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Andreas Becker

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### Editorial office:

ORT Publishing  
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*Usenko Dmytro Valerievich, Student of Poltava Yuriy Kondratyuk National Technical University,  
Usenko Irina Sergeevna, Assistant Professor of hydraulics,  
supply and sanitation of Poltava Yuriy Kondratyuk National Technical University,  
Sheverdova Natalia Alexandrovna, Lecturer of Poltava Yuriy Kondratyuk National Technical University,*

### **Way of ship stability describing in stormy sea using a design automated system AutoCad**

Ship stability in a stormy sea description was made and its motions in phase space behavior patterns were analyzed. Geometric approach in the study of ship behavior during the storm was used and on this basis the analysis for different conditions was made. Zones of instability were specified and ship plunging conditions as the intersection of the phase trajectory with the separatrix surface were investigated. To determine the hazardous areas during ship movement a program was written.

The subject of research in this paper is the ship behavior during a storm using graphs describing his movement. The object of study is a mathematical model of a ship during a storm. The purpose of research is to develop practical recommendations that can predict the ship stability during a storm using analytical methods the ship behavior on long intervals schemes analysis. The problem of ships stability is topical because with the help of applied mathematics methods it is possible to determine the ship instability zone. Thereby ensure its safe implementation of its goals. Fundamentals of modern prospective construction ships design demand reducing of the cost for their construction, adjustment of speed ships to cargo operations, operating costs reduction, crew and passengers comfortable living conditions creating, prevention of the environmental pollution, and the maritime traffic security increasing, what is especially important. The practical importance of this research is:

- a graphical approach to the study of ship behavior during a storm and the analysis for different conditions that was made on this basis;
- the ship overturning conditions determining method and its cause by using the phase trajectory intersection with the separatrix surface algorithms and the instability zones allocation;
- adverse frequency finding, leading to the ship's overturning;
- drift velocity resistance finding<sup>1</sup>.

To meet the challenges the applied methods of engineering hydraulics, differential equations qualitative analysis are used in the study material for the course "Hydraulics" in "Swimming bodies. Archimedes' principle"<sup>2</sup>.

Trim is a longitudinal inclination of the ship. It's said, "trim by the bow" if the deepening of the ship bow is more and the stern deepening is less. In the opposite case, it's said, "trim by the stern." If ship immersion is parallel to designed waterline we say that the ship is "trim on an even keel".

Dynamic stability is ship's ability to withstand, without tumbling, the effect of tilting moment the increase of which to the maximum happens in a short period of time<sup>3</sup>.

Metacenter is a point of pushing force lines intersection that runs through the center displacement, as well as through the longitudinal axis of the ship's symmetry. When the ship tilts metacenter position is changing. Ship stability is guaranteed if the lowest of its metacenters lies above the ship gravity center.

Initial stability is a part of the ship theory which studies ship stability at small tilt angles. The size of heel and trim of the upper deck door edge into the water is taken for the small tilts.

Ship vitality is the ability of a ship to resist natural elements at dangerous level of wave high. Ship vitality is provided by hull design, security devices, systems, hardware, their redundancy, duplication and rational allocation, personnel professional development.

Ship stability is the ship's ability to withstand external forces that cause it to roll or trim, and to return to the original position of equilibrium after their termination.

The displacement is called the weight of the liquid that displaces the body weight and center of gravity in the bulk liquid submerged parts of the body — the center displacement.

Waterline is the line of the fluid free surface intersection from the ship's lateral surface, and the plane inside the body, limited waterline, called the plane diving.

Axis swimming is a vertical axis passing through the center displacement.

Eccentricity is the distance between the center of gravity and the center displacement.

Buoyancy is the ability of the body to float at a certain weight. A measure of the body buoyancy is its displacement or lift.

Ship's direct provision afloat depends on the relative position of the two values: the center of the ship gravity and the geometric center of the ship submerged parts. Thus, a heavy load (metal, ore), located at the bottom of the ship lowers its center of gravity and increases the metacentric height. On the contrary, the heavy load placed on top of the deck, raises the center of the ship gravity and reduces metacentric height. The more metacentric height, the greater the ship stability is, i. e. its ability to recover straight position when a heel (trim) under the action of wind, waves and other external forces<sup>4</sup>.

