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Fishing gear

ANALYSIS OF RESISTANCE AND MOUTH GEOMETRY OF PELAGIC TRAWLS USED TO CATCH SCATTERED FISH SCHOOLS *

ANALIZA OPORU I GEOMETRII WLOTU WŁOKÓW PELAGICZNYCH DO POŁOWU ROZPROSZONYCH ŁAWIC RYBNYCH

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Models (1:10) of large pelagic trawls to be used by large trawlers for catching scattered fish schools were compared in terms of their performance parameters, with a particular reference to mouth geometry and resistance characteristics in relation to changes in construction and rigging parameters.

INTRODUCTION

The recent progress in pelagic trawl construction involves primarily a mouth opening increase and improved hydrodynamic properties (Świniarski et al., 1979; Dudko et al., 1982), which is closely connected with application of better, stronger netting materials of improved hydrodynamic properties (Kwidziński et al., 1985; Wagner et al., 1985). An increase in the trawl mouth gap is attained mostly by using a netting fabric with larger mesh size or by substituting netting with ropes. The mouth size determines the amount of water swept and the amount of fish caught, which is particularly important in open ocean fishing grounds and whenever scattered fish schools are to be harvested.

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The trawl size and, consequently, its resistance characteristics have to be adjusted to the towing power of a vessel (Świniarski, 1976; Nowakowski, 1980; Cetinić and Świniarski, 1980). Along with operating small and medium–size boats, many countries use large (5 000 – 10 000 HP) super–trawlers (Świniarski, 1989), which is also the case in Polish deep–sea companies.

The objectives of the present study are:

1. To characterize performance parameters of large pelagic trawls, based on model studies, with a particular attention being paid to:
   – mouth geometry analysis,
   – drag analysis;
2. To analyze effects of changes in trawl construction and rigging parameters on mouth opening surface.

MATERIALS AND METHODS

The object of the study was the WP4/8–150/456×4 pelagic trawl, a basic trawl construction designed for use by the Polish 5 000 HP trawlers to catch scattered fish schools.Construction of the trawl and its 1:10 model is presented in Fig. 1; the standard rigging is shown in Fig. 2. Details of the trawl construction are listed below:

a symmetric 4–wall belly;

bar–cut (B) sling wings (3–mesh base, 1–mesh height) constructed of 3 m long slings;

equal length of all the framing ropes (head, foot, side, and wing ropes), bosoms formed by additional transverse ropes or by kite lines;

the sling belly perimeter, hung on 8 identical wings, consists of twenty four 38 m meshes,

the terminal part of the sling belly with mesh sizes of 13, 8, 6, and 6 m is strongly creased (1:4), which allows to hung one of the eight 12–wing parts of the netting belly underneath each 3–mesh wing;

the netting belly consists of 8 identical parts; the first 3 segments of 1600, 1200, and 800 mm mesh sizes and the last segment (50 mm mesh size) are cut normally (N), which makes it possible to lace them with mesh hoods;

the three middle segments (400, 200, and 100 mm mesh size) are identically cut (1N1B) and are laced in 1/2 cycle, similarly to the lacing pattern between the last segment and the codend.

The studies were made at the Model Research Station at Ińsko, using the methodology and underwater observations developed at the Station and described in detail in earlier papers (Kwidziński, 1986, 1990; Świniarski et al., 1990).

As the present study is comparative in character, results of tests on WP4–118/336× 104/224 are presented as a reference.

