ACTA ICHTHYOLOGICA ET PISCATORIA
Vol. XII Fasc. 1 Szczecin 1982

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Fishing technics

EFFECTS OF LINEAR DIMENSIONS OF CONICAL NETTING CONSTRUCTIONS ON PROPERTIES OF THEIR RESISTANCE

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Studies on 34 conical and cylindrical netting constructions were made. Regardless of hauling speed, geometric characteristics of netting surfaces, and webbing characteristics, the resistance coefficient of conical constructions (within the method error of ± 12%) was found to be independent of their linear dimensions. The conclusions are valid for geometrically similar netting surfaces of a mouth diameter amounting to $D \geqslant 0.95$ m.

INTRODUCTION

The knowledge en effects of netting construction linear dimensions on resistance properties of the constructions is of a significance from the standpoint of methodology of model studies on trawls. The problem has attracted attention of a few workers only, e.g., Dvernik and Gamma (1969); to date, it has not been fully elucidated in the literature. It is for this reason that the present study has been aimed at determining the effect of linear dimensions of conical netting surfaces on properties of their resistance. The surfaces in question are a representation of netting sections of a trawl.

Materials and methods

The studies were carried out on netting constructions made of knotted polyamide webbing manufactured by the Olsztyn Fishing Net Company, Korsze. The nettings used and their more important characteristics measured when wet are given in Table 1.

Each conical construction consisted of 4 triangular sections of netting joined by their equal sides (without forming a selvedge) and mounted on rigid circular frame (Fig. 1). A shape of the netting surface thus formed was determined by the cutting rate (C) of the equal sides of each triangle (Fig. 1 a) and by the hanging proportionate (u) of the base.

Each cylindrical construction consisted of a rectangular section of netting in which edges cut along the "N" were joined (without forming a selvedge); one of the edges cut along the "T" (a base) was mounted on a rigid frame, the remaining part of the edge being left free.

Conical and cylindrical constructions of the following respective mouth diameters were studied: D = 0.96; 1.44; 1.915; 2.44; 2.89 m and D = 0.96; 1.915 m. The details of each construction are given in Table 2.

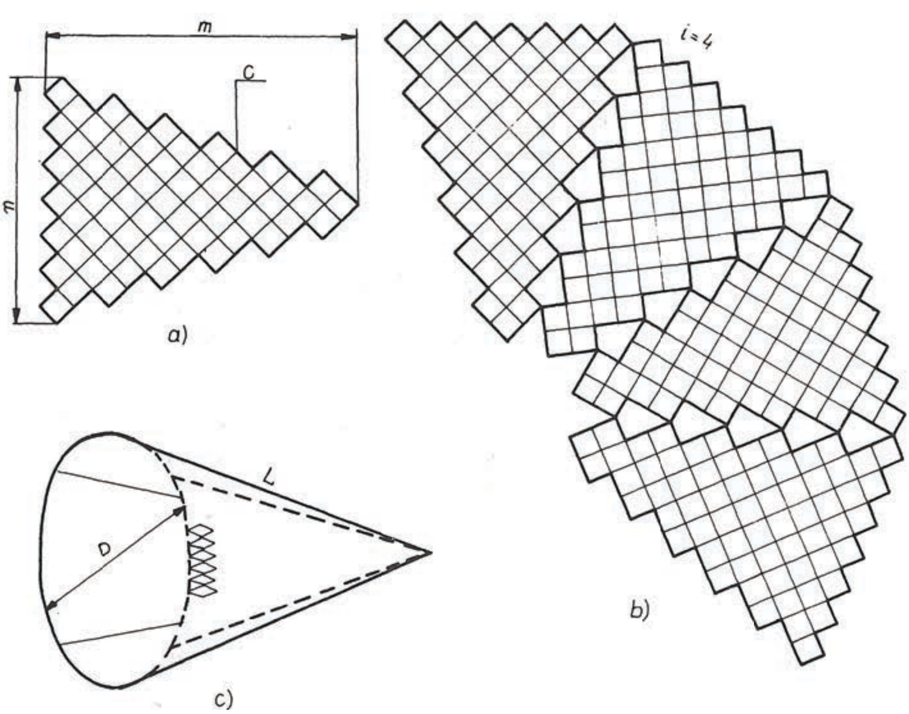

Fig. 1. Elements of a conical netting construction

Table 1

Characteristics of webbing types used for manufacture of the constructions tested

