WAYS OF SELF-REGULATION OF STEADY MOVEMENT OF A TRAWLING BOARD

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ABSTRACT

In paper some constructive ways of maintenance of self-regulation of steady movement of a trawling board are considered. In all described cases self-regulation occurs at the expense of creation of conditions for aspiration of all operating forces to some geometrical point or area in which the enclosed resultant force of hydrodynamic pressure does not create considerable on size the overturning moments. Offered graphic - analytical way of delimitation of area of steady pressure by conditional a friction interface forms be resulted an example of optimization of the geometrical form of a trawling board by methods of computer modeling with AutoCAD, 3Dmax and MathCAD.

Keywords: *the trawling board, self-regulation of steady movement, displacement of centre of hydrodynamics pressure*

1. INTRODUCTION[1]

Within last decades of years there was a replacement of trawling fleet from the most productive and well mastered shelf areas of a craft in open spaces of the World Ocean. The increase in depth and speeds trawling, increase of the sizes of trawls, growth of traction efforts of vessels and trade mechanisms, necessity mobile congestions of fish have led to sharp increase in dynamic loadings in various parts of trawling system. Trawling systems even more often began to work in non-stationary modes, that is in such modes of movement when the vessel speed, length etched cable, depth of a course of a trawl, force of resistance of various links of trawling system, presence of superficial and internal excitement of ocean simultaneously changes.

Many manufacturers of trawls assert that the trawl overall productivity on 80 % depends on work of trawling boards. With increase productivity extraction the geometrical sizes of trawling boards accordingly raise that leads to possibility of loss of stability of the form of balance.

A trawling board - an element of equipment the trade trawl, providing its horizontal disclosing. It is characterized by the area, the form and hydrodynamic quality — the relation otter forces of a trawling board to force of its resistance at towage. The trawling board contains following basic details: spreading screen, stringers, keel, arches for fastening (fig.1) [1].

The problem of maintenance of stability of movement of a trawling board in the conditions

[1] This paper was translated from Russian with computer software and may be difficult to read in English. As the National Committee did not have resources for professional translation of this paper, Russian text was used for peer review and included in the electronic version of the proceedings for further references.

of excitement of the sea and onboard rolling exists and, typically mutual influence of external loadings and moving concerns that class of problems of hydrodynamics, for which: when not only moving (and deformations, pressure) depend on loading, but also loadings vary depending on moving.

The quantity rotations of a trawl raises with increase trawling depth. The traction efforts increases. It is necessary to remember that any perpendicular effort to a stream is accompanied by occurrence of additional hydrodynamic efforts of front resistance which delays trawling system back on a stream reduces depth trawling one of the reasons unsuccessful work. Inefficient reduction of speed trawling on the big depths is caused by resistance increase wire not only at the expense of length, but also at the expense of increase in an angle of attack to a stream. Therefore so a vital topic of stability of position of a trawling board in trawling system: a trawl −a wire − a vessel.