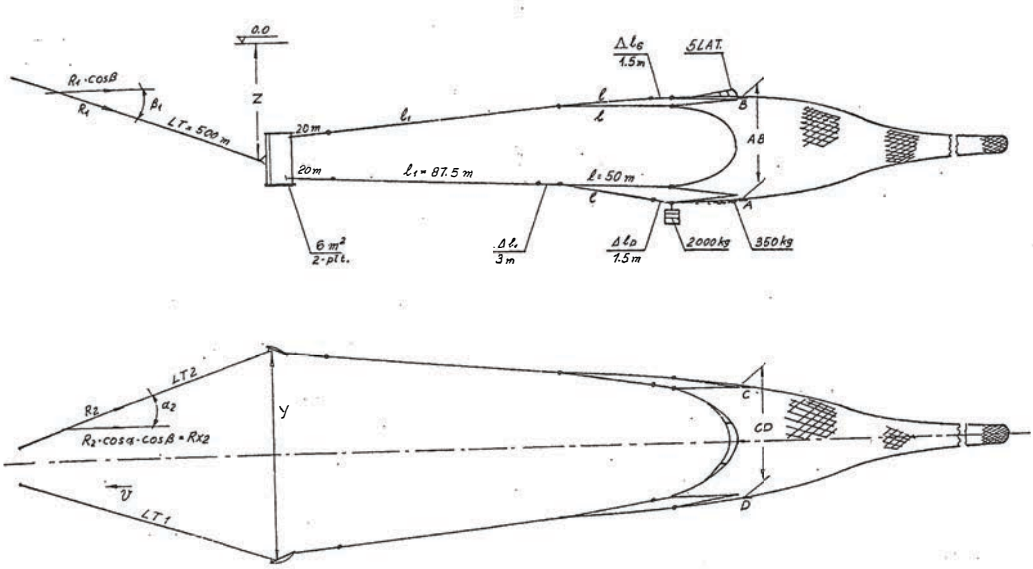

Fig. 1. Construction of the pelagic trawl WP/8–150/456×4

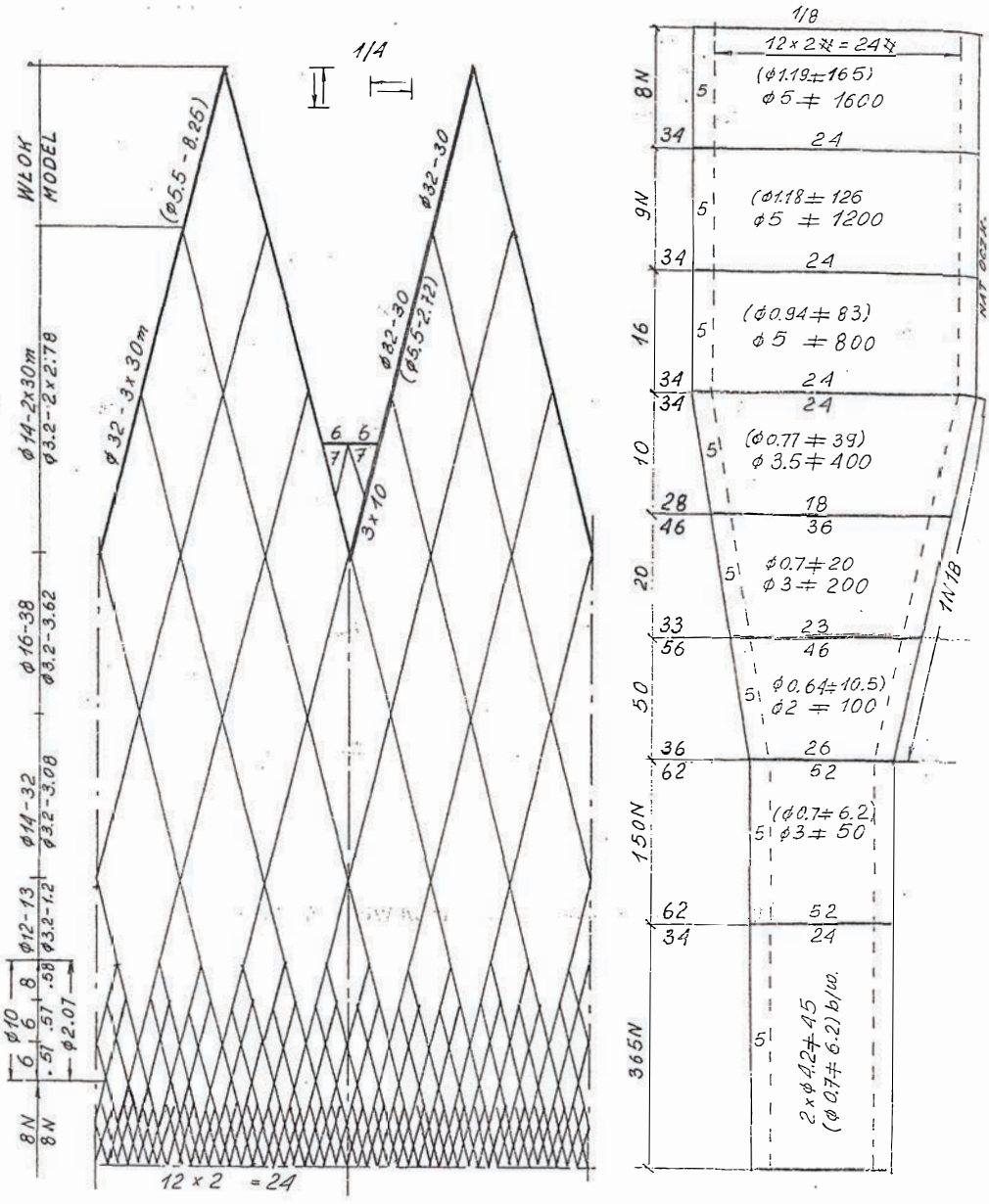

Fig. 2. Standard rigging of trawls modelled and diagram of performance measurements of models towed by warps

RESULTS AND DISCUSSION

Each model tested was observed and photographed under water and its technical parameters measured.

The underwater observations demonstrated the necessity to change the length of two slings originating from head and foot rope bosoms. Once the slings were shortened to lengths given in Fig. 1, the kite set performed well (Fig. 3). The framing ropes were observed to twist during shooting and hauling in. However, once the trawl opened in the water, the ropes were observed to straighten out. Additionally, the meshes in the terminal part of the belly were observed to open unevenly (Fig. 4 and 5). This is the result of creasing used in that part of the trawl. The 8–wall netting belly performed well and smoothly passed into the 8–wall codend (Fig. 6); this evidenced a smooth transfer of drag forces by individual meshes, which is a sign of a good construction.

Table 1 contains data on rigging variants of the two trawl models (the reference one and the tested one) and summarizes trawl parameters, calculated from regression equations developed for the models. The table contains absolute values (Wi) and relative parameter values (Wc/Wj) as the percentages of the respective reference trawl parameter.

Comparison of the geometric parameters of the tested (Fig. 1, Table 1) and the reference trawl (Table 1) the model of which was tested in 1988, showed that WP4/8–150/456 had larger:

- resistance surface (by 33%)
- belly mouth perimeter (by 46%)
- sling belly length (by 66%)
- netting belly length (by 60%)
- trawl length (without wings) (by 64%).

On the other hand, comparison of the performance of the two trawls with standard rigging (Fig. 2, Table 1) showed that, at a slightly higher (by 2 – 5%) drag, the WP4/8–150/456 had larger:

- between–doors distance (by 12 – 19%)
- horizontal opening (by 18 – 26%)
- vertical opening (by 2 – 6%)
- opening surface (by 26 – 27%),

while the specific drag was lower by 16 – 23%.

