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Working Party on Inland Water Transport

Working Party on the Standardization of Technical and Safety Requirements in Inland Navigation
(Twenty-fifth session, 19-21 March 2003, agenda item 4)

HARMONIZATION OF THE REQUIREMENTS CONCERNING ANCHORS FOR INLAND NAVIGATION VESSELS

Submitted by the Government of the Russian Federation

Note: At the twenty-third session of the Working Party, the delegation of the Russian Federation agreed to draft a discussion paper on the requirements concerning anchor equipment for inland navigation vessels other than self-propelled cargo vessels and submit it for the consideration of the Working Party at its twenty-fifth session (TRANS/SC.3/WP.3/47, para. 16).

The views of the delegation of the Russian Federation on this question are reproduced below.

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CHOICE OF ANCHOR EQUIPMENT

1. Paragraph 16 of the report of the Working Party on its twenty-third session states: "the delegation of the Russian Federation agreed to try to analyse the table data from Governments and draft a proposal for consideration by the Working Party, at its twenty-fifth session".

2. At the time this paper was drafted, however, no additional information had been received from Governments. Consequently, the following conceptual proposals on the choice of the combined mass of anchors and the length and calibre of anchor chains are based entirely on a study of the material in the compendium of existing regulations on anchors applied on European inland waterways (TRANS/SC.3/117) and documents submitted previously by a number of Governments.

3. After studying these documents, the experts of the Russian Federation have reached the following conclusions.

Basic parameter

4. The main task in harmonizing anchor equipment is to choose the correct parameter as a basis for calculating the combined mass of the anchors and the length and calibre of the anchor chains.

5. In the view of the experts, article 8-2 of the annex to the Rhine Vessels Inspection Regulations, currently in force, does not fully meet these requirements even for self-propelled cargo vessels.

6. Paragraph 8-2.1.1 of the article states that self-propelled cargo vessels must be equipped with bow anchors of a total mass in kg M_a, calculated according to the formula:

$$M_{\mathrm{a}} = c \cdot B \cdot T \sqrt{L/8B} \qquad (1)$$

where: c is the empirical factor;

B is the breadth of the vessel at its widest point in metres;

T is the maximum permissible draught in metres;

L is the maximum length in metres.

7. It is abundantly clear that such a simplified formula does not properly address the problem of choosing anchor equipment capable of withstanding hydrodynamic forces dependent on the flow velocity of the water or aerodynamic forces dependent on wind pressure on the superstructure, wheelhouse and deck cargo. This is illustrated by the following example.

8. Imagine two vessels of identical length and cargo capacity, with underwater cross sections as shown in figure 1.

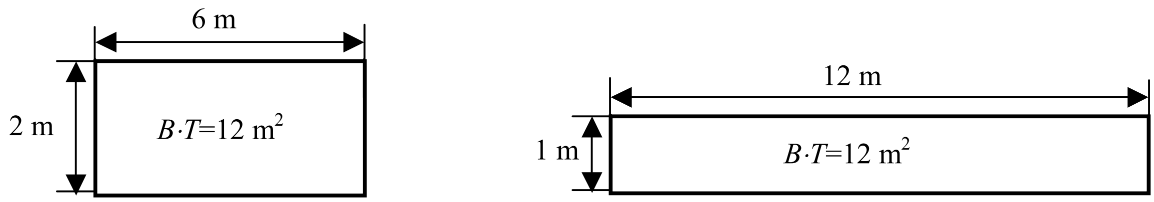


Fig. 1

9. As figure 1 shows, both vessels have an identical underwater cross-sectional area ($B{\cdot}T = 12$ m^2). Consequently, assuming equal length and cargo capacity, they should be equipped with anchors of equal combined mass. But, considering the physical impacts of hydrodynamic forces on the underwater part of the hull, the combined masses of the anchors of these two vessels should be different for two reasons:

(i) The resistance