Netting type	Construction No.	Diameter d (mm)					Mesh side length a (mm)				
		Nominal value	Real value	σ	v (%)	u (%)	Nominal value	Real value	σ	v (%)	u (%)
94tex x7x3*	1– 5	2.00	2.46	0.09	3.79	1.42	60.00	64.81	0.29	0.44	0.16
94tex x7x3	6–10	2.00	2.33	0.08	3.45	1.29	100.00	104.45	0.16	0.15	0.06
23tex x5x3	11–25	–	1.00	0.04	4.10	1.54	40.00	40.89	0.19	0.46	0.17
94tex x3x5x3	26–28	3.00	3.34	0.08	2.27	0.85	80.00	82.25	0.52	0.63	0.23
94tex x7x3	29–31	2.00	2.30	0.06	2.43	0.91	50.00	52.03	0.15	0.29	0.11
94tex x7x3	30	2.00	2.30	0.05	2.03	0.76	50.00	50.84	0.21	0.41	0.15
23tex x3x31	32–34	–	0.77	0.02	2.04	0.76	20.00	21.66	0.06	0.27	0.10

* no physico-chemical finish treatment

Measured when wet at 0.5 G/tex weighting, under a microscope

σ = standard deviation

v = coefficient of variation (degree of non-uniformity)

u = error of the mean at P = 0.95

Table 2

Characteristics of constructions tested and results obtained

Construction No.	Construction characteristics						Characteristics of of netting section			C_x^{**}
	Internal diameter of frame D(m)	u	on wet				C	n	m	
			d (mm)	a (mm)	d/a	F_n (m^2)				
1*	0.960	0.42	2.46	64.81	0.038	0.245	1N2B	14	11.5	0.384
2*	1.440	,,	,,	,,	,,	0.573	,,	21	18.0	0.365
3*	1.915	0.41	,,	,,	,,	1.028	,,	28	25.5	0.363
4*	2.400	0.42	,,	,,	,,	1.601	,,	35	32.0	0.381
5*	2.890	,,	,,	,,	,,	2.310	,,	42	39.5	0.364
6	0.960	0.30	2.33	104.45	0.022	0.295	,,	12	11.5	0.230
7	1.440	,,	,,	,,	,,	0.656	,,	18	17.5	0.214
8	1.915	,,	,,	,,	,,	1.156	,,	24	23.5	0.227
9	2.400	,,	,,	,,	,,	1.801	,,	30	29.5	0.196
10	2.890	,,	,,	,,	,,	2.587	,,	36	35.5	0.232
11	0.960	0.42	1.00	40.89	0.024	0.164	,,	22	21.5	0.338
12	1.440	,,	,,	,,	,,	0.366	,,	33	32.0	0.346
13	1.915	,,	,,	,,	,,	0.648	,,	44	43.5	0.345
14	2.400	,,	,,	,,	,,	1.010	,,	55	54.0	0.324
15	2.890	0.41	,,	,,	,,	1.497	,,	67	66.0	0.308
16	0.960	0.42	,,	,,	,,	0.076	AB	22	11.5	0.705
17	1.915	,,	,,	,,	,,	0.313	,,	44	22.5	0.702
18	0.960	,,	,,	,,	,,	0.243	1N1B	22	31.5	0.270
19	1.915	,,	,,	,,	,,	0.967	,,	44	64.5	0.254
20	0.960	,,	,,	,,	,,	0.459	AN	22	31.5	0.146
21	1.915	,,	,,	,,	,,	3.132	,,	44	107.5	0.106
22	0.960	0.31	,,	,,	,,	0.303	1N2B	30	29.5	0.191
23	1.915	0.30	,,	,,	,,	1.242	,,	61	60.0	0.212
24	0.960	0.51	,,	,,	,,	0.110	,,	18	17.5	0.416
25	1.915	,,	,,	,,	,,	0.435	,,	36	35.5	0.467
26	0.960	0.42	3.34	82.25	0.041	0.280	,,	11	10.0	0.322
27	1.935	0.40	,,	,,	,,	1.206	,,	23	22.0	0.290
28	2.890	0.41	,,	,,	,,	2.629	,,	34	33.5	0.315
29	0.960	0.40	2.30	52.03	0.044	0.319	,,	18	17.5	0.340
30	1.935	,,	,,	50.84	0.045	1.326	,,	37	36.0	0.309
31	2.890	0.39	,,	52.03	0.044	3.096	,,	56	55.5	0.316
32	0.960	,,	0.77	21.66	0.036	0.278	,,	45	44.0	0.325
33	1.935	0.37	,,	,,	,,	1.206	,,	94	93.5	0.310
34	2.890	,,	,,	,,	,,	2.750	,,	142	141.5	0.284

