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Netting materials

FISHING NET KNOT SLIP RESISTANCE VERSUS KNOT TIGHTENING FORCE AND SYNTHETIC YARN NUMBER

ANALIZA ODPORNOŚCI NA PRZESUWANIE WĘZŁÓW SIECI RYBACKICH Z PRZĘDZ SYNTETYCZNYCH W FUNKCJI SIŁY WIĄZANIA ORAZ NUMERU PRZĘDZ

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The knot slip resistance of polyamide and polyester nettings of various numbers is studied in relation to knot tightening force applied. The relationship was followed from the analysis of regression area. A binomial was an accepted approximating function. The results are tabulated and plotted on graphs.

INTRODUCTION

The quality of nettings, very relevant from the prospect user's standpoint, is related to properties of an original material (netting yarn) as well as to the production technology employed. There is a multitude of factors influencing indices of neeting quality; the quantification of each single factor's influence is, however, difficult to attain. Nettings are produced of a variety of raw materials; on the other hand their quality is restricted by the machines available and finishing treatment administered. An index describing the fishing net knot stability should be regarded as one of the netting quality indices. The results of studies, to be found in the literature (Volkov, 1955; Dembiński, 1956; Lomakina, 1959; Kalinowski, 1962; Baranov, 1969; Sadowska, 1976), show the knot stability to be affected by yarn properties, knot tightening force, parameters of finshing treatment etc. The authors mentioned carried out their studies on a variety of materials, different methods being employed, thus no comparison is possible. In general, however, they point out to the necessity of the knot tightening force to be increased in the net production in order to obtain good knotting effects. The analysis presented below deals with the relationship between the stability of knots made of synthetic (polyamide and polyester) yarns of various numbers and the knot tightening force, the knot stability being expressed as the knot slip resistance.

MATERIALS AND METHODS

Materials

Hand-and factory-made weaver's knots were tested. The nettings were produced of polyamide (lov-viscosity stylon NL, license-based stylon, stylon with lubunox, enkalon, amilan, lilion) and polyester (torlen) yarns. Single yarns were supplied by the Polish and overseas (Holland, Japan, Italy) producers. The following sorts of polyamide cabled netting yarns were tested: 23 tex x 1 x 2, 23 tex x 4 x 3, 23 tex x 8 x 3, 93 tex x 7 x 3; the 23 tex x 1 x 2 and 110 tex x 1 x 3 torlen yarns were studied as well. 11 sorts of "raw" nettings (no physico-chemical finsish treatment) were produced by net making looms, while hand-made weaver's knots (English knote) were knitted in the laboratory.

Methods

ZT–20, ZT–40, and ZT–200 tensile testing machines were used to tighten the knots with the pre-determined force and to test the knot slip resistance. The latter was tested as specified in the Polish Standard PN-69/P-85036 and using Wijngaarden's method (Wijngaarden, 1959; Brandt and Carrothers, 1964). The knot slip resistance of factory-made nettings was analysed on 50 knots taken on random from each sort of netting. In order to follow the knot slip resistance-knot tightening force relationship, weaver's knots of yarns of different thickness were knitted by hand. These were tightened with a pre-set force in the tensile testing machine. Tightening forces (kG) were calculated for each sort, the calculations being based on the resultant actual number of yarn (tex). Each sort of netting provided 50 knots to be examined. These were tightened in the machine using forces of 10, 20, 30, 40, 50, 60, and 70 G/tex, the knot slip resistance being tested 24 hours later. The amount of the load (kG) at which the tested knot is deformed in that the warp yarn (slips out of the knot or the yarn ruptures in the knot serves as a measure of knot slip resistance.

Processing and evaluation of the results

The knot slip resistance was calculated as the arithmetic mean of the readings obtained. The data on the factory-made knots yielded also standard deviation (s), coefficient of variance (v), and standard error (u). Analysis of variance was applied to evaluate the knot slip resistance in factory-made nettings of yarns of a similar thickness but supplied by various producers. To assess the significance of differences between the group means, multiple-mean variance and Fisher-Snedecor test (F test) were used. Duncan's new multiple range procedure was applied to detect means differing from each other and to assess the significance of these differences. The generally available tables of each coefficient's critical values were made use of when analysing the parameters.

In order to ascertain the interrelationships between knot slip resistance, knot tightening force, and actual tex, the regression area analysis was employed (Zieliński, 1974). Using this method, the analytical form of the interrelationship was determined in order to present the nature of this interrelationship more precisely. The general form of the relationship was given as

$$F_p = f(u_1, u_2) \quad (1)$$

where:

F_p = knot slip resistance in kG (dependent variable)
u_1 = knot tightening force in G/tex
u_2 = resultant actual tex of yarn

(u_1 and u_2 are independent variables)

A binomial in the form of

$$Y_{(u_1 u_2)} = \gamma_0 + \gamma_1 u_1 + \gamma_2 u_2 + \gamma_{11} u_1^2 + \gamma_{22} u_2^2 + \gamma_{12} u_1 u_2 \quad (2)$$

where:

u_1, u_2 as in (1)
γ = regression coefficients

was assumed for an approximating function in finding the analytical form of (1).

