

Effect of Cyclic Loading on Polyethylene Netting Yarn

M. Mukundan* and M. Shahul Hameed

Department of Industrial Fisheries

Cochin University of Science & Technology

Cochin - 682 016, India

Polyethylene netting yarn (0.75 mm nominal dia) was subjected to repeated stressing for 10, 20, 30 and 60 cycles under different loads of 5, 10 and 20 g tex⁻¹ and the remaining elongation assessed after relaxation periods of 0, 2, 24 and 48 h. Elongation for maximum load and for two intermediate values of load (37 and 74 N) were recorded. The elongation values with respect to particular load remained almost the same in tests with 5 g tex⁻¹ load. Strained specimens under all stages never reached the original value of breaking load. Statistical analysis to ascertain causative factors indicates the dependence of the amount of loading on elongation but not the other factors like number of cycles or relaxation time.

Many studies are conducted to evaluate the physical properties of netting yarn, both natural and synthetic, with a view to recommend suitable material to the fishing industry and to draw up standard specifications for its manufacture. Elastic properties of the netting yarn confer the capacity to absorb energy and shock loads and regain original length on removal of the load. These are essential for maintaining constancy of mesh size and for taking up high strain. Himmelfarb (1957) observed that elastic properties change with use. Dahn (1978) conducted experiments with nylon (polyamide) netting yarns by repeatedly loading and unloading to ascertain the causative factors and measure their influence. Despite better strength and high elastic properties of nylon, polyethylene is used for the construction of trawls and an attempt is made here to study the extensibility and breaking strength of this material after repeated loading.

Materials and Methods

Polyethylene monofilament twisted netting yarn of 0.75 mm nominal diameter was used in the study. The test procedure suggested by Brandt & Carrothers (1964)

and Bureau of Indian Standards (BIS, 1968; 1970 a, b) were followed for the tests. To study the effect of three factors such as load, stressing cycles and duration of relaxation of load on elongation, a factorial experiment was conducted with straining cycles of 10, 20, 30 and 60; relaxation time of 0, 2, 24 and 48 h and loads of 5, 10 and 20 g tex⁻¹ on wetted netting yarn. The material was cyclically loaded at the rate of 120 mm min⁻¹ giving a pause of 5 seconds at the minimum and maximum loads. After describing the cycles, load was withdrawn at the same rate. The rate of 120 mm min⁻¹ was selected based on the work of Dahn (1978).

The resultant elongation of the material corresponding to 37 and 74 N load was noted for different combinations of the above factors. The load of 37 N is nearly equal to 30% of the wet breaking load of the specimen and well within the range normally encountered in fishing operations (Klust, 1973). 37 N load is also slightly less than half the wet knot breaking load of the specimen while 74 N is less than the wet knot breaking load. The maximum breaking load at each level and corresponding elongation were also recorded. The tough-

* Present address : 27/216 "Rasya", Cochin - 682 020, India

ness index of the specimen stressed to maximum amount of load and cycles under test was recorded. The universal Testing Machine ZWICK 1484 was used for the experiments.

Results and Discussion

The physical properties of polyethylene netting yarn used in the study are presented in Table 1. Table 2 shows the elongation values corresponding to loads of 37 and 74 N after repeated loading and relaxation. The maximum value of load and corresponding elongation of the strained wet netting yarn are also presented.

Table 1. *Properties of polyethelene netting yarn*

Nominal diameter, mm		0.75
Rtex		320.00
Coefficient of twist		115.00
Breaking load, N	Dry	116.60
	Wet	127.92
	Wet knotted	84.59
Elongation, mm	Dry	156.00
	Wet	49.16
Toughness index	Dry	3.97
	Wet	4.12

The load elongation curve of the sample when loaded to break and for a representative test when loaded to 20 g tex⁻¹ 60 cycles and relaxed for 48 h are presented in Figs. 1a & b. Figs. 2a, b & c give a comprehensive view of the simultaneous influence of load as well as cycles on elongation at 37 N load.