* cut cones ** mean of 15 measurements within the speed range of 1.4–1.7 m/s

METHODS

The constructions tested were hauled from the measuring platform (a catamaran) operating on a lake in the vicinity of the Model Studies Station, Ińsko.

The study set-up is diagrammatically presented in Fig. 2. A construction to be tested was placed in the undisturbed flow zone between the catamaran hulls by means of a jib (1) and a hauling line (5) passing through blocks (2), strops (6), and a rope (8). In order to eliminate effects of the frame (10) and gear weights on the resistance, a weight (4) compensating for the weights of the elements listed was hung on a rope (8) via a system of block (7).

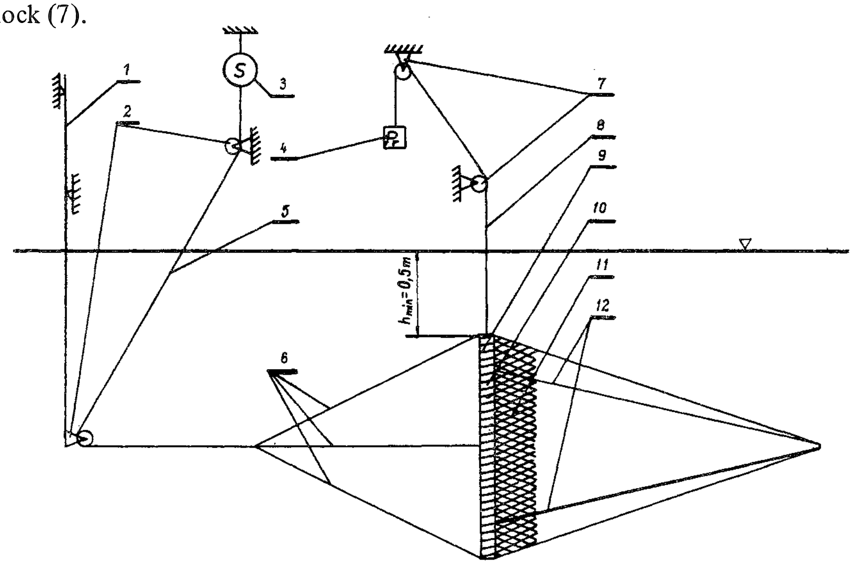

Fig. 2. A diagram of a measuring set-up for studies on hydrodynamic properties of netting construction

The resistance was measured, to ± 0.5%, by means of PRL-T1 bail dynamometers (0–100 and 0–200 kG working ranges) outfitted with clock-type sensors. At the same time, the water flow velocity (V) for the steady flow was measured in the free current. The velocity was measured to ± 2.0:% with a propeller-type OOT flowmeter equipped with a digital-analog transducer.

In order to determine the net resistance (Rs) of a netting construction (11) mounted, by means of a fine yarn (9), on a frame (10), resistance characteristics of the gear $R_o = f(v)$ were determined. The gear resistance (Ro) was subtracted from the total resistance (R_{tot}) (= the resistance of netting and gear combined) to obtain the net resistance of a construction (Rs).

$$Rs = R_{tot} - Ro \tag{1}$$

In the tests performed, the Ro/R_{tot} ratio did not exceed 0.3.