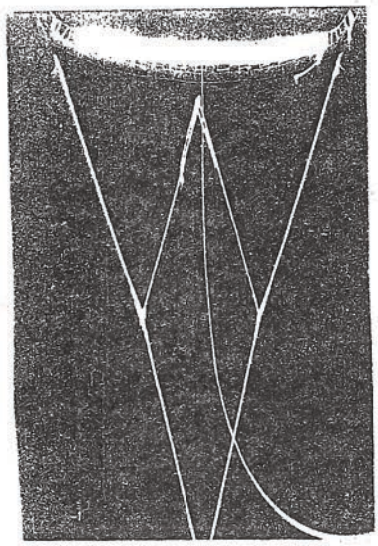

Fig. 3. Properly performing kites

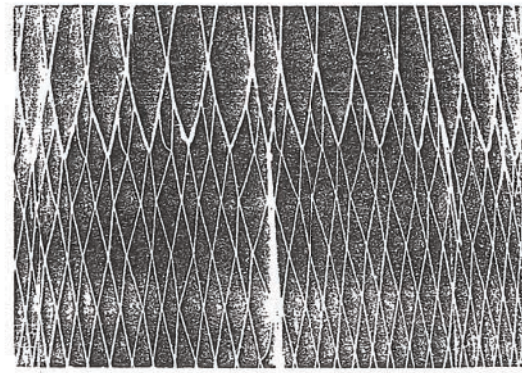

Fig. 4. Line and netting belly junction

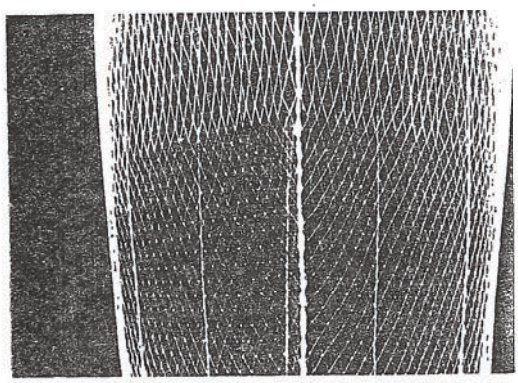

Fig. 5. Belly 800 and 400 m segment junction

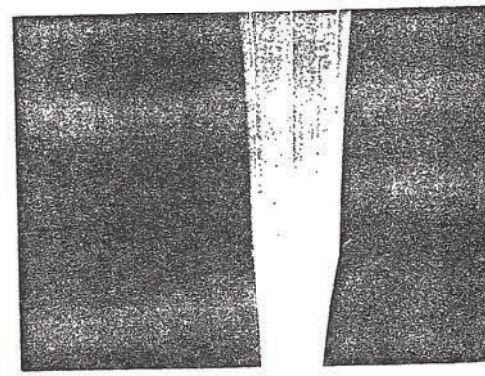

Fig. 6. Belly – codend junction

Table 1

Rigging and performance parameters (W) of WP4/8–150/456×4 vs. WP4–118/336 trawls as determined from tests on models

Trawl/model		WP4–118/336			WP4/8–150/456×4					
resistance area	m^2	288 / 6.32			384 / 8.1					
legs	m	88	154	154	88	154		154		
Additional legs	m	50	88	88	50	88		88		
Main sinker weight	kg	2000			2000					
Groundrope sinker weight	kg	350			350					
Kites	m^2	5			5					
Doors	m^2/°	7/18			7/18					
Warps	m	500	500	900	500	500		900		