The following parameters were introduced to assess the goodness of fit of the approximation: vector R and variance of the random component. The structural parameters $\gamma_0, \gamma_1, \gamma_2, \gamma_{11}, \gamma_{22}, \gamma_{12}$ for the sorts tested were drawn on the XY point recorder fitted to the Hewlett Packard 2100A computer.

RESULTS OF STUDIES AND DISCUSSION

Machine-made netting knot slip resistance

Knot stability proved to be a very important index of netting quality. The index was represented by the mean knot slip resistance ($\bar{F}_p$). Table 1 contains the results of studies on this index for machine-made nettings; the results indicate the absolute value (kG) of the knot slip resistance to be related to the yarn number. Machine-made nettings produced, under the same conditions, of synthetic yarns of a similar number, supplied by different manufacturers, were found to display varying knot slip resistance.

Torlen knots show a clearly higher resistance to slippage. The analysis of variance and F test (Table 2) corroborated the high significance of differences between mean slip resistances of knots made of various grades of yarns, regardless of the producer and chemical composition. The knot slip resistance increases with the yarn number.

Table 1

Knot slip resistance ($\overline{F}_p$) in pre-adjusted machine-made „raw" nettings

Sort of netting		Knot slip resistance (kG)	Number of measurements (n)	Standard deviation (s)	Coefficient of variance (v)	Standard error (u)
1		2	3	4	5	6
stylon NL	23 tex x1x2≠40	0.67	50	0.2635	38.80	10.97
	23 tex x4x3≠40	1.27	50	0.6336	49.60	14.03
	23 tex x8x3≠40	2.17	50	0.7513	34.56	9.77
enkalon	23 tex x1x2≠40	0.58	50	0.20	34.48	9.75
	23 tex x4x3≠40	1.68	50	0.8215	48.80	13.80
	23 tex x8x3≠40	2.04	50	1.0912	53.43	15.11
amilan	23 tex x1x2≠40	0.70	50	0.2211	31.42	8.88
	23 tex x4x3≠40	1.50	50	0.8480	56.66	16.02
	23 tex x8x3≠40	2.64	50	1.0548	39.77	11.25
torlen	28 tex x1x2≠40	1.53	50	0.170	11.11	3.14
	110 tex x1x3≠40	3.20	50	2.8964	90.62	25.63

Table 2

Table of analysis of variance performed for knot slip resistance in "raw" nettings made of yarn of different actual tex

Sort of netting		Source of variation	Degrees of freedom	Variance	F test (calc.)	F test (from tables)
1		2	3	4	5	6
stylon NL	23 tex x1x2≠40 23 tex x4x3≠40 23 tex x8x3≠40	between-group within-group	2 147	28.4050 0.3483	81.55	$F_{0.05} = 3.06$ $F_{0.01} = 4.75$
enkalon	23 tex x1x2≠40 23 tex x4x3≠40 23 tex x8x3≠40	between-group within-group	2 147	28.8625 0.6395	45.13	$F_{0.05} = 3.06$ $F_{0.01} = 4.75$
amilan	23 tex x1x2≠40 23 tex x4x3≠40 23 tex x8x3≠40	between-group within-group	2 147	47.3975 0.6312	75.09	$F_{0.05} = 3.06$ $F_{0.01} = 4.75$
torlen	28 tex x1x2≠40* 110 tex x1x3≠40	–	–	–	–	–

* in torlen yarns, the significance of differences was found for two means. The calculated value was compared to t_{α} of Student test ($t_{0.05} = 1.98$; $t_{0.01} = 2.62$)

Table 3

Tightening forces (kG) of hand-made knots

Sort of yarn		Actual tex	Relative tightening force G/tex						
			10	20	30	40	50	60	70
1		2	3	4	5	6	7	8	9
stylon-NL	23 tex x1x2	49.88	0.5	1.0	1.5	2.0	2.5	3.0	3.5
enkalon	23 tex x1x2	49.80	0.5	1.0	1.5	2.0	2.5	3.0	3.5
amilan	23 tex x1x2	47.58	0.48	0.96	1.4	1.9	2.4	2.8	3.3
torlen	28 tex x1x2	58.57	0.6	1.2	1.8	2.4	3.0	3.6[y]	–
stylon NL	23 tex x4x3	312.85	3.2	6.4	9.6	12.8	15.6	18.8	21.8[y]
enkalon	23 tex x4x3	315.53	3.2	6.4	9.6	12.8	15.6	18.8	21.8[y]
amilan	23 tex x4x3	292.21	2.9	5.8	8.8	11.7	14.6	17.5	20.5[y]
torlen	110 tex x1x3	353.02	3.5	7.0	10.5	14.1[y]	17.6[y]	–	–
stylon NL	23 tex x8x3	629.26	6.3	12.6	18.9	25.2	31.5	37.6	44.0[y]
enkalon	23 tex x8x3	630.25	6.3	12.6	19.0	25.2	31.5	37.8[y]	44.2[y]
amilan	23 tex x8x3	604.28	6.0	12.0	18.1	24.2	30.2	36.2	42.3[y]
stylon lic.	93 tex. x7x3	2276.0	22.8	45.5	68.3	91.0	113.8	–	–
stylon with lub.	93 tex x7x3	2259.70	22.6	45.2	67.8	90.4	113.0	135.6[y]	–
amilan	93 tex x7x3	2174.25	21.8	43.5	65.3	87.0	108.7	130.5[y]	–
lilion	93 tex x7x3	2069.0	20.7	41.4	62.1	82.8	103.5	124.2	–