To compare resistance properties of geometrically similar netting constructions of various sizes, a resistance coefficient (Cx) was calculated from the formula

$$Cx = \frac{2\,Rs}{\rho\, v^2\, Fn} \tag{2}$$

where: Rs = resistance of a netting construction (N)

ρ = water density (1000 kg m^{-3}, on the average)

Fn = true net surface (yarn surface) of the netting (m^2).

The true net surface was calculated as

$$Fn = a\,d\,i + d^2 p \tag{3}$$

where: a = mesh side length (m)

d = yarn diameter (m)

i = no. of meshes in the construction

p = no. of knots in the construction.

Considering the accuracy of measurements and unevenness of the netting under study, the maximum error of a Cx value calculated did not exceed ± 12%. The magnitude of the error was determined according to Świnarski et al. (1979).

RESULTS AND DISCUSSION

The relationships between linear dimensions of netting surfaces and their resistance properties were determined at different

- speeds,
- netting characteristics,
- geometric characteristics of the netting surfaces.

Resistance properties of geometrically similar, conical netting surfaces of different linear dimensions as related to various speeds were the subject of earlier studies (Świniarski et al., 1979). The course of function Cx = f(v) within the speed range of 0.6–3.6 m/s was found to be independent of a conical surface linear dimensions due to the fact of a weak (not exceeding the measurement accuracy) relationship of Cx = f(Re^d) existing for netting surfaces made of various types of nettings and showing various geometric characteristics (angles of incidence).

The studies referred to were performed on four-walled netting constructions manufactured so that each selvedge contained two rows of meshes. As a result, the ratio between the netting surface confined in selvedges and the total surface ranged within 0.02–0.25, higher values being found for small and lower for large constructions. A different composition of resistance characteristics in large and small constructions made it impossible to compare the resistance coefficients quantitatively. It is for this reason that selvedges have not been used in the constructions tested in the present studies, the net surface of a netting being equal to the total surface of yarn used.

The results, presented on a graph (Fig. 3) allow to state that within the speed range of 1.3–2.1 m/s, regardless of the size of a construction, deviations from the mean Cx value

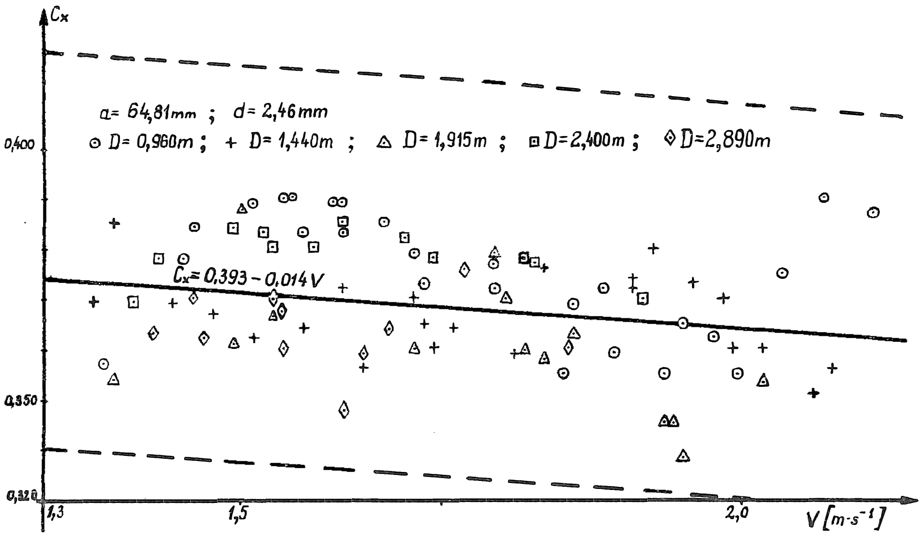

Fig. 3. Effects of speed and size of netting constructions on their resistance properties

do not exceed the measurement accuracy. The zone of possible deviations from the mean, resulting from the method employed, is limited by the broken lines in Fig. 3.

Based on the results reported by Świniarski et al. (1979) and those presented in Fig. 3 it can be concluded that the resistance coefficients of geometrically similar netting constructions differing in linear dimensions remain similar regardless of hauling speed. It is for this reason that the mean Cx calculated for each construction from 15 measurements of resistance and speed (within the speed range of 1.4–1.7 m(s) will be used further on.

