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ANALYSIS OF ACCIDENTS WITH HULLS OF INLAND AND RIVER-SEA VESSELS

В работе обработаны статистические данные по авариям судов внутреннего и смешанного плавания за период 1991-2012, предложена классификация видов повреждения корпусных конструкций, определены статистические вероятности отдельных видов аварий.
***Ключевые слова**: судно смешанного река-море плавания, авария судна, статистические данные, классификация видов повреждения.*

В роботі оброблено статистичні данні по аваріям суден внутрішнього та змішаного плавання за період 1991-2012, запропонована класифікація видів пошкоджень корпусних конструкцій, розраховано статистичну ймовірність окремих видів аварій.
Ключові слова: судно змішаного ріка-море плавання, аварія судна, статистичні данні, класифікація видів пошкоджень.

Statistical data of accidents of inland and river-sea going vessels for 1991-2012 is analyzed. Classification of hull's damages is proposed. Statistical probabilities of accidents' types are defined.
***Keywords**: river-sea going vessel, accident, statistical data, classification of hull's damages.*

Problem statement. Special operational feature of inland and river sea going vessels in comparison with sea going ones is significant operational term in the conditions of rivers, canals, sluices, narrow water. That's why the probability of collisions, grounding and other accidents is increased essentially. Statistical data of Russian River Register and database «Fleet», additional sources [1-2] was analyzed to get mean dimensionless values. These values can be used for probability assessment of accidents' occurrence and reasons.

The article purpose is to analyze and treat data concerning accidents of inland and river sea going vessels for the period of 1991-2012, to classify types of hull damages, to get mean values of probabilities of accidents' types.

The basic material. Gennady Egorov proposed the classification of main groups of identified casualties [3] when processing statistical data for discussed problem (as the first step on the way to formal assessment of risk during vessels' operation). Main three sections of this classification are as follows:

- the dangers connected with technical condition of the hull, machinery, mechanisms and systems of the vessel;
- the dangers connected with incorrect technology of cargo transportation;
- the dangers connected with actions of the ship-owner, coastal operators and crew.

Such approach allows analyzing and sorting the whole range of input data if array of known emergency situations is considered.

Single part is sorted from input data that connects partly 1 and 3 sections of mentioned classification, that is the dangers connected with technical condition of the hull, machinery, mechanisms and systems of the vessel and the dangers connected with actions of the ship-owner, coastal operators and crew.

The reasons of hull damage are divided into following groups in accordance with following classification (see fig. 1): collisions, ice damages, groun-ding, excess of the wind-wave mode, explosions and fires, other.

Also this classification considers damage localization along the vessel and/or depth of damage (breach or deformation).

246 cases are chosen among considered emergency accidents that caused vessel hull damage during 1991-2012. Distribution by types of damages and localization along the vessel is shown in table 1.

Index of conditional probability is defined

$$\mu = \sum_{i=1}^{T} \left(\frac{n_i}{N_i} \right) \Big/ T,$$

where n_i – cases' quantity of certain type of damage in the considered year;

N_i – total number of vessels in operation in the considered year;

T = 22 years – the time period which is considered when processing input data.

Also in tab. 1 the probability $k = n_{кат}/n_i$ is defined, where n_{cat} – cases' quantity of each category of damage taking into account localization along the vessel.

Ratio of $\boldsymbol{n_i}$ to $\boldsymbol{N_{acc}}$ is shown in fig. 2, where $\boldsymbol{n_i}$ – cases of each accidents' types, $\boldsymbol{N_{acc}}$ – total number of accidents.

Probabilities of some accidents' types according to the offered classification during 1991-2012 are shown in fig. 5.

The mentioned statistics cannot be considered absolutely reliable. Firstly, decrease of accident rate can reflect the economic situation in the considered year, change of number of the operated cargo vessels at inland waterways, change in fleet structure, etc. Secondly, the bigger quantity of sources, probably, would allow to fill gaps in the specific types accidents. Thirdly, lack of some accidents in the corresponding years does not mean 100 % probability that they did not occur actually. Information about accidents is held back by the ship-owner for a number of reasons, for example because of their insignificant effects. The inaccuracies connected with accounting order in the organizations which are responsible for collecting statistical data are possible also.

Distribution of mean values of probabilities by types of accidents is shown in fig. 6.