y = knots breaking when tightened were recorded in the sample

Knot slip resistance versus tightening force and tex

The methods of study as used in the present investigations made it possible to analyse the relationship existing between knot slip resistance and tightening force. The latter was expressed as relative values in G/tex (Table 3); thus knots of various yarns (differing in make, chemical composition, and number) could be tied with equal relative forces ranging within 10–70 g/tex. The tests performed as well additional studies on kontted joints* show the upper limit off knot tightening forces to approximate the knot breaking load. The maximum knot tightening force for the materials studied ranges within 60–80 G/tex., and decreases with an increase in tex (Table 3). The results of studies on slip resistance of knots tied with a pre-determined force ranging within 10–70 G/tex are given in Table 4. The resistance is shown to increase with the tightening force. According to the procedure adopted, the knot slip resistances were expressed in absolute units (kG), while the relative units (G/tex) were ascribed to tightening forces. Another index, the one representing knot slip resistance in relative units (G/tex), was also introduced as a direct measure of the knot tightening force increase. Values of this index are given in Table 5; they show the knot slip resistance of all the yarns tested to increase with the tightening force. However, the values of the relative knot slip resistance found for fine yarns (23 tex x 1 x 2) are much higher than those found for yarns of higher tex. For example, the relative slip resistace in fine yarn (23 tex x 1 x 2) knots tightened with a force of 10 G/tex appreaches the knot resistance of the 23 tex x 8 x 3 ones tightened with 40 G/tex. Consequently, it can be concluded that the knot tightening force increase is more efficient when producing nettings of fine yarns, while being indispensable in nettings made of higher tex yarns ad twines. Also, the knot slip resistance appears to depend on a yarn number.

The interrelationship between yarn number (u_2), knot tightening force (u_1), and knot slip resistance for the yarns tested is presented as the approximating function calculated from (1) and (2). The binomial as in (2) was found to have sufficiently described the relationship studied, as shown by low numerical values (approaching 0) of the vactor R and the numerical estimation of the random component variance in the approximating equation adopted, calculated for all the materials tested. Table 6 contains the regression area equations expressing the interrelationships between tex (u_2), knot tightening force (u_1), and knot slip resistance. Regression curves based on the equations were fitted for each material tested. The curves show that:

the knot slip resistance increases with tightening force and tex;

the knot slip resistance increments are not proportional to an increase in tightening force, the relationship being described by (2);

there are no points indicating the presence of optimal knot tightening forces for synthetic yarns.

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* according to the project of Polish Standard PN-72/P...: Determinantion of knot tensile strength for yarns, twines and cordage.

Table 4

Knot slip resistance (kG) vs. tightening force

Sort of yarn		Relative tightening force G/tex						
		10	20	30	40	50	60	70
1		2	3	4	5	6	7	8
stylon NL	23 tex x1x2	0.49	0.53	0.70	0.83	0.93	1.19	1.37
	23 tex x4x3	0.57	1.60	2.51	3.21	3.73	4.89	5.11
	23 tex x8x3	1.22	3.96	5.26	6.25	7.85	8.62	10.73
stylon lic.	93 tex x7x3	7.24	16.02	26.80	28.95	36.37	–	–
stylon with lub.	93 tex x7x3	3.33	11.57	18.99	23.52	25.28	29.09	–
enkalon	23 tex x1x2	0.49	0.55	0.86	1.03	1.21	1.22	1.34
	23 tex x4x3	0.91	2.09	3.12	4.08	4.33	4.83	4.31
	23 tex x8x3	1.43	3.62	4.55	5.47	6.69	7.54	8.80
amilan	23 tex x1x2	0.37	0.45	0.79	1.0	1.15	1.37	1.41
	23 tex x4x3	0.54	2.14	3.17	4.14	4.97	5.88	6.88
	23 tex x8x3	1.16	3.69	4.34	6.16	6.51	9.56	9.68
	93 tex x7x3	3.66	10.96	21.72	22.19	26.84	31.34	–
lilion	93 tex x7x3	5.09	15.93	20.11	22.45	32.47	33.46	–
torlen	28 tex x1x2	0.91	1.08	1.35	1.49	1.58	1.60	–
	110 tex x1x3	1.62	3.08	5.12	6.74	7.56	–	–

Table 5

Relative knot slip resistance (G/tex)