Figs. 4 and 5 present resistance coefficients determined from measurements of resistance characteristics of conical surfaces with D = 0.96 m and D = 1.915 m base diameter, showing different geometric characters. A comparison of these data shows the resistance coefficient Cx to be practically independent of the construction dimensions, when tested at various angles of incidence resulting from both a changing hanging coefficient (Fig. 4) at C = const = 1N2B and a changing cutting rate at u = const = 0.4 (Fig. 5).

The graphs in Fig. 6 show results of tests performed on netting constructions of various size made of several types of netting. The data indicate the change in size of a construction, whatever the netting type, tp bear no direct effect on Cx. The conclusion is substantiated by the fact that the deviations from Cx are for each construction within the range limited by the measurement accuracy and show no tendency to change in any defined direction with changes in the construction size.

The results presented here are consistent with those obtained from cut cones of netting by Dvernik and Gamma (1969). They point to a weak effect of linear dimensions of a netting surface on its resistance properties and netting characteristics of the

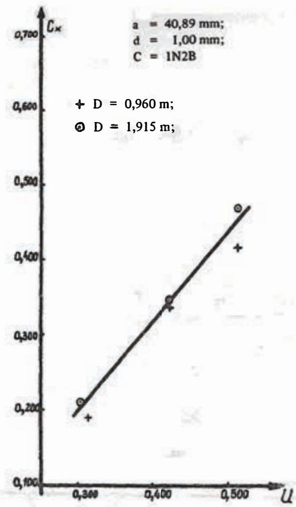

Fig. 4. Effects of hanging coefficient and size of netting constructions on their resistance properties

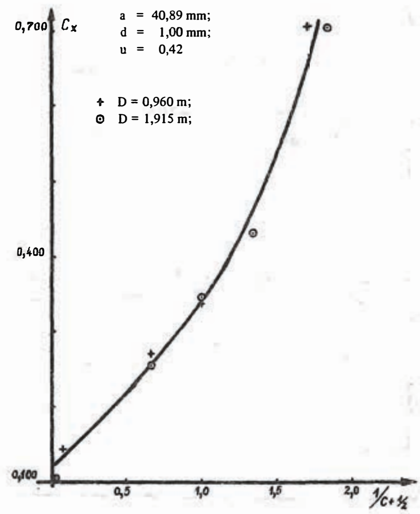

Fig. 5. Effects of cutting rate and size of netting constructions on their resistance properties

construction. The results confirm the hypothesis adąanced by Fridman (1969) that, in a netting construction showing a certain angle of incidence relatiąe to the water flow direction, a mesh is the element in which the major hydromechanical processes occur. Therefore any change in the construction, the geometric characteristics remaining constant, brings about an increased resistance, proportional only to the resistance area (Fig. 7) and speed.

The results were obtained from netting constructions of various size (the maximum difference in size as measured by the inlet diameter and resistance area were 1: 3 and 1: 9, respectively) that could be treated as simplified representations of trawl elements.

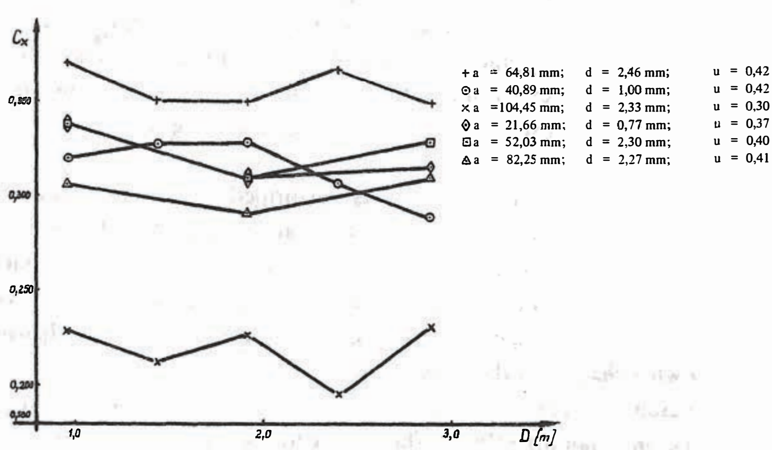

Fig. 6. Effects of webbing type and size of netting constructions on their resistance properties

