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A METHOD OF STUDYING TRAWL MODELS IN THE EXPERIMENTAL STATION OF THE FACULTY OF SEA FISHERIES AND FOOD TECHNOLOGY

TECHNIKA BADANIA MODELI REDUKCYJNYCH WŁOKÓW W OŚRODKU DOŚWIADCZALNYM WYDZIAŁU RYBACTWA MORSKIEGO I TECHNOLOGII ŻYWNOŚCI

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Techniques of measurements and underwater observations of models of trawls and other fishing gear in a lake, with the use of a motor catamaran, are presented

INTRODUCTION

Trawling is still of a considerable importance for the Polish sea fisheries. Therefore problems of trawl construction and operation play a significant role in teaching and research programmes of the Faculty which educates cadres for the fisheries.

Experimental work in this field of technology calls for setting up special research facilities adjusted to the existang needs and technological-financial possibilities.

First practical moves in this direction were undertaken at the Faculty within 1960–1963: a series of experiments on trawl models was performed (Zięcik and Kwidziński, 1966). The models were towed by a motor boat along a water course on a lake. Movement resistance at various trawling speeds was measured and underwater observations on behaviour of the models were made. A group of divers, consisting of the Faculty's students and staff, participated in that programme.

Within 1968–1970, further research was carried out on a series of geometrically similar models; the experiments were performed at the Shipbuilding Institute, Gdańsk Technical University's experimental centre at Iława (Kobyliński, 1971).

Practical experience accumulated during the above projects was made use of to set up, in 1971–1975, the Model Research Station at Ińsko.

The Station was formally established in 1975 as a unit belonging to the Institute of Aquaculture and Fishing Techniques. The location of the Station at Ińsko, on the Lake Ińsko, was decided based upon the advantageous hydrographic conditions of the Lake (4–6 m water transparency, elongated shape), a rather easy access, and a possibility of obtaining a partly prepared area.

In July 1976, a dock and the Station building were ready; the building contains an electronic laboratory, a photographic darkroom, a workshop, and bedding arrangements for 7 people.

The aims of the station are:

- to carry out research-development projects in fishing techniques and trawl construction, with a due consideration to the needs of the Polish fisheries;
- to carry out practical training of students in fishing gear construction and exploitation;
- to demonstrate new technological achievements to fishing vessels officers.

Additionally, the Station serves as a diving base for the training of divers and for experimental work involving SCUBA diving.

Each year a symposium is held at the Station, with a participation of fishing gear

Fot. 1. The catamaran during work on the lake

specialists, fishing vessels officers, and employees of other institutions. Current research, is discussed and new constructions demonstrated on trawl models.

Facilities and techniques, described below, serve to implement these aims.

Measurement platform

The basic ficility of the Station is a floating measurement platform (Fot. 1), patterned on a similar construction serving to study ships models at the Gdańsk Technical Universit's experimental centre at Iława.

The platform is a motor (2x77 KW) two-hull craft (a catamaran), 11.7 m long, 8.3 m wide, 83.4 kN displacement. The maximun speed is 4.5 m/s; the maximum tractive effort is about 6 kN at the 3 m/s speed.