Sort of yarn		Tex	Relative tightening force G/tex						
			10	20	30	40	50	60	70
1		2	3	4	5	6	7	8	9
stylon NL	23 tex x1x2	49.88	9.82	10.62	14.03	16.64	18.64	23.86	27.46
enkalon	23 tex x1x2	49.80	9.83	11.04	17.27	20.68	24.30	24.50	26.91
amilan	23 tex x1x2	47.58	7.78	9.46	16.60	21.02	24.17	28.79	29.63
torlen	28 tex x1x2	58.57	15.54	18.44	23.05	25.44	26.98	27.32	–
stylon NL	23 tex x4x3	312.85	1.82	5.11	8.02	10.26	11.92	15.63	16.33
enkalon	23 tex x4x3	315.53	2.88	6.62	9.89	12.93	13.72	15.31	13.65
amilan	23 tex x4x3	292.21	1.85	7.32	10.85	14.17	17.0	20.12	23.54
torlen	110 tex x1x3	353.02	4.59	8.72	14.50	19.09	21.41	–	–
stylon NL	23 tex x8x3	629.26	1.95	6.32	8.34	9.93	12.47	13.70	17.05
enkalon	23 tex x8x3	630.25	2.27	5.74	7.22	8.68	10.61	11.96	13.96
amilan	23 tex x8x3	604.28	1.92	6.11	7.18	10.19	10.77	15.82	16.10
stylon lic.	93 tex x7x3	2276.0	3.18	7.04	11.77	12.72	15.98	–	–
stylon with lub.	93 tex x7x3	2259.70	1.47	5.12	8.40	10.41	11.19	12.87	–
amilan	93 tex x7x3	2174.25	1.68	5.04	9.99	10.21	12.34	14.41	–
lilion	93 tex x7x3	2069.0	2.46	7.70	9.72	10.85	15.69	16.17	–

Table 6

Regression area equations describing the interrelationship between tex (u_2), tightening force (u_1), and knot slip resistance in different yarns

Sort of yarn	Tex range (u_2)	Tightening force range (u_1)	equation area regression
1	2	3	4
stylon NL	49.88–629.26	10–70	$Y_{(u_1 u_2)} = (-0.025)+(0{,}026u_1)+(-0{,}0015u_2)+(-0.00026u_1^2)+(0{,}000003u_2^2)+(0.00022u_1 u_2)$
enkalon	49.80–630.25	10–70	$Y_{(u_1 u_2)} = (-0.69)+(0.064u_1)+(0.0039u_2)+(-0.00072u_1^2)+(-0.000004u_2^2)+(0.00017u_1 u_2)$
amilan	47.58–604.28	10–70	$Y_{(u_1 u_2)} = (-0.95)+(0.044u_1)+(0.0076u_2)+(-0.00031u_1^2)+(-0.000011u_2^2)+(0.00021u_1 u_2)$
amilan	47.58–2174.25	10–70	$Y_{(u_1 u_2)} = (-1.58)+(0.146u_1)+(-0.00070u_2)+(-0.00185u_1^2)+(0.0000004u_2^2)+(0.00024u_1 u_2)$
lilion	2069.0	10–60	$Y_{(u_1 u_2)} = (-2.10)+(0.88u_1)+(-0.0046u_1^2)$
stylon lic.	2276.0	10–50	$Y_{(u_1 u_2)} = (-3.96)+(1.20u_1)+(-0.0081u_1^2)$
stylon with lub.	2259.7	10–60	$Y_{(u_1 u_2)} = (-6.27)+(1.06u_1)+(-0.0080\ u_1^2)$
torlen	58.57	10–60	$Y_{(u_1 u_2)} = (0.58)+(0.033u_1)+(-0.00027u_1^2)$
torlen	353.02	10–50	$Y_{(u_1 u_2)} = (-0.69)+(0.228u_1)+(-0.0012u_1^2)$

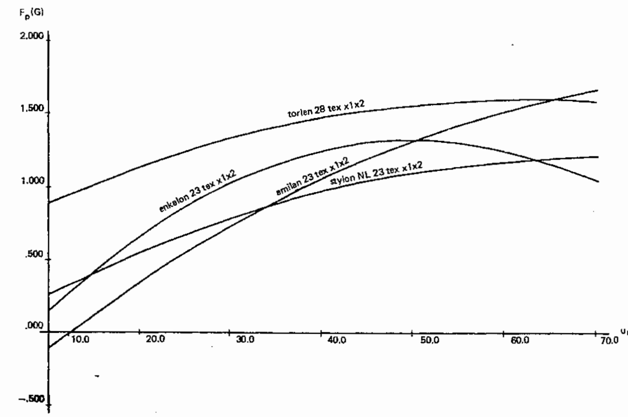

Fig. 1. Knot slip resistance (F_p) vs. tightening force (u_1) in knots made of different 23 te x1x2 yarns