Parameter	v (m/s)	W_0	W_1	W_2	W_3	$\frac{W_3}{100}$ %	W_4	$\frac{W_4}{W_3}$ %	W_5	$\frac{W_5}{W_3}$ %
Between doors distance (v) m	1.8	123	118	165	140	114	138	99	152	109
	1.9	127	127	166	143	113	144	101	167	117
	2.0	130	134	166	146	112	150	103	180	123
	2.1	132	140	167	149	113	165	111	190	128
	2.3	134	152	168	155	115	169	109	204	132
	2.5	131	154	169	156	119	173	111	209	134
Vertical gap (AB) m	1.8	80	88	90	85	106	107	126	105	124
	1.9	76	84	85	81	106	101	125	98	121
	2.0	73	81	81	77	105	96	125	92	119
	2.1	70	78	77	74	104	91	123	87	118
	2.3	66	75	70	68	103	84	124	78	115
	2.5	64	74	65	65	102	78	120	72	111
Horizontal gap (CD) m	1.8	65	54	70	77	118	68	88	82	106
	1.9	66	57	70	78	119	71	91	85	109
	2.0	66	60	70	79	120	74	94	88	111
	2.1	67	62	70	80	121	76	99	90	113
	2.3	66	64	71	81	123	79	98	93	115
	2.5	65	64	72	81	126	81	100	92	114
Belly mouth surface area (AW) m^2	1.8	5180	4800	6290	6560	127	7340	112	8610	131
	1.9	5000	4800	5970	6330	127	7200	114	8330	132
	2.0	4820	4900	5680	6120	127	7060	115	8100	132
	2.1	4660	4900	5420	5920	127	6920	117	7830	132
	2.3	4390	4900	4990	5560	127	6620	119	7250	130
	2.5	4170	4700	4690	5270	126	6310	120	6620	125
Drag on warps (RX) kN	1.8	160	169	167	158	99	161	102	174	110
	1.9	174	183	190	173	100	176	102	193	112
	2.0	190	197	211	189	100	192	102	211	112
	2.1	205	211	232	206	101	209	101	230	112
	2.3	235	242	270	243	103	245	101	267	110
	2.5	266	275	303	283	103	286	101	305	108
Unit drag (Q) N/m^2	1.8	31	36	26	24	77	22	92	20	83
	1.9	35	38	32	27	78	24	89	23	85
	2.0	39	41	38	31	79	27	87	26	84
	2.1	44	43	43	35	80	30	86	29	83
	2.3	54	50	54	44	81	37	84	37	84
	2.5	64	58	64	54	84	45	83	46	85

Analysis of the performance of the trawls tested allows a suggestion that the trawls could have reached better parameters with longer hauling ropes.

To test this hypothesis, the length of whiskers, legs, and warps was increased to 88 m, 154 m, and 900 m, respectively, and the models were tested with the remaining rigging elements unchanged. Compared with the standard rigging (Table 1, Fig. 7), the trawls thus modified and towed at 1.8 – 2.5 m/s reached:

	WP–118/336	WP–150/ 456
– between–doors distance larger by	34 – 29%	10 – 20 %
– horizontal opening larger by	8 – 11%	6 – 14%
– vertical opening larger by	13 – 2%	24 – 11%
– belly mouth surface larger by	21 – 12%	32 – 25%
– total drag higher by	4 – 14%	11 – 8%
– specific drag lower by	16 – 0%	17 – 15%

The vertical gap and between–doors distance in WP4/8–150/456 exceeded 100 m and 200 m, respectively. One can suppose that the use of slings longer than 30 m in the wings, elongation of whiskers and legs to 100 m and 200–250 m, respectively, and introduction of larger doors will result in a mouth opening surface exceeding 10 000 m^2 .

The comparison between WP–118/ 336 and WP–150/456 shows the latter to have a better potential to reach a larger mouth opening and more advantageous drag characteristics.

CONCLUSIONS

1. Underwater observations of the model revealed slight construction defects in the first version of the trawl. After the necessary changes had been made, each part of the model as presented in Fig. 1 performed well, without twists and deformations near lace hoods. Also the kite set behaved as required.
2. Analysis of the results contained in Table 1 and Fig. 3 showed that longer ropes (whiskers, legs, and warps measuring 88 m, 154 m, and 900 m, respectively) allowed to increase the belly mouth opening surface by 25 – 32% with drag being increased by 8 – 11% only and the specific drag being reduced by 17 – 15%, which resulted in a very advantageous value of 20 – 46 N/m^2