<sup>1</sup> Аксютин Л. Р. Аварии судов от потери остойчивости/Аксютин Л. Р., Благочестенский С. Н.//— Л. Судостроение - 1975, 200 с.

<sup>2</sup> Войкунский Я. И. Справочник по теории корабля. Т. 2. Статика судов. Качка судов./Войкунский Я. И. //— Л., Судостроение, 1986, 80 с.

<sup>3</sup> Константинов Ю. М. Гидравлика/Константинов Ю. М.//— К., 1988—398 с.

<sup>4</sup> Кузнецова И. А. Геометрическая интерпретация и решение задач качественного анализа остойчивости судна на волнении: дис... канд. техн.

If gravity center and metacenter coincide at one point, then the ship will have neutral stability: it will not have restoring force. Tilted to the side, it will remain in the inclined position. Naturally, under the influence of external forces the ship's tilt can grow until the ship overturns. However, a large slope is dangerous even under normal metacentric height. Reaching a very large bank angle ( $-50^{\circ}$   $-70^{\circ}$ ), i. e. the so-called angle of approach, when the deck is submerged, the ship is unable to stand up straight and overturns. It happens because metacenter is below the center of gravity and instead of stability moment the ship is influenced by overturning moment.

Causes of the ship stability loss is extremely diverse. One of them is when the ship sails on following waves, and the speed of the ship and its length is approximately coincide with the speed and length of following waves. At that time the ship is on the crest of a wave with its middle part, and its bow and stern are out of water, causing ship support force in the normal position reduction and it can easily turn over. Associated wave is of the same danger for small ships when the wavelength is longer than the ship length, but their speeds coincide<sup>1</sup>.

Critical slope after which the ship overturns is equal to static stability chart approach corner. Then separatrix, constructed for autonomous movement, can be regarded as the limit curve that defines the ship stability limit. Overturning moment coincides with the intersection point of the separatrix phase trajectory.

Ships stability study is a complex process that requires research general technology, which includes all the features of the problem, starting from its formulation to the results documentation. The ship stability process study should contain such elements as analysis, synthesis and informative assessment of the proposed solutions.

Methods of the ship stability predicting in rough seas should be:

- a) pretty common, suitable for all types of surface ships study;
- b) available for study and use;
- c) flexible and expandable;
- d) ensure reliability, speed, efficiency in the instability zones finding in specific situations.

Methods should be simple, convenient, provide all the system functionality and eliminate discomfort for user in any system state<sup>2</sup>.

Figure 1 shows the ship behavior. Point 1 shows the beginning of the ship movement. In the period from point 1 to point 3 the ship has an increase in the angular velocity, bank angle and drift speed. The interval from point 3 to point 4 for the ship was critical. There was increase in bank angle, angular velocity and drift velocity. The simultaneous increase of these parameters leads to its overturning. Point 4 is the point of intersection of the ship behavior phase trajectory to the surface of separatrices and is the overturning point<sup>3</sup>.

The interval between the point 4 and point 6 shows the ship behavior after the loss of stability. A gradual decrease in the angular velocity and the drift velocity is taking place. At this time, the angle of heel is rapidly increasing. Each point on the graph is a certain coincidence of parameters in the ship movement<sup>4</sup>.

Step 1. Entering initial data.