Load elongation curve was typical of the material, i.e., at low loads elongation was less and at higher loads the curve tended to be concave to the elongation axis. The pattern of curve remained essentially the same after stressing for maximum cycles and load under test and relaxed for 48 h.

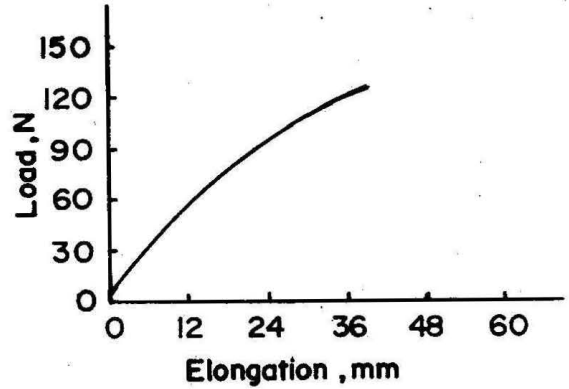


Fig. 1a. Load-elongation curve of 0.75 mm dia PE netting yarn

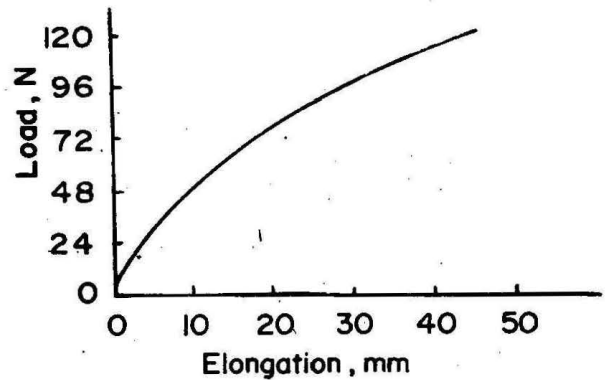


Fig. 1b. Load-elongation curve of 0.75 mm dia PE netting yarn after repeated loading upto 60 cycles at 20 g tex⁻¹ and relaxation period of 48h

It is seen from Table 2, Figs. 2a, b & c that elongation values corresponding to 37 N were almost similar with 5 g tex⁻¹ load for different loading cycles and relaxation time. In the case of 10 g tex⁻¹, elongation values on immediate withdrawal of load increased up to 20 cycles, then decreased (30 cycles) and attained maximum value at 60 cycles. In the case of 20 g. tex⁻¹ load, the maximum elongation was on immediate withdrawal for all cycles except 30. Strained specimens at all stages showed some difference in elongation from the original and the minimum value recorded was 5.84 mm as against the original value of 8.16 mm. By comparing Tables 1 and 2 it can be seen that at no stage the original breaking load was attained on repeatedly stressing the samples. At 74 N more or less the same pattern was observed as at 37 N.

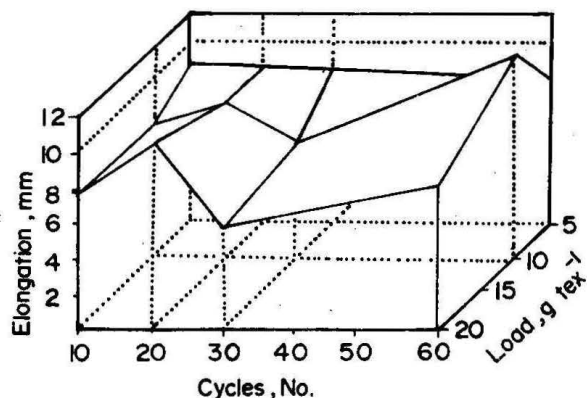


Fig. 2a. Elongation of PE netting yarn for 37 N after stressing and relaxation for 0 h