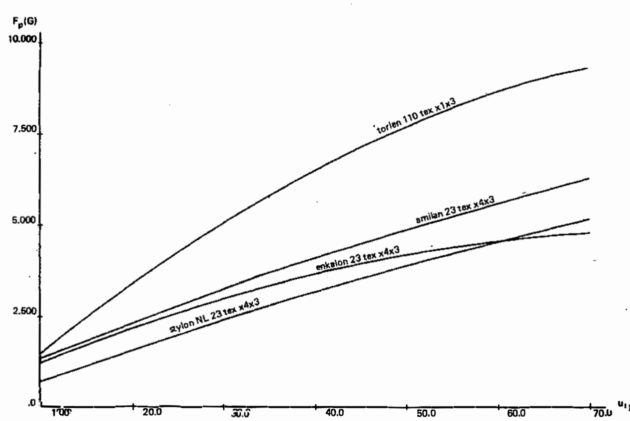

Fig. 2. Knot slip resistance (F_p) vs. tightening force (u_1) in knots made of different 23 tex x4x3 yarns

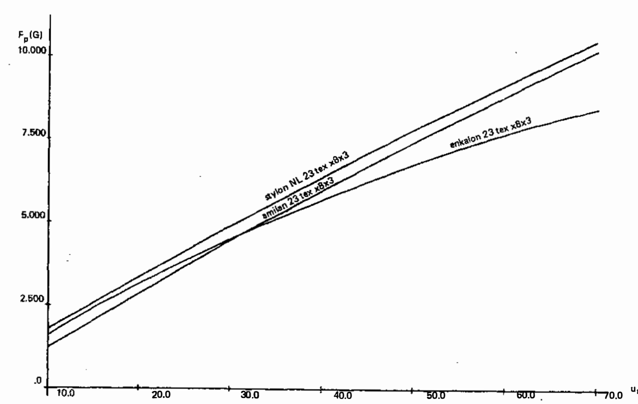

Fig. 3. Knot slip resistance (F_p) vs. tightening force (u_1) in knots made of different 23 tex x8x3 yarns

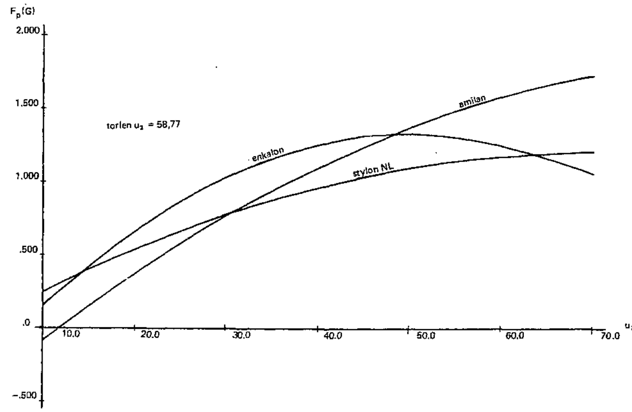

Fig. 4. Knot slip resistance (F_p) vs. tightening force (u_1) in knots made of different yarns of u_2=50 tex

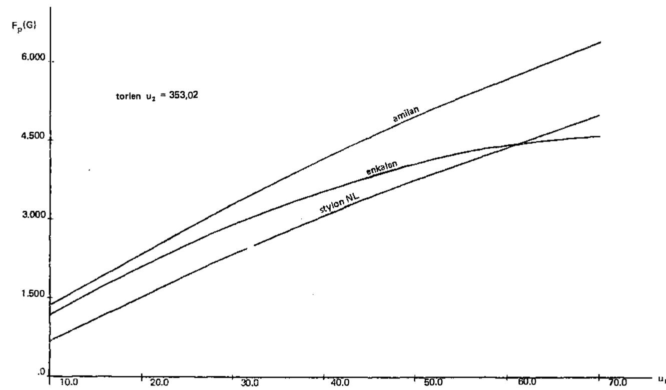

Fig. 5. Knot slip resistance (F_p) vs. tightening force (u_1) in knots made of different yarns of u_2=300 tex

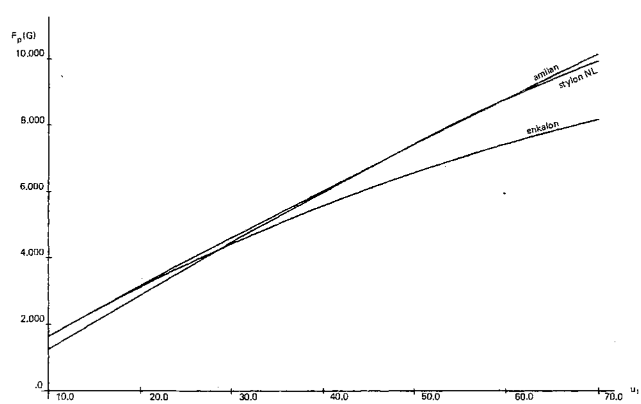

Fig. 6. Knot slip resistance (F_p) vs. tightening force (u_1) in knots made of different yarns of u_2=600 tex

