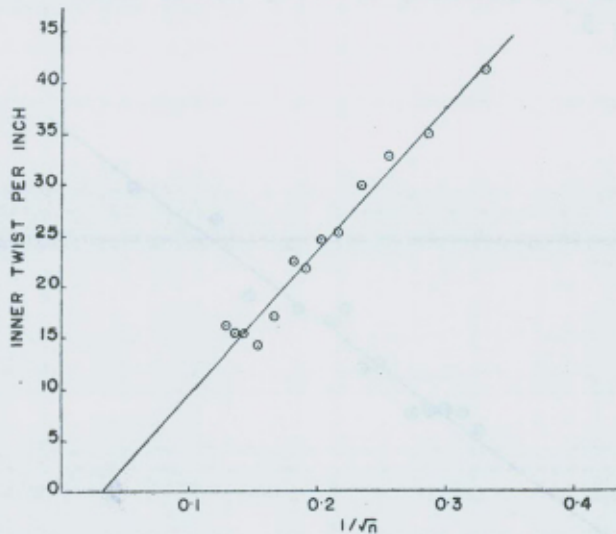


FIG. 5. Showing the relation between the inner twist and $1/\sqrt{n}$. (n = number of threads in the twine.)

From Fig. 4 the relation between the outer twist and the square root of the number of threads ($1/\sqrt{n}$) can be worked out as:

$$T_o = (29.75 \times 1/\sqrt{n}) + 1.2.$$

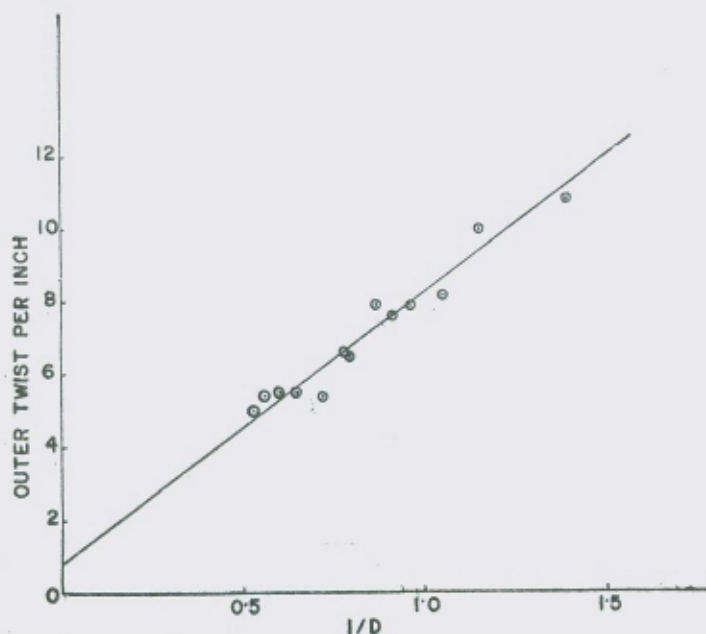


FIG. 6. Showing the relation between outer twists and diameter of the twines ($1/D$).

From Fig. 5 the relation between inner twist and the square root of the number of threads ($1/\sqrt{n}$) of each strand can be worked out as follows:

$$T_i = 137 \times 1/\sqrt{n} - 4.3.$$

Figure 6 represents the relation between the outer twist and the respective diameters ($1/D$) of the twines. From the Figure the relation between the outer twist (T_o) per inch of twine and the diameter (D) in mm. can be worked out as:

$$T_o = (7.48 \times 1/D) + 0.8.$$

The samples were fairly well twisted taking into consideration the diameter and the number of outer twist.

(iii) *Breaking strength.*—Figs. 7 and 8 represent the relationship between the breaking strength (dry and wet) and the number of threads and the square of the diameter of the twines. From the Figures it would be evident that breaking strength is proportional to both these factors.

Let S denote the breaking strength of twines in kgm. and n the number of threads, then, from Fig. 7, S can be expressed as follows:

$$S = 0.425n + 0.25 \text{ in dry condition}$$

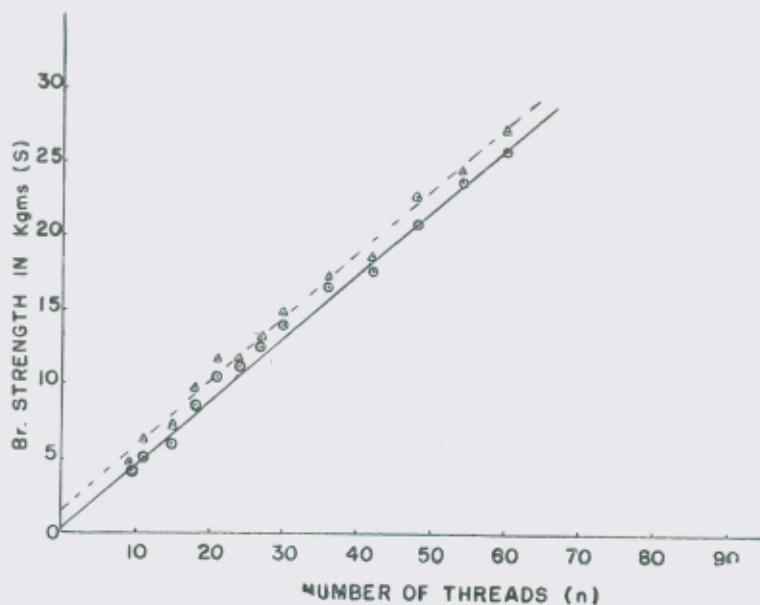


FIG. 7. Showing the relation between breaking strength (S) in kgm. and the number of threads (n).