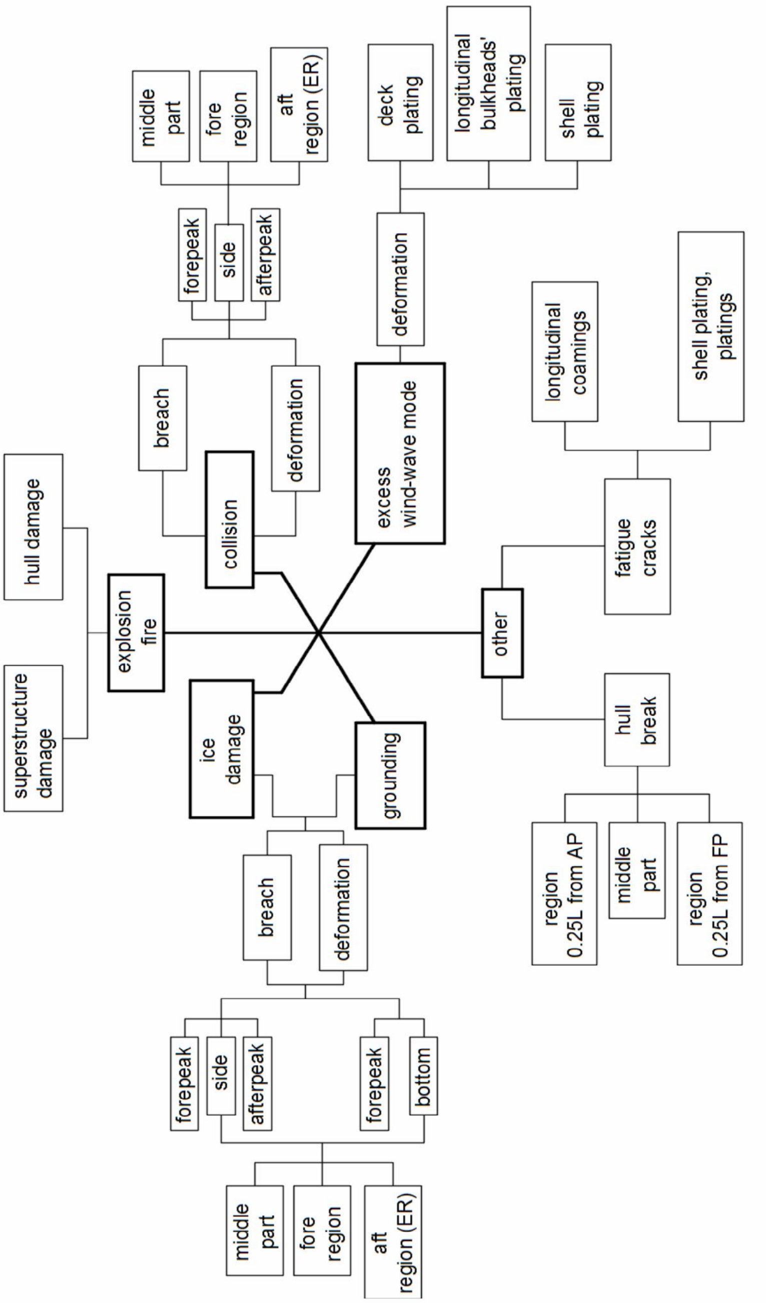

Fig.1. Classification of hull damages

Table 1

Definition of index of conditional probability

Damage description		n_i	μ	n_{cat}	n_{cat}/n_i
Grounding		**47**	**0,0000744**		
Breach					
forepeak	–			1	0,021
bottom	fore region			30	0,638
bottom	middle part			5	0,106
bottom	aft region			5	0,106
Deformation					
bottom	fore region			5	0,106
bottom	aft region			1	0,021
Fatigue craks		**17**	**0,0000258**		
shell plating and horizontal plating				6	0,353
coaming				11	0,647
Hull break		**24**	**0,0000308**		
region 0.25L from AP				1	0,042
middle part				20	0,833
region 0.25L from FP				3	0,125
Ice damage		**40**	**0,0000529**		
Breach					
forepeak	–			1	0,025
side	fore region			2	0,050
bottom	fore region			4	0,100
Deformation					
side	fore region + mid. part			27	0,675
side	whole length			2	0,050
bottom	+side			1	0,025
Breach and deformation					
side	whole length			3	0,075
Excess wind-wave mode		**25**	**0,0000368**		
deck plating				16	0,640
longitudinal bulkheads’ plating				7	0,280
shell plating				2	0,080
Collision		**33**	**0,0000521**		
Breach					
forepeak	–			8	0,242
side	fore region			13	0,394
side	middle part			6	0,182
side	aft region			2	0,061
side	fore and aft region			2	0,061
side	+inner side (mid. part)			1	0,030
side	bilge region			1	0,030
Explosions and fires		**60**	**0,0000901**		
superstructure damage				22	0,367
hull damage				35	0,583
superstructure and hull damage				3	0,050