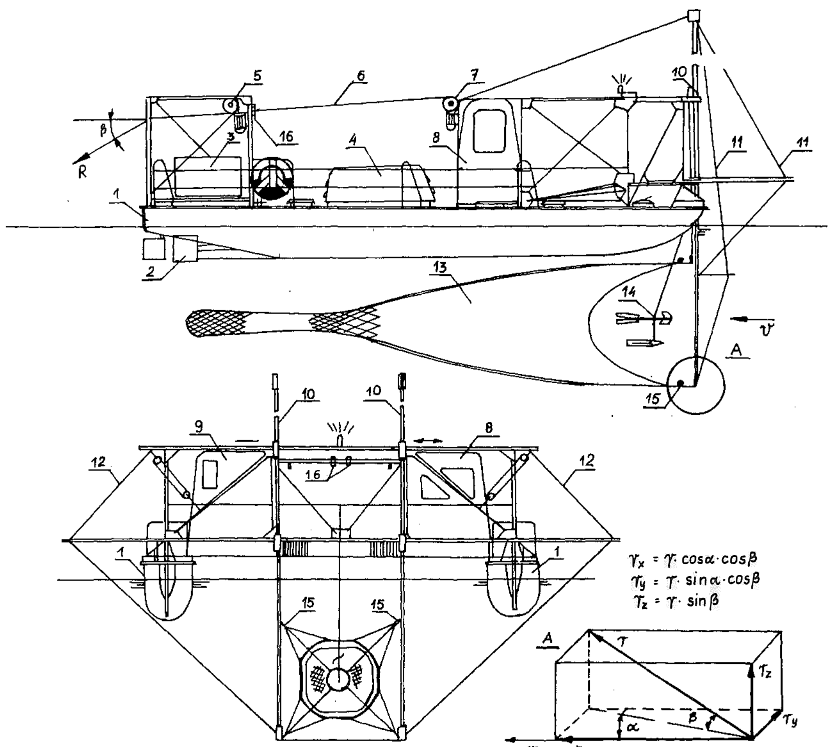

Fig. 1. The measurement platform (catamaran) for testing trawl models:
1. platform float, 2. screw shielding, 3. electric generator, 4. engine room, 5. diver winch, 6. warp, 7. trawl winch, 8. steering room, 9. measurement room, 10. beam, 11. bow spring, 12. side spring, 13. trawl model, 14. log, 15. underwater dynamometr coupled with angle-meter, 16. on-board dynamometr coupled with angle-meter α and β; r = hydrodynamic reaction; r_x, r_y, r_z = reaction components; v = speed

The platform's construction makes it possible to tow a trawl model in two ways:

a) the main body of the trawl, supported by two beams in the bow is towed underneath the platform (Fig. 1). The trawl mouth opening is pre-set and can be adjusted within the ranges of 0.5–7.6 m and 0.25–6.5 m horizontally and vericallly respectively. The model can be directly viwed in motion after removing the deck boards. The model resistance is measured with electric dynamo meters coupled with angle maters, mounted on the beams;

b) a model with its rigging (towing ropes, otter boards, loads) is towed behind the stern on warps, put out and hauled in by means of a hydraulic winches. In this case, the process of trawling used on board stern trawlers is being modelled.

Measuring equipment

The platform is equipped with multi-channel electric digital devices to control and register data describing model's resistance and opening in water. The devices include:

– analog signals feeding and standardisation system for the screw log and electric dynamo meters, each of the latter being coupled with electric angle-meters;
– an ultrasonic opening meter provided with 4 tubular ultrasonic transducers;
– a KB-5502 eight-channel digital recorder coupled with a DT-105 tape punching machine or with a PK-1 cassette memory.

The equipment described above allows to simultaneously measure 8 parameters describing the model behaviour. The initial signal (0–4 V) of various transducers is brought to the recorder where it is transformed into a digital form in an analog-digital transformer. Then the signal is fed into the tape punching machine control system where it is transformed according to the ISC-7 code. Cassette recording is also possible. The repetition period is 2 s. The data are recorded as sequences of eight 4-digit numbers, each with a 2-digit channel number. They can be printed as matrices (using a tape reader and a telex) or shown on an alpha-numerical screen. This is usually done at random to check the reliability of recording and measuring. The data from correct measurements are fed, directly from the tape, into a computer where they are decoded, ordered, sorted, and worked out according to an appropriate program. The computer produces results as tabular prints.

In 1985, the measuring equipment on the katamaran was coupled with a ZX – Spectrum microcomputer provided with appropriate software and peripheral facilities (monitor, casette memory, printer). Such a set up has made it possible to increase the number of measurement channels to 32 and to obtain mathematical, graphic, and tabular work-out of the data, the results being printed aut on the spot, on termination of the measurements.

The following measurements on models towed on beams are made with the above-described equipment (Fig. 1):

- towing speed V, with the accuracy of 1% of the measured value;
- hydrodynamic reaction r_1 (where i = n = 4) at the points of mounting the model on the beams (Fig. 1), with the accuracy of 2% relative the 1 kN range;
- angles between the catamaran symetry plane and the reaction r_1 direction, α_i, with the accuracy of 2% relative the 0.4 rad range.

The angles α_i and the distance between electric dynamo meter's mounting points being known, the angles β_i between the horizontal plane and the reactions r_i can be calculated.

On the other hand, the following parameters are measured on models towed on trawling lines:

- trawling speed V;
- warp tension; r_1 for the right-hand warp and r_2 for the left-hand one, with the accuracy of 2.5% relative the 3 kN range;
- mean angle of warps spacing relative the catamaran symmetry axis, $\bar{\alpha} = 0.5\ (\alpha_1 + \alpha_2)$, with the accuracy of 2% relative the 0.4 rad range;
- warp angle β_1 andβ_2, relative the horizontal plane, with the accuracy of 2% relative the 0.4 rad range;
- vertical opening AB and horizontal opening CD, with the accuracy of 1% relative the 10 m range.