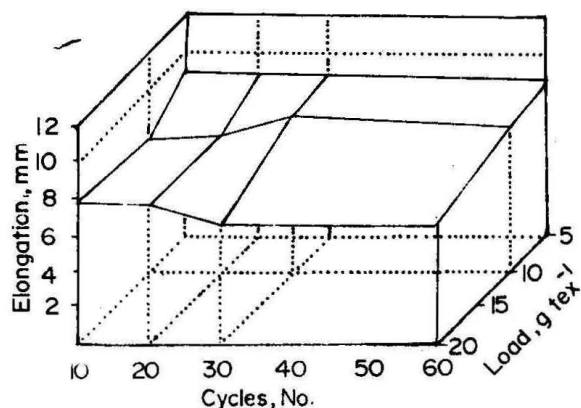


Fig. 2b. Elongation of 0.75mm dia PE netting yarn for 37 N after stressing and relaxation for 2h

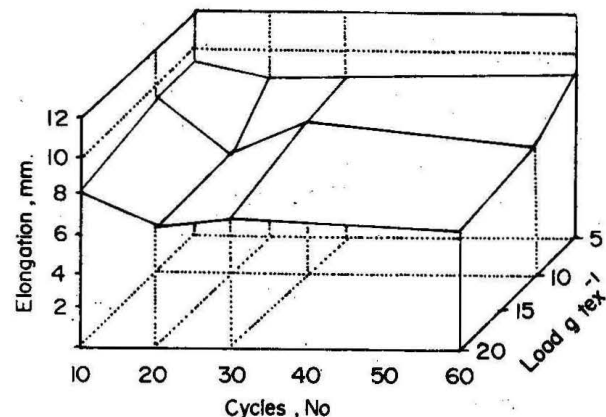


Fig. 2c. Elongation of 0.75 mm dia PE netting yarn for 37 N after stressing and relaxation for 24h

The data on elongation corresponding to 37 and 74 N load when the material was cycled through different amounts of load and relaxed for different periods were analysed statistically using ANOVA.

Variation between loads alone was significant at 1% level with F values equal to 15.29 and 25.36 (df:2,3), respectively for elongation corresponding to 37 N and 74 N. The results indicate that elongation is related to the amount of load applied but not on the number of loading cycles or relaxation time. In the case of nylon, Dahn (1978) observed a rapid deterioration of elongation capacity from 20 to 11% after 10 load changes at a load of 25 g tex⁻¹. Toughness index represented by the area enclosed by the load elongation curve was initially 4.12, but for the specimen describing maximum number of cycles and maximum load under test; when relaxed to 48 h, had a toughness index of 2.72. The mechanical properties of the samples were affected by the process and the sample had undergone mechanical wearing.

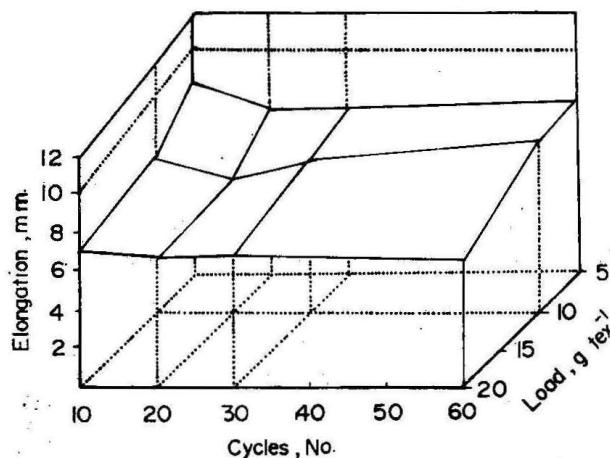


Fig. 2d. Elongation of 0.75 mm dia PE netting yarn for 37 N after stressing and relaxation for 48h

The present study was carried out with a maximum load of 20 g tex⁻¹ and 60 cycles. The magnitude of load was 25 g tex⁻¹ in the experiments conducted by Dahn (1978), while Klust (1983) mentions about repeated loading tests with 50 percent of the original strength successively loaded for 10 times. Therefore further studies with increase in load, change in cycles and relaxation time are suggested.