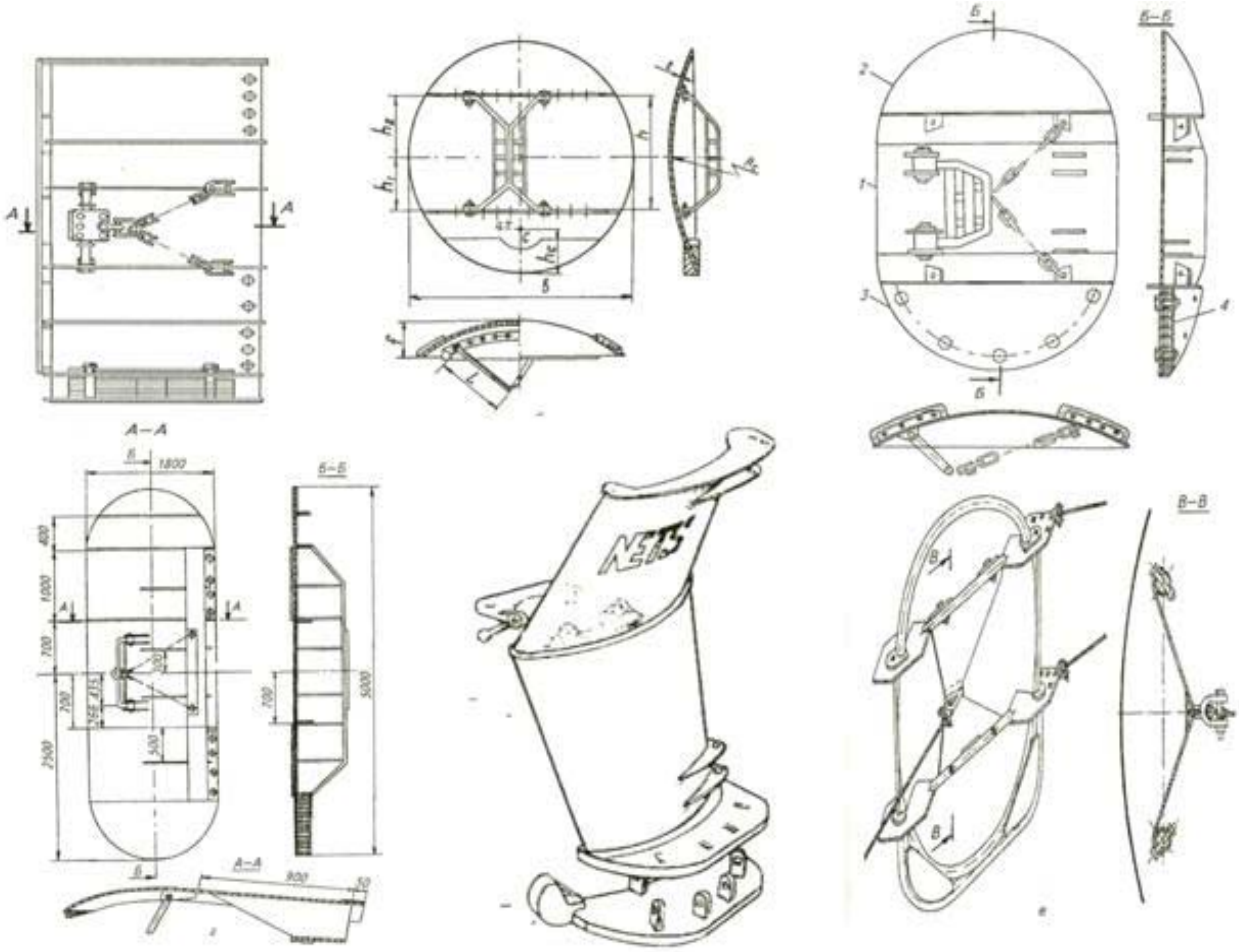


Figure 1. Designs of trawling boards: (from left to right and down) rectangular cylindrical with sub-wing; the round spherical; oval cylindrical; oval cylindrical by V.A.Kuzik; V-shaped board; composite board by V. Voskresenski.

2. SOME PRACTICAL METHODS

2.1 Recommendations of decrease additional bending - torsion fluctuations

There are some traditional practical methods of decrease additional bending - torsion fluctuations in thin-walled spreading screen. This application of the symmetric, closed sections, installation so-called «rigidity edges», excluding *deplanation,* of cross-

section, displacement of a resultant of external forces in «the shear centre» (it «the bend centre», «the rigidity centre» or «the centre of elastic forces») by changing form such as fig.2 [2]. Stability of movement of a trawling board can be raised at the expense of fall of its centre of gravity by weight increase keel, or manufacturing a guard from easier and rigid material (composite boards).

Figure 2. 3D model of V-form trawling board for combination the centre of elastic forces ("the centre of shear") with centre of gravity.

2.2 Some constructive ways of maintenance of self-regulation of steady movement

The basic problem pelagic way trawling especially on the big depths to 1000 m is repeated torsions a trawling board. The points of view on this problem are various, the phenomenon carries the name of autorotation and there is an opinion that an original cause torsions – the big inclination of a board on an outer side in view of a high arrangement of a point of fastening of arches over a plane of a chord and small displacement upwards projections of a point of fastening wire concerning a horizontal axis of a board.