Piezo-ceramic transducers used to measure openings and denoted A, B, C and D are mounted within the foot line (A), head line (B), right side line (C), and left side line (D) bosums. The small size (20 mmdiameter, 90 mm height) and low weight of the tubular transducers cause no noticeable model deformations on measurement, which has been confirmed by underwater observations on trawling. The radial characteristics of ultrasonic impulses (62.5 kHt frequency) emmission facilitates mounting of the transducers on the model. It is necessary only to see that their axes are approximately parallel to the direction of movement.

The electric coupling between the transducers and the opening meters on board proceeds through a 4-strand cable (about 7 mm external diameter). The terminal 10 m long section of the cable towards the model consists of 4 single 4 mm diameter cables connecting the main cable with the in dividual transducers.

The openings of the model are measured in a hydroacoustic communication system. The transducers A and C send signals as ultrasonic impulses, while B and C receive the signals and transform them into electric field passed through the cable to a receiver in the opening meter. A precise measurement of the amount of time from sending a signal to receiving it, carried out by an electronic system, gives a direct information on a distance between the individual transducers, assuming the ultrasonic waves propagation velocity in water being known and constant under the circumstances gives. The final effect of the further transformation of this information is that in the "out" section of the electronic system of a reciver, a voltage proportional to A-B and D-C distances appears.

Moreover, the transducer, A can be eoupled to the ultrasonic echosounder echograph, in which case its operation in based upon the echo reflected from the water surface, and sometimes from the bottom, too. Thus is possible, based on the continuous record on the echogram, to follow the model location in water and in relation to the bottom.

When the trawling speed and depth are established, the transducer A is switched over to the opening meter for the time of data recording (15–20 s). At that time the following parameters are measured and recorded: vertical and horizontal opening in synchrony with the speed measurement, resistance, and warp angles. Having recorded 5–8 sequences of the parameters measured, the transducer A is switched over to the echograph, which is accompanied by an 0.1–0.2 m/s change in speed and another measurement is made. Usually 6–10 such measurements are performed within the trawling speed range of 1.8–3 m/s.

The results, processed mathematically in a computer, are presented as tabular prints in function of speed (V). Apart from the parameters measured directly (V, α_i, β_i, r_i, AB, and CD), each table contains values of derived parameters, calculated from the previous ones.

The sum of absolute values of the hydrodynamic reaction components is calculated from the equations:

$$RX = \sum_{i=n}^{i=1} r_i \cdot \cos\alpha_i \cdot \cos\beta_i$$

$$RY = \sum_{i=n}^{i=1} r_i \cdot \sin\alpha_i \cdot \cos\beta_i$$

$$RZ = \sum_{i=n}^{i=1} r_i \cdot \sin\beta_i$$

where: n = 4 for measurements of the model on beams

and

n = 2 for measurements of the model on warps.

For the latter, the between-otter boards distance (Y and their dept (Z) are calculated from the relationships:

$$Y = 2\, l_t \sin\bar{\alpha} \cdot \cos\bar{\beta} + O \cdot S$$

$$Z = l_t \cdot \sin\bar{\beta} - 2$$

the between-dynamometers distance (0.8), their location above the water level (2), and warp lenght (l_t) being included.

To compare different trawls, the trawl resistance (Q) per 1 m^2 mouth surface area A_w = AB x CD is calculated.

$$Q = \frac{R_x}{A_w} \cdot \frac{C_L^2}{C_F}$$

where: C_L = model dimensions scale,
C_F = forces scale.

For a set of measured data W_j (e.g., R_x, AB, CD, Q, Y), correlation coefficiens (R), and regression equation coefficients (A_0, A_1, A_2) in function of speed

$$W_j = f(V) = A_o + A_1 V + A_2 V^2$$

are calculated with the least squares method. The equations are used to plot collective graphs to compare functional parameters of different trawl models.

Underwater observations and photography of trawl Models

The Station is provided with SCUBA diving gear and unterwater photography equipment, the Station's staff consisting of qualified divers.