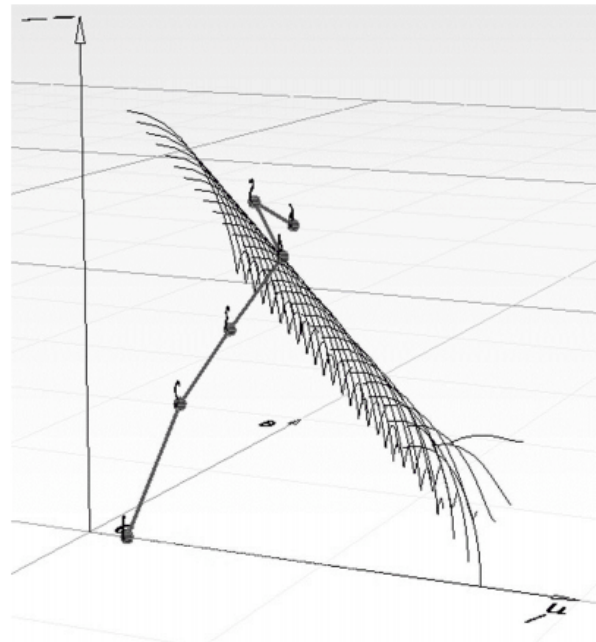
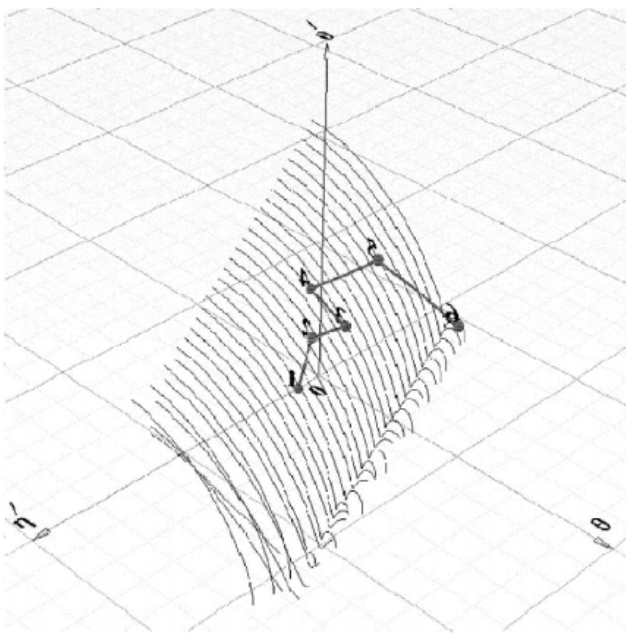
Step 2. Using a computer-aided design (CAD) AutoCad as a basic program with the autonomous motion separatrices construction for a ship with preset parameters, the programming language AutoLISP, create a new file «stability».

Step 3. Asking the initial parameters for determining the ship stability: the ship length, its speed and width.

Step 4. CAD AutoCad maths performs calculations on the raw data is a point builds surface separatrices autonomous movement, and ship behavior chart.

Step 5. According to these data the ship state can be determined. By the ship state is understood its position in space, drift velocity, roll angle and angular velocity.

Step 6. To visualize the model use mode 3-D modeling "Limited orbit." This mode allows you to observe the ship behavior in 3-D space using any angle of view.



наук: 05.01.01; 05.08.01/Севастопольский приборостроительный институт; Киевский Ордена Трудового красного знамени инженерно-строительный институт. – К., 1992. – 128 с.

<sup>1</sup> Renilson, M. R., "Assessment of ship stability using dynamics" 2001, p. 10 c.

<sup>2</sup> Galeazzi, R, Vidic-Perunovic, Blanke, M, J, Jensen, JJ, (2008). " Stability Analysis of the Parametric Roll Resonance under Non-Constant Ship Speed ", p. 12

<sup>3</sup> Vidic-Perunovic, J, Jensen, JJ, (2009). "Estimation of Parametric Rolling of Ships – Comparison of Different Probabilistic Methods", p. 36