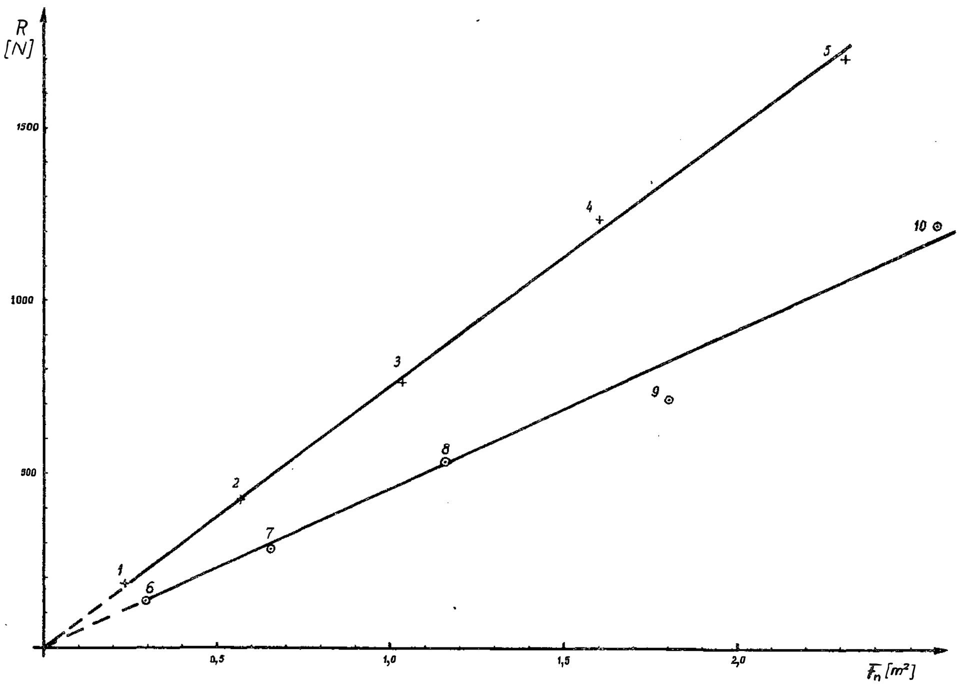

Fig. 7. Relationship between the resistance of geometrically similar netting constructions and their size 1–10: consecutive numbers of constructions tested

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WPŁYW WYMIARÓW LINIOWYCH STOŻKOWYCH KONSTRUKCJI SIECIOWYCH NA ICH WŁAŚCIWOŚCI OPOROWE

Streszczenie

W pracy przedstawiono wyniki badań 34 stożkowych i cylindrycznych konstrukcji sieciowych. Na podstawie wyników badań ustalono, że (niezależnie od prędkości holowania, charakterystyka

geometrycznych powierzchni sieciowych i charakterystyk jadra) współczynnik oporu stożkowych konstrukcji sieciowych, w granicach dokładności pomiarów ± 12%, nie zależy od ich wymiarów liniowych. Wnioski dotyczą geometrycznie podobnych powierzchni sieciowych o średnicy wlotu D ⩾ 0,95 m.

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ВЛИЯНИЕ ГАБАРИТНЫХ РАЗМЕРОВ КОНИЧЕСКИХ СЕТНЫХ КОНСТРУКЦИЙ НА ИХ ГИДРОМЕХАНИЧЕСКИЕ СВОЙСТВА

Р е з ю м е

В работе представлены результаты исследований 34-х конических и цилиндрических сетных конструкций. На основе результатов экспериментов нашли, что (независимо от скорости буксировки, геометрических параметров сетных оболочек и характеристик сети) коэффициент сопротивления конических сетных конструкций, в пределах точности измерений ± 12%, не зависит от их габаритов. Выводы справедливы для геометрически подобных сетных оболочек с основанием D = 0,95 м.

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Received: 25 VIII 1981 r.

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