Preliminary, rather cursory, observations of a model towed by beams can be made, as already mentioned, from the catamaran's deck. Detailed observations on the shape of the model and its various elements in motion can be made and underwater pictures taken only by a diver towed along with the model. By means of a special device, called the aquaplane. the diver gets access to various elements of the model. The equaplane is towed on an echosounder cable, which makes it possible for the diver and the catamaran crew to communicate by means of an underwater telephone. The cable is wound on the hydraulic winch drum on the deck. The winch operator, responding to the diver's signals by putting out or hauling in the cable, allows the diver to move along the model.

The aquaplane is provided with a waterproof short length (15 mm) objective photographic camera, which makes it possible to take pictures of relatively large model fragments from a short distance.

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Streszczenie

Badania modeli włoków zapoczątkowane zostały na naszym Wydziale na początku lat sześćdziesiątych. W 1975 r. utworzony został ośrodek doświadczalny nad jeziorem Ińsko w którym prowadzone są:

– prace badawczo-rozwojowe z zakresu techniki połowów i konstrukcji włoków, z uwzględnieniem potrzeb naszego rybołówstwa morskiego;
– zajęcia praktyczne ze studentami naszego Wydziału i innych Uczelni, z zakresu budowy i eksploatacji narzędzi połowu;
– demonstracje nowych rozwiązań technicznych sprzętu połowowego dla oficerów ze statków rybackich;
– szkolenia i treningi płetwonurków;
– sympozja na temat techniki rybołówstwa morskiego.

Prace doświadczalne i szkoleniowe prowadzone są na pomoście pomiarowym (rys. 1). Pomost jest jednostką pływającą, dwukadłubową (katamaran) z napędem motorowym (2 x 77 kW), o długości 11.7 m, szerokości 8.3 m i wyporności 83,4 kN. Prędkość maksymalna pomostu wynosi 4.5 m/s, a uciąg około 6 kN przy 3 m/s.

Konstrukcja pomostu (rys. 2) umożliwia holowanie modelu korpusu włoka na wysięgnikach dziobowych, pod pokładem, lub na linach trałowych, za rufą z pełnym uzbrojeniem.

Pomost pomiarowy zaopatrzony jest w wielokanałową, elektroniczną aparaturę cyfrową do kontroli i rejestracji danych pomiarowych, opisujących opory ruchu modelu w wodzie i jego rozwarcie, jako funkcje prędkości. Dane te są zapisywane automatycznie na perforowanej taśmie papierowej lub na taśmie magnetycznej, co umożliwia później opracowanie ich na elektronicznej maszynie cyfrowej.

Wykonywane są też obserwacje i zdjęcia podwodne modeli włoków w ruchu, przez płetwonurków.

Зигмунт Квидзиньски

ТЕХНИКА ИССЛЕДОВАНИЙ МОДЕЛЕЙ ТРАЛОВ В ОПЫТНОМ ЦЕНТРЕ ФАКУЛЬТЕТА МОРСКОГО РЫБОЛОВСТВА И ТЕХНОЛОГИИ ПИЩИ

Р е з ю м е

Исследования моделей тралов начались на нашем факультете в начале 60-х годов. В 1975 г. создан опытный центр на озере Иньско, в котором ведутся;
- исследовательские работы по технике промысла и конструкциям тралов с учётом нужд нашего морского рыболовства;
- практические занятия со студентами нашего факультета и других вузов в области создания и эксплуатации орудий лова;
- демонстрации новых технических решений орудий лова офицерам рыболовецких судов;
- обучение и тренеровка аквалангистов;
- симпозиумы по теме: „Техника морского рыболовства".

Опытные учебные работы ведутся на измерительной платформе (Рис.1). Платформа - это плавающая единица, двукорпусная (катамаран), с моторным приводом (77кв), длиной 11,7м, шириной 8,3м, водоизмещением 83,4кН. Максимальная скорость платформы 4,5 м/сек, тяговое усилие около 6 кН при 3 м/сек.

Конструкция платформы (Рис.2) даёт возможность буксировать модель корпуса трала на носовых пилонах, под пулубой, или на траловых тросах за кормовой с полным вооружением.

Измерительная платформа снабжена многоканальной электронной цифровой аппаратурой для контроля и регистрации измеряемых данных, описывающих сопротивления движения модели в воде и её раскрытие, как функции скороста. Эти данные записываются автоматически на перфоленте или магнитной ленте, что даёт возможность обработать их позднее на ЭВМ. Также проведень наблюдения и сделаны подводные снимки моделей тралов в движении аквалангистами.

Перевод: к.т.н. М. Лучак

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