Elimination torsions at the expense of reduction of cables or full refusal of them (but in this case to have to reduce the pickled area with what reduction product for one trawling as it is known is connected) or to choose those designs at which stabilization or small displacement of position of the centre of pressure at change of a different of boards is observed during sharp braking of one of wire in the process of trawl immersing on depth. With that end in view use the data of an aerodynamic purge about displacement of the centre of pressure on height z_D. These requirements are answered with round spherical boards. Rectangular cylindrical boards of Zjuberkrjuba have extremely big deviation z_D at minor alteration of angles of attack ($\pm 4^0$). It leads to a variable list that is interfaced to certain difficulties of descent and lifting of a trawl with depth. There are attempts of regulation of attempt of a trawling board both by means of electric motors and by means of the mobile device of fastening wire with a board, providing itself stabilization of position at the expense of combination of the centre of pressure with a fastening point wire. In these cases the board works steadily.

The device in a cavity of a trawling screw pipe with metal balls having apertures and the lowered viscosity filled with oil for creation of additional inertia forces (fig.3) may be increase stability mode [3].

Other offered similar way of failure of impulses of autorotation the device emergency stabilization work position of a trawling board: in a cavity of a trawling board there is the pendant cargo kept in the top part of a boot by the lock (fig.4). On any set angle of attack the board can be established in several ways: by selection of certain length of a cable and with helping any mechanism, for example the underwater electric motor.

Figure 3. Trawl board with balls in pipe offered by authors

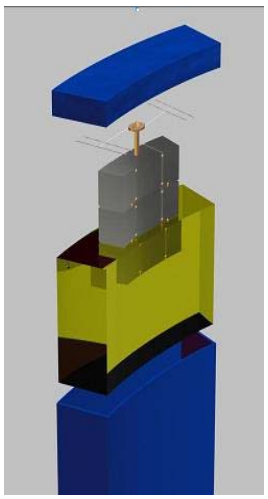


Figure 4. The device of emergency stabilization work position of a trawl board offered by authors

The other board (fig.5) consists from profiling screw round form in the plan which is inserted in ring, allowing it to rotate round a vertical axis.

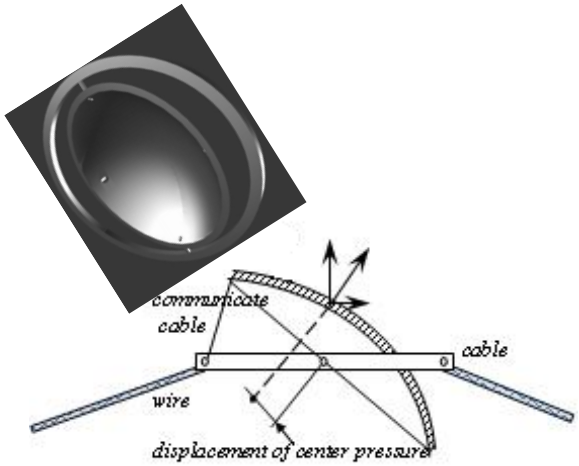


Figure 5. Rotating trawling board.

It is transferred the command on a cable-wire (or to a communication cables) or on the hydro acoustic channel and is carried out turn profiling a screw on the set corner of profiling screw can be closed with a ring and its angle of attack thus becomes equal to zero.

Installation rotary keels reduces resistance of a ground trawling and thus at a separation of boards from a ground and transition on pelagic - deep trawling rotary keel is automatically developed in such a manner that is a single whole with trawl board and works on otter.

The trawling board [4] for the raised stability at which combination of a plane of the centre of gravity with the centre of hydrodynamic pressure is known is provided at the expense of mobility of fastening of pads by means of a longitudinal cut. Such board works steadily on any modes.

2.3 The geometrical form as a variant of self-regulation of movement stability

In all described cases self-regulation occurs at the expense of creation of conditions for aspiration of all operating forces to some geometrical point or area (let's allow to name it area of steady pressure) in which the enclosed resultant force of hydrodynamic pressure does not create considerable on size the overturning moments. However the geometrical form it too as a variant of self-regulation of movement at the expense of creation of contours of a surface directing and concentrating a water stream.