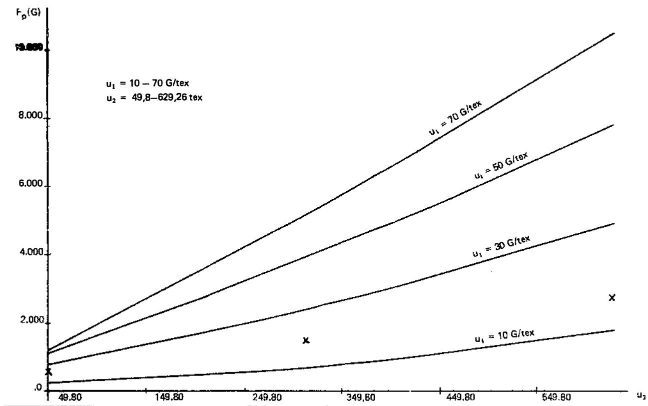

Fig. 7. Knot slip resistance (F_p) vs. actual tex (u_2) in stylon NL knots (x = results F_p for machine-made "raw" nettings)

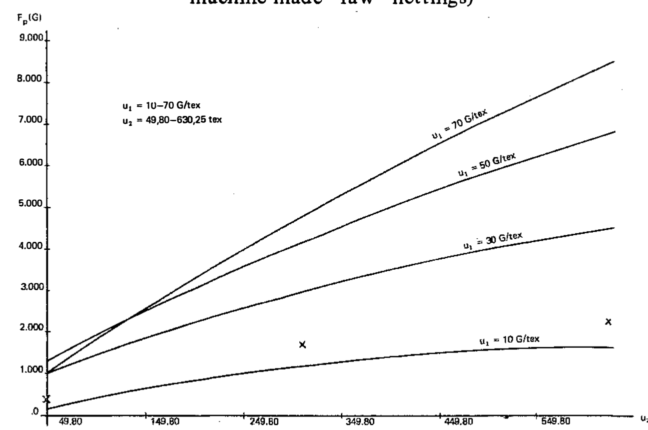

Fig. 8. Knot slip resistance (F_p) vs. actual tex (u_2) in enkalon knots (x = results F_p for machine-made "raw" nettings)

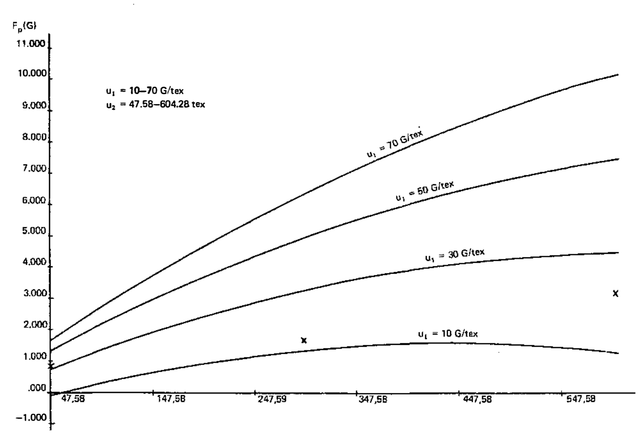

Fig. 9. Knot slip resistance (F_p) vs. actual tex (u_2) in amilan knots (x = results F_p for machine-made "raw" nettings)

Figs. 1–3 show the regression curves describing the relationship for the resistance to slippage of knots tightened with a predetermined force, the knots being made of yarns of a similar number but differing in their chemical composition and producer. The figures clearly show the knot slip resistance to increase with tightening forces. The resistance of torlen knots is much higher than that observed for polyamide yarns. On the other hand, it is difficult to prove "a higher usefulness" of any yarn of the polyamide range. With this purpose on mind, the regression curves were plotted for three selected yarn grades (u_2): 50, 300, and 600 tex. These curves are presented in Figs. 4–6. The tex values adopted excluded torlen yarns from the comparisons. The graphs show amilan, of the polyamide yarns tested, to be distinct in that the knots made of this material display a higher resistance to sllippage than those made of enkalon and stylon, the appropriately high tightening force being applied.

Figs. 7–9 present the formula (2) – based regression curves for hand-made knots of stylon NL, enkalon, and amilan; results of knot slip resistance tests for machine-made "raw" nettings were superimposed on the curves. The comparisons show the machine-made polyamide nettings to have their knots tightened with low forces: about 30, 20, and 15 G/tex for the 23 tex x 1 x 2, 23 tex x 4 x 3, and 23 tex x 8 x 3, respectively. Of the polyamide yarns tested, amilan displayed the best properties with respect to machine-production of nettings, the knots proving most resistant to slippage.

The analysis of data collected in the course of studies presenteed allowed to determine the relationship between the synthetic netting knot slip resistance, yarn number, and knot tightening forces. The factors contributing were easy to measure and compare. Hence the analytical form of the relationship, i.e., the binomial as in (2), concerning these factors, makes it possible to predict (in yarns supplied by different producers) values of any of the pair of properties, provided the other one is known (Table 6, Figs. 4–9). Regression coefficients calculated show the knot tightening force (u_1) to exert a greater effect than tex (u_2) in the tightening forces and tex ranges of 10–70 G/tex and u_2 (Table 6), respectively. It should be emphasized here that torlen knots exhibit a highly significant effect of the knot tightening force increase (Table 4, Figs. 1–2), whereas polyamide yarns remain more "resistant" in their responses to tightening forces.

Consequently, an important conclusion could be drawn: when producing nettings of polyamide yarns, which are the material used most frequently, it is desirable – from the prospect user's point of view – to increase the knot tightening force.