<sup>4</sup> <http://www.diveclub.lv>

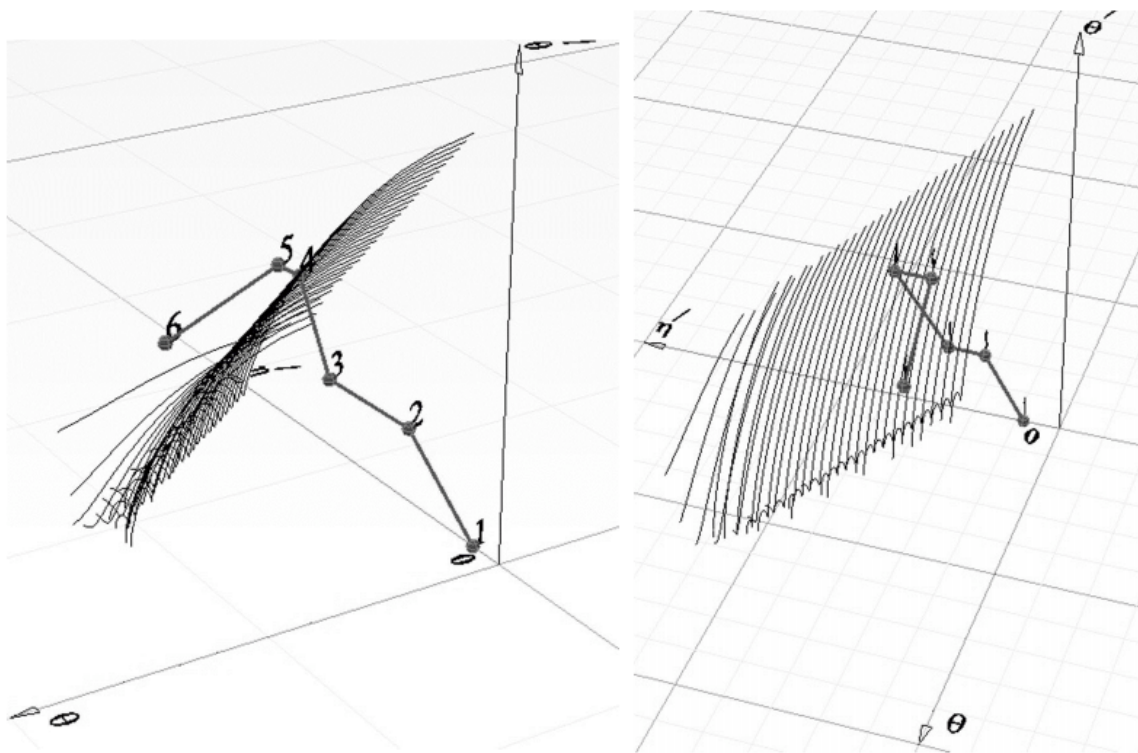


Figure 1 View from different angles of the separatrixes surface and ship behavior graphics

**Conclusions:**

1. Prediction of the ship stability during the storm was studied with the help of the ship motion in phase space schemes analysis using CAD AutoCad.
2. Geometric approach to the ship behavior during a storm study was applied and the analysis for different conditions was made on this basis.
3. The ship overturning conditions as the intersection of the phase trajectory with the separatrixes surface and the allocation of instability zones were studied.

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*Khusnullina Aliya Rafaelevna, the State Marine Technical University of St. Petersburg, postgraduate student, Department ecology of industrial zone and water area*

*Хуснуллина Алия Рафаэлевна, Санкт-Петербургский государственный морской технический университет, аспирант кафедры экологии промышленных зон и акваторий*

## About granary technology of construction of oil wells

### Об амбарной технологии строительства нефтяных скважин

Интенсивные темпы освоения нефтяных месторождений Западной Сибири, стали причиной того, что в 90-х годах прошлого столетия специалистам-экологам пришлось решать ряд проблем, связанных с утилизацией отходов бурения, которые в то время складировались в земляные котлованы — шламовые амбары.

Шламовый амбар — это природоохранное сооружение, предназначенное для централизованного сбора, накопления и захоронения отходов бурения (рис. 1).

Мощность амбара определяется количеством токсичных промышленных отходов, которые должны быть приняты в амбар в течение года, и методами их обезвреживания или утилизации. Габариты амбара определяются расчетными сроками накопления токсичных отходов. Глубина амбара составляет в основном 2–4 м, но, в зависимости от конкретных производственно-технических условий, их глубина может варьироваться в большую или меньшую стороны.

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