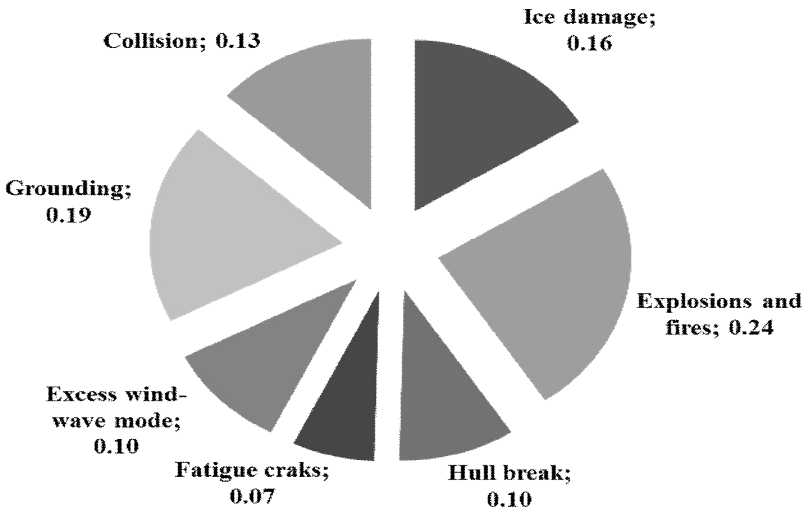

Fig. 2. Relative distribution of accidents' types

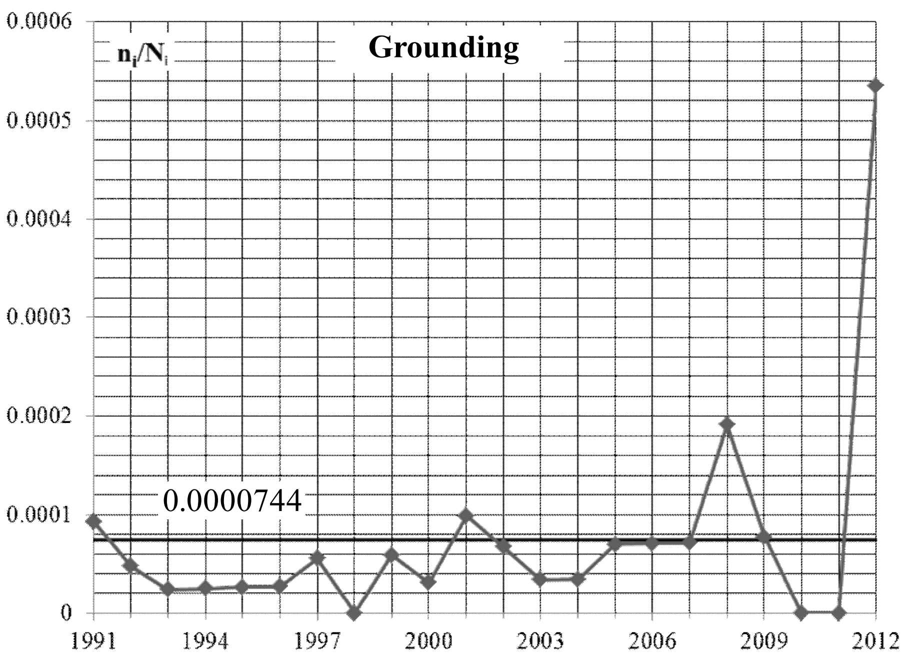

Fig. 3. Probability of grounding

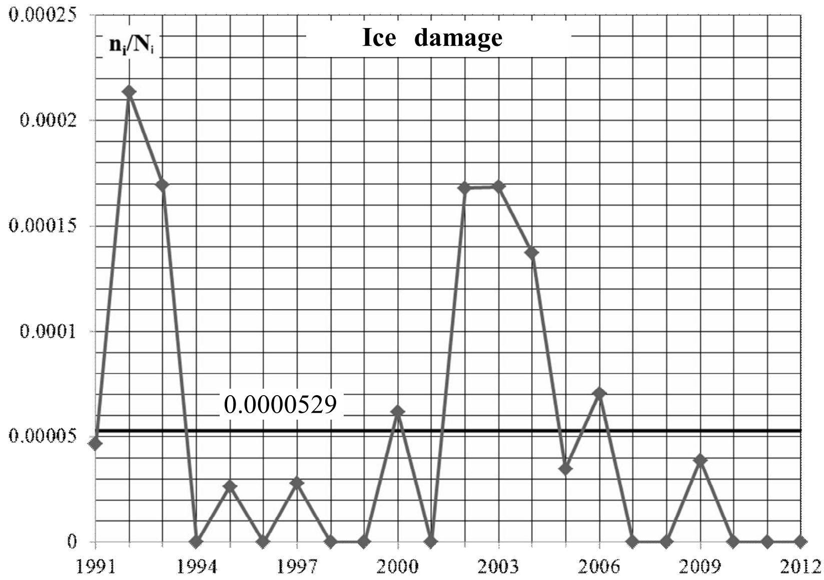

Fig. 4. Probability of receiving the ice damage

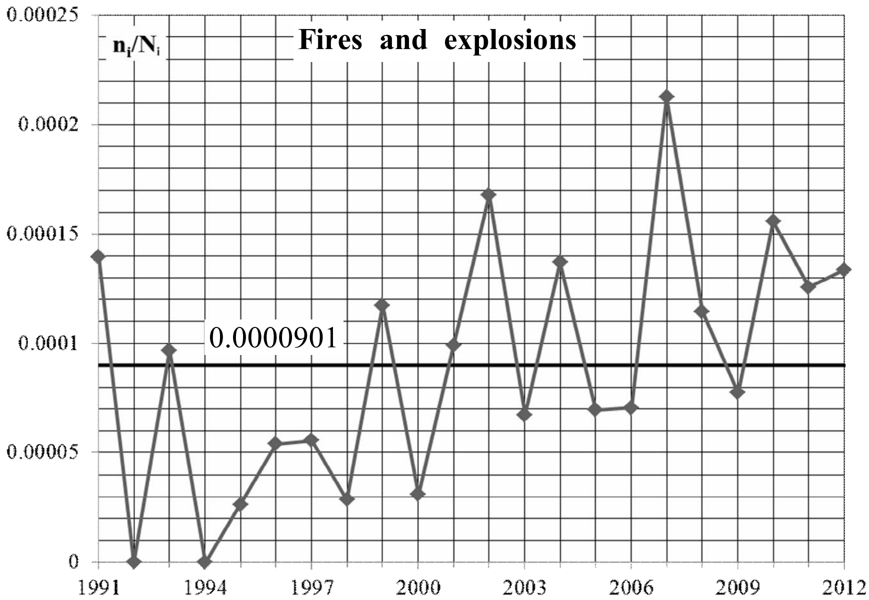

Fig. 5. Probability of explosions and/or onboard at the vessels

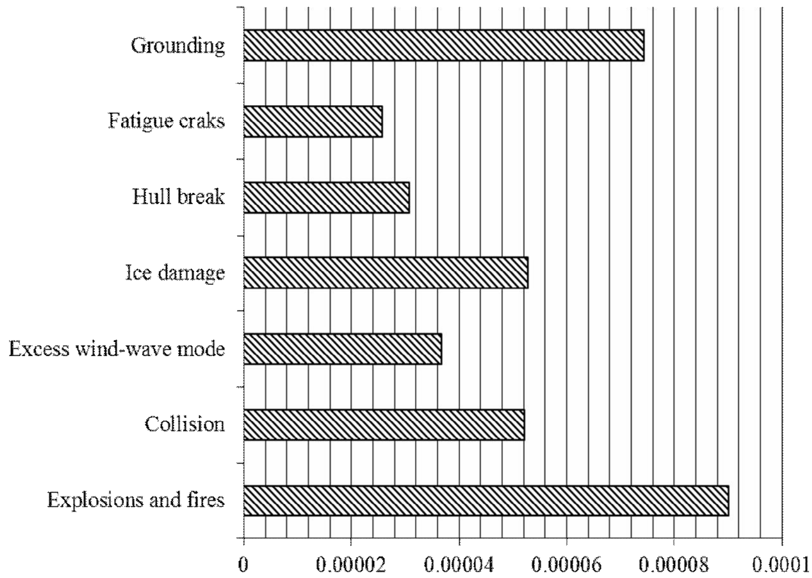

Fig. 6. Distribution of mean values of probabilities by types of accidents

Conclusions. The analysis of statistical data of vessels' casualties of the internal and river-sea going vessels' types for the period of 1991-2012 is carried out in the article. The idea of defining of conditional probabilities for concrete types of hull damage is initially put.

Therefore more detailed classification of hull damages that takes into consideration damage localization along the vessel is proposed. Such classification does not damages of gears, systems and mechanisms of the vessel. By the received results it is possible to make a conclusion that the most probable types of damage of inland waterways vessels are the fires and explosions (μ = 0,0000901 cases a year), groundings (μ = 0,0000744 cases a year) and ice damages (μ = 0,0000529 cases a year).

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