As the results of the present studies show, in order to obtain agreeable effects the tightening forces of net making machines should be increased, this recommendation being particularly relevant to nettings made of thicker yarns and twines.

CONCLUSIONS

1. The knot slip resistance increases with knot tightening force and yarn number, the interrelationship being adequately described by the binomial.

$$Y_{(u_1 u_2)} = \gamma_0 + \gamma_1 u_1 + \gamma_2 u_2 + \gamma_{11} u_1^2 + \gamma_{22} u_2^2 + \gamma_{12} u_1 u_2$$

2. The maximum tightening force is limited by the knot tensile strength in mesh joint. The relative maximum value of tightening force for polyamide yarns ranges within 60–80 G/tex, decreasing with the tex increase. The range is lower for polyester yarns (40–60 G/tex). The best effects of tightening force increase is observable in fine and polyester yarns.
3. Machine-made nettings have their knots tightened with a force too low to meet the requirements (Table 1, Figs. 7–9). In order to obtain good knotting effects the tightening force needs to be increased. This recommendation is particularly important as far as nets made of thicker yarns and twines are concerned as well as justified from the standpoint of a prospect user.

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ANALIZA ODPORNOŚCI NA PRZESUWANIE WĘZŁÓW SIECI RYBACKICH Z PRZĘDZ SYNTETYCZNYCH W FUNKCJI SIŁY WIĄZANIA ORAZ NUMERU PRZĘDZ

Streszczenie

Opracowanie dotyczy określenia zależności odporności na przesuwanie (wskaźnik trwałości węzłów) węzłów tkanin sieciowych wykonanych z przędz poliamidowych i poliestrowych o różnych numerach od siły wiązania węzłów. Materiał do badań stanowiły węzły tkanin sieciowych wyprodukowanych maszynowo oraz węzły (szotowe) wywiązane ręcznie i zawiązywane z określoną siłą (Tab. 3). Badano węzły z przędzy poliamidowej krajowej (stylon NL, licencyjny, z lubunoxem) oraz z przędz poliamidowych produkowanych za granicą (amilan-Japonia, enkalon-Holandia, lilion-Włochy) o następujących oznaczeniach: 23 tex x 1 x 2, 23 tex x 4 x 3, 23 tex x 8 x 3, 93 tex x 7 x 3 (przędze poliamidowe) i 28 tex x 1 x 2, 110 tex x 1 x 3 (przędze poliestrowe). Ocenę wyników pomiarów odporności na przesuwanie węzłów tkanin sieciowych wykonanych fabrycznie oparto o testy analizy wariancji dla wielu średnich, test Fishera-Snedecora (test F) oraz nowy wielokrotny test rozstępu Duncana. Zależność odporności węzłów na przesuwanie od siły wiązania i numeru przędzy określono metodą analizy powierzchni regresji. Jako funkcję aproksymującą przyjęto wielomian stopnia drugiego według wzoru:

$$Y_{(u_1 u_2)} = \gamma_0 + \gamma_1 u_1 + \gamma_2 u_2 + \gamma_{11} u_1^2 + \gamma_{22} u_2^2 + \gamma_{12} u_1 u_2$$

w którym:

- u_1 – siła zawiązywania węzłów w G/tex (zmienna zależna),
- u_2 – rzeczywisty numer przędzy w texach, (u_1 u_2 – zmienne niezależne)
- γ – współczynniki regresji.

Stwierdzono różną odporność na przesuwanie węzłów tkanin sieciowych wyprodukowanych maszynowo z przędz syntetycznych o różnych numerach oraz zbliżonym numerze, lecz pochodzących od różnych producentów (Tab. 1, 2). Wyraźnie wyższą odpornością na przesuwanie charakteryzują się węzły z przędz torlenowych.

Wyniki badań odporności na przesuwanie węzłów wiązanych z określoną siłą wskazują (Tab. 4), że ze wzrostem siły wiązania oraz numeru przędzy następuje wzrost odporności węzłów na przesuwanie. Przyjęty wielomian stopnia drugiego dobrze opisuje badaną zależność. W tab. 6 podano zestawienie równań powierzchni regresji, obliczone dla wszystkich badanych materiałów, a na ryc. 1–9 przedstawiono krzywe regresji badanej zależności. Wskazują one, że odporność węzłów na przesuwanie z wszystkich badanych przędz wzrasta ze wzrostem siły wiązania. Odporność węzłów z przędz torlenowych jest znacznie wyższa od odporności węzłów z przędz poliamidowych. Z tych ostatnich, przy odpowiednio wysokiej sile wiązania wyróżniają się wyższą odpornością na przesuwanie węzły z przędzy amilan w porównaniu z węzłami z przędzy enkalon i stylon (ryc. 4–6).

Na ryc. 7–9 na tle krzywych regresji naniesiono wyniki badań odporności na przesuwanie węzłów „surowych" (bez wykończenia) tkanin sieciowych wyprodukowanych maszynowo z tych samych przędz. Z porównania wynika, że w tkaninach sieciowych produkowanych maszynowo z przędz poliamidowych węzły wiązane były z małą siłą.