Table 2. *Breaking load and elongation values of the sample after repeated loading and relaxation*

Load g tex ⁻¹	Relaxation Period, h Cycles, no.	Maximum breaking load (F max.), N				Elongation for F max., mm			
		0	2	24	48	0	2	24	48
5	10	118.2	118.6	113.4	115.6	55.5	54.9	52.7	54.5
	20	119.1	125.7	121.0	112.3	50.8	51.9	47.9	50.9
	30	115.8	115.4	119.4	114.8	50.8	48.7	48.1	47.8
	60	120.3	123.6	121.6	120.5	48.8	55.6	52.8	49.7
10	10	114.1	111.8	106.9	109.7	45.8	42.4	49.8	44.1
	20	111.5	113.9	122.5	110.3	39.7	40.1	35.7	44.1
	30	120.7	112.7	115.7	114.4	39.2	37.7	48.8	42.9
	60	104.1	119.6	114.5	108.5	58.0	40.6	42.3	53.8
20	10	112.1	112.3	116.3	112.7	39.0	41.1	42.9	42.4
	20	109.5	105.9	120.9	117.7	38.2	35.8	37.1	33.3
	30	115.0	113.2	114.6	116.5	35.8	36.0	41.1	42.5
	60	103.8	118.7	107.2	116.2	35.6	31.5	28.2	38.5

Table 2. *contd..*

Load g tex ⁻¹	Relaxation Period, h Cycles, no.	Elongation for 37 N, mm				Elongation for 74 N, mm			
		0	2	24	48	0	2	24	48
5	10	8.9	9.3	9.0	10.2	24.0	24.1	25.9	25.5
	20	8.4	8.4	8.4	8.6	23.5	22.3	22.2	23.8
	30	8.6	9.0	8.6	8.5	23.4	22.6	23.1	23.3
	60	8.3	8.4	8.8	8.9	21.7	24.2	23.3	22.5
10	10	7.2	7.9	9.4	-	20.8	20.1	25.3	20.8
	20	8.7	7.6	6.3	6.5	21.4	20.1	16.7	16.7
	30	6.5	7.6	8.3	7.8	16.3	20.5	21.0	21.6
	60	11.6	7.2	6.9	9.1	29.3	19.5	17.1	25.5
20	10	7.6	7.1	7.4	7.2	19.0	16.4	15.6	20.3
	20	9.6	7.9	6.2	6.8	18.4	11.9	16.5	18.6
	30	5.8	6.8	7.1	6.9	17.1	18.4	18.8	18.0
	60	8.2	6.6	6.5	6.4	18.0	15.5	16.1	17.5

The authors are thankful to the Director, Central Institute of Fisheries Technology, Cochin for extending facilities to carry out the work. Help rendered by Smt. K. Radhalekshmy, Fishing Technology Division and Shri K. Krishna Rao, Extension, Information and Statistics Division, CIFT are also gratefully acknowledged.

References

BIS (1968) *Indian standard method for designating netting yarns in the tex system*, IS : 4640, Bureau of Indian Standards, New Delhi, India

BIS (1970 a) *Indian standard methods of test for fishing gear materials Part II - Determination of linear density (mass/unit length)*, IS : 5815 (Part II), Bureau of Indian Standards, New Delhi, India

BIS (1970 b) *Indian standard methods of test for fishing gear materials Part IV - Determination of breaking load and knot breaking load*, IS : 5815 (Part IV), Bureau of Indian Standards, New Delhi, India

Brandt, A.v. & Carrothers, P.J.G. (1964) in *Modern Fishing Gear of the World*, Vol. 2, (Kristjonsson, M., Ed.), p. 9, Fishing News (Books) Ltd., London, UK

Dahn, E. (1978) *Investigations on the strain of netting yarns after repeated loading and after application of stress in different magnitude.*, Presented at ICES meeting, October 8, 1978, Charlottenlund, Denmark

Himmelfarb, D. (1957) *The Technology of cordage fibres and ropes*, P. Leonard Hill (Books) Ltd., London, UK

Klust, G. (1973) *Netting materials for fishing gear*, Fishing News (Books) Ltd., London, UK

Klust, G. (1983) *Fibre Ropes for fishing gear*, Fishing News (Books) Ltd., London, UK