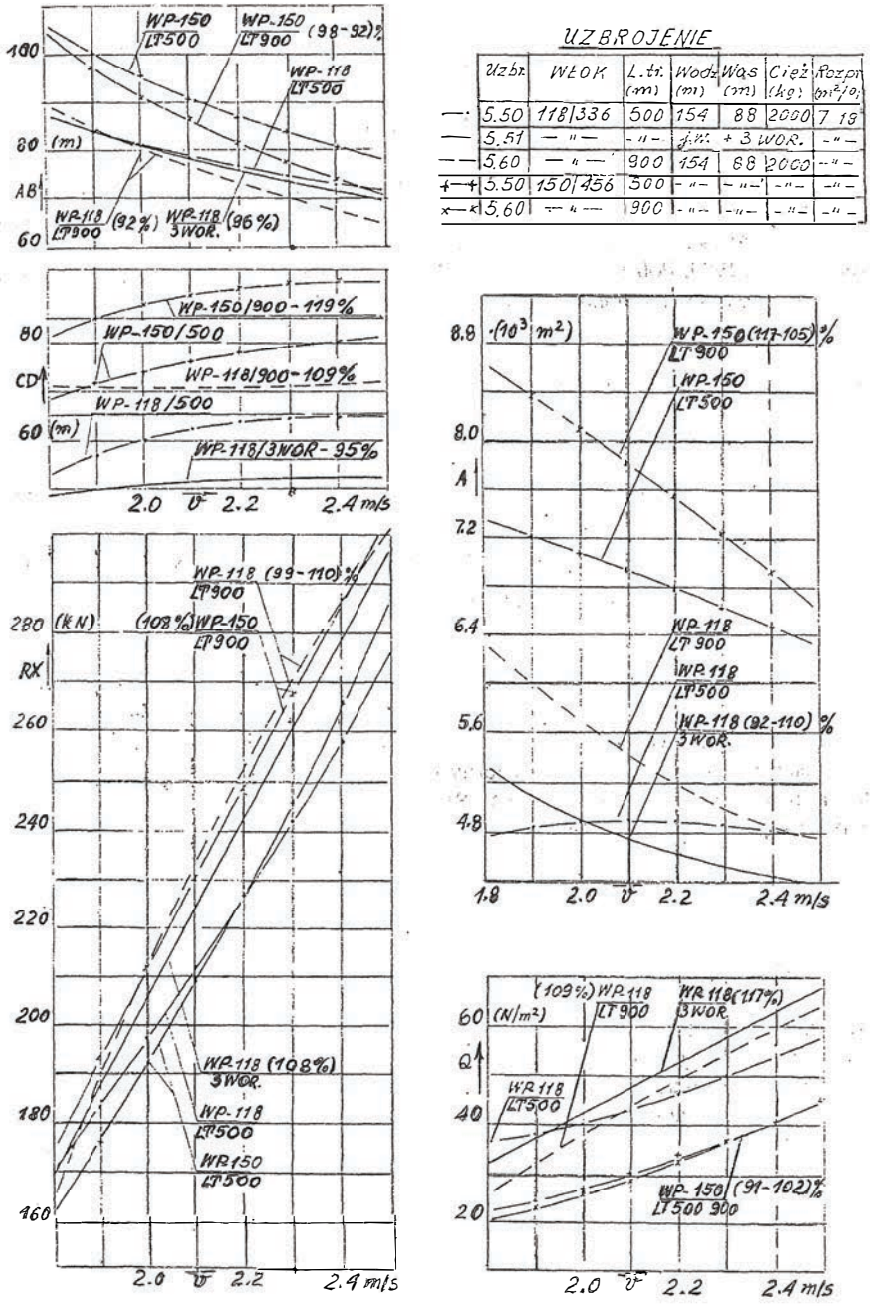

Fig. 7. Performance parameters of WP4/8−150/456×4 vs. WP4−118/336 with elongated legs and additional legs after elongated warp from 500 to 900 m(%; 2.4 m/s)

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ANALIZA OPORU I GEOMETRII WLOTU WŁOKÓW PELAGICZNYCH DO POŁOWU ROZPROSZONYCH ŁAWIC RYBNYCH

STRESZCZENIE

W pracy przedstawiono porównanie parametrów geometryczno–oporowych modeli, w skali 1:10, wielogabarytowych włoków pelagicznych stosowanych na trawlerach o mocy 5–10 kM do połowu rozproszonych ławic rybnych. Szczególnie uwzględniono geometrię wlotu oraz charakterystyki oporowe w zależności od zmian konstrukcji i uzbrojenia.

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