Przeprowadzone badania wskazują, że przy produkcji tkanin sieciowych z przędz syntetycznych wzrost sił wiązania węzłów jest uzasadniony z eksploatacyjnego punktu widzenia. Wzrost sił wiązania jest bardziej skuteczny w przypadku wiązania tkanin sieciowych z przędz poliestrowych w porównaniu z poliamidowymi oraz przy produkcji tkanin sieciowych z cienkich przędz poliamidowych. Stąd wypływa konieczność wzrostu sił wiązania węzłów tkanin sieciowych z przędz o wyższych numerach i sznurków. Wyniki badań mogą być praktycznie wykorzystane w zakresie produkcji węzłowych tkanin sieciowych.

З. Садовска

АНАЛИЗ УСТОЙЧИВОСТИ К СМЕЩЕНИЮ УЗЛОВ РЫБОЛОВНЫХ СЕТЕЙ ИЗ СИНТЕТИЧЕСКОЙ ПРЯЖИ В ФУНКЦИИ УСИЛИЯ ЗАТЯЖКИ И НОМЕРА ПРЯЖИ

Р е з ю м е

В настоящей работе рассматривается вопрос определения зависимости устойчивости к смещению узлов сетных полотен (показатель прочности узлов), изготовленных из полиамидной и полиэфирной пряж разных номеров, от усилия затяжки узлов. Предметом исследований были узлы сетных полотен машинной вязки и узлы (шкотовые), ручной вязки, затягиваемые с определённым усилием (табл. 3). Предметом исследований являлись узлы из полиамидной пряжи отечественного производства (стилон лицензионный, с любоноксом) и из полиамидной пряжи зарубежного производства (амилан - Япония, энкалон - Голландия, лилион - Италия) со следующими параметрами: 23 текс x1x2, 23 текс x4x3, 23 текс x8x3, 93 текс x7x3 (полиамидные пряжи) и 28 текс x1x2, 110 текс x1x3 (полиэфирные пряжи).

Оценка результатов определения устойчивости к смещению узлов сетных полотен, изготовленных фабричным способом, основана на тестах анализа дисперсии для множества средних, на тесте Фишера - Снедекора (тест F) и новом многократном тесте расхождения Дункана. Зависимость устойчивости узлов к смещению от усилия затяжки и номера пряжи определяли по методу анализа поверхности регрессии. В качестве функции аппроксимации был взят многочлен второй степении по формуле:

$$Y(u_1u_2) = \delta_0+\delta_1u_1+\delta_2u_2+\delta_{11}u_1^2+\delta_{22}u_2^2+\delta_{12}u_1u_2$$

где:

u_1 - усилие затяжки узлов в G /текс (переменная зависимая),

u_2 - действительный номер пряжи в тексах, (u_1, u_2 - переменные независимые),

δ - коэффициент регресии.

В процессе исследований установлена неодинаковая устойчивость к смещению узлов сетных полотен машинной вязки из синтетической пряжи разных и близких номеров, но изготовленных разными предприятиями (табл. 1, 2). Более высокой устойчивостью к смещению характеризуются узлы из торленовой пряжи.

Результаты исследований устойчивости к смещению узлов, затягиваемых с определённым усилием, указывают на то, что с увеличением усилия затяжки и номера пряжи (табл. 4) наблюдается одновременное увеличение устойчивости узлов к смещению. Взятый многочлен второй степени хорошо иллюстрирует исследуемую зависимость. В табл. 6 приводится система уравнений поверхности регрессии, расчитанная для всех исследуемых материалов, а на иллюстрациях 1-9 приведены кривые регрессии исследуемой зависимости. Они указывают на то, что устойчивость узлов к смещению из всех исследуемых пряж увеличивается с увеличением усилия затяжки. Прочность узлов из торленовых пряж является

значительно более высокой, чем прочность узлов из полиамидных пряж. Среди последних, при соответственно большем усилии затяжки, более высокой по сравнению с энкаловыми и стилоновыми пряжами устойчивостью к смещению отличаются узлы из амилановой пряжи (иллюстрации 4-6).

На иллюстрациях 7-9 на фоне кривых регрессии нанесены результаты исследований устойчивости к смещению узлов из так называемых сырых (без окончательной обработки) полотен, изготовленных машинным способом из вышеназванных пряж. При сравнении становится очевидным, что в сетных полотнах, изготовляемых машинным способом из полиамидной пряжи, узлы затягивались с небольшим усилием.

Проведенные исследования свидетельствуют о том, что при производстве сетных полотен из синтетической пряжи увеличение усилий затяжки узлов является вполне обоснованным с эксплуатационной точки зрения. Увеличение усилий затяжки является более эффективным при изготовлении сетного полотна из полиэфирной пряжи по сравнению с полиамидной, а также при изготовлении сетного полотна из тонкой полиамидной пряжи. Отсюда вытекает необходимость увеличения усилий затяжки узлов сетного полотна из пряжи больших номеров и шнуров. Результаты исследований могут быть использованы практически при производстве узловых сетных полотен.

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