The interface theory in a hydromechanics assumes friction presence on a surface of streamline object. In case of a continuous flow and a thickness of an interface conditionally accepted equal unit can receive co-ordinates of the theoretical centre of hydrodynamic pressure on the basis of hydrodynamic analogy of circulation of speed of a stream on border «a liquid wing» with tangents pressure in thin-walled sections at a bend.

The offered technique of definition of the centre of a resultant of a carrying power is similar to a technique of definition of the "centre of shear" for a thin-walled profile. In both cases position of the centre of shear, as well as the pressure centre depends only on the geometrical form of thin-walled section or in our case of the form of an interface:

$$\alpha_u = \frac{S_{\omega v}}{J_u}, \qquad \alpha_v = \frac{S_{\omega u}}{J_v};$$

where $S_{\omega u}$, $S_{\omega v}$ − sector-line characteristics of boundary layer water's mass concerning the main axes of inertia, α_u, α_v – co-ordinates of the centre; J_v, J_v, u, v – main moments inertia and main coordinates.

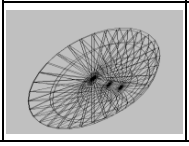
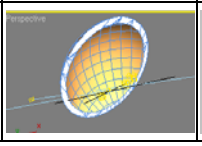
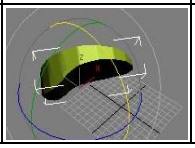
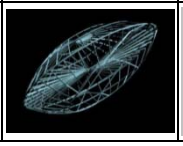
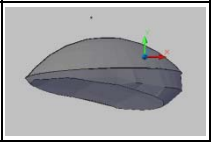
In case of discrepancy of the geometrical centre of gravity and the theoretical centre of hydrodynamic pressure of a volume figure there is an overturning moment having essential value at a high-speed mode of movement or considerable otter forces.

From the analysis of the experimental hydrodynamic optimum forms given for choice and designs of screws vertically disclosing of a mouth of a trawl researchers TINRO have come to a conclusion to expediency to concentrate design efforts to floats at which stable position, the pressure centre independent of angles of attack (x_D=const) is revealed. Stable position of the centre of pressure gives the chance to pass to one-dot fastening of screws. Stable position is revealed at screws of the round spherical form in respect of an aerodynamic profile with relative thickness ($\bar{t} = \frac{t}{D}$) of a nasal part $\bar{t}$ =26,6 % and at a similar profile of a round cylindrical float with $\bar{t}$ =18,5 % (similar computers models are shown in Table) [5].

3. CONCLUSIONS

The graphic - analytical way of delimitation of area of steady pressure by conditional a friction interface forms - an example for optimization of trawling board geometrical form a by methods of computer modeling with AutoCAD, 3Dmax and MathCAD.

Table. The computer models of the main hydrodynamic screws designed by researchers TINRO

Types of spreading	*Round spherical plan-concave*	*Round spherical concave (f)-convex*	*Round spherical doubly convex as dissymmetric*	*Aerodynamic round-spherical*	*Aerodynamic round cylindrical*	*Aerodynamic round spherical strongly convex*	*Aerodynamic round spherical strongly bent*
							

4. REFERENCES

[1] Gabryuk V.I. Computers technologies in the industry fishing.-M.:Kolos,1995.-544c

[2] Slavgorodskaya A.V., Lihacheva V.V. Taking in account of the influence of the elastic forces center on the otter board motion and balance stability // The 21st Asian-Pacific Technical Exchange and Advisory Meeting on Marine Structures 10 - 13 September 2007, Yokohama, Japan.-c.45-51

[3] Slavgorodskaya A.V., Slavgorodski M.V., Proskura D.U., Ostanin V.A. Trawling board. RU № 72 812 U1, 2008

[4] Seslavinski V.I. Otter trawling board. USSR № 528914, 1977

[5] Rykunov E.M. Deepwater trawling Dalryba, Vladivostok, 1974