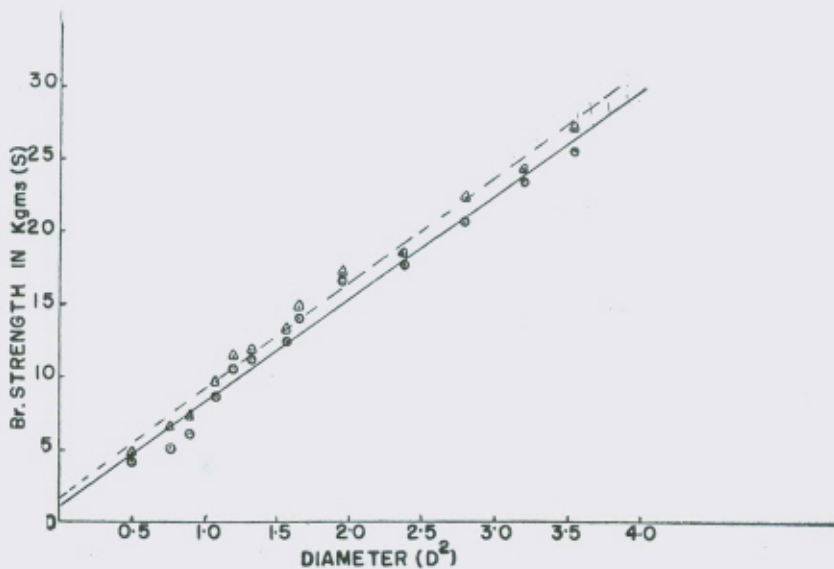


FIG. 8. Showing the relation between breaking strength (S) in kgm. and square of the diameter (D) of twines.

and

$$S = 0.43n + 1.5 \text{ in wet condition.}$$

Relation between diameter of twine (D) and S is worked out from Fig. 8 as follows:

$$S = 7.25D^2 + 1.0 \text{ in dry condition}$$

and

$$S = 7.5D^2 + 1.5 \text{ in wet condition.}$$

In the first series, the values of the constants were $0.49n$ (dry), $0.55n$ (wet) and $7.1 D^2$ (dry) and $8.2 D^2$ (wet) respectively. Though it may not be quite accurate to compare these two results on account of the possible differences that might exist in the qualities of the cotton fibres constituting the basic threads of the twines in the two series, the samples of the latter series appear to be a little weaker than the former. This may be partly due to the 'hard' twists of the twines of the II series. However, further experiments are necessary to reasonably assess the effect of twists on the breaking strength of twines.

Although in the present series as well, the twines record an increase in the breaking strength as a result of wetting (48 hours immersion), the increase in strength is not as much as that of the twines of 20-count thread of I series. This fall in the wet breaking strength is partly attributable to the hard nature of the twists of the twines of the II series.

(iv) *Breaking stretch.*—Fig. 9 shows the trend of relation between the percentage breaking stretch and the number of threads.

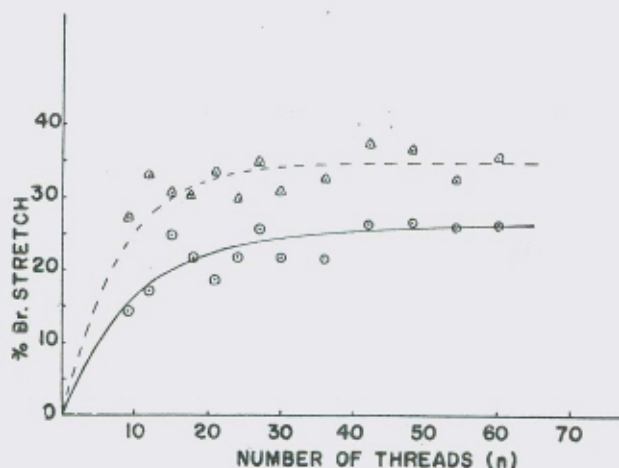


FIG. 9. Showing the percentage breaking stretch and the number of threads.

Although the samples of the II series record only a lower breaking strength, when compared with the samples of the earlier series, the elongation till the breaking point is distinctly more in the second set of twines. It could, therefore, be assumed that harder the twist greater the breaking stretch.

(v) *Effects of knots.*—The percentage loss in strength of the twines while made into reef knots and trawl knots is presented in Table VI. From the table it would be evident that while in the trawl knot the loss of strength is greater in the direction of the top mesh, in the reef knot the loss is greater towards the side mesh.

TABLE VI

The percentage decrease in the original breaking strength at knot

	Trawl knot				Reef knot			
	Dry		Wet		Dry		Wet	
	Top mesh	Side mesh	Top mesh	Side mesh	Top mesh	Side mesh	Top mesh	Side mesh
Mean	.. 28.45	23.14	26.93	20.93	20.97	31.09	18.83	30.43
Maximum	.. 38.99	32.78	33.01	30.27	34.22	37.86	26.16	40.74
Minimum	.. 21.24	11.19	18.18	8.78	10.44	22.78	14.33	21.64

SUMMARY

The paper describes the results of a II series of experiments to evaluate the common characteristics of cotton fishing net twines.

REFERENCE

- Kuriyan, G. K. and Cecily, P. J. The common characteristics of cotton fishing net twines—
1959 A preliminary account. *Indian Jour. Fish.*, 6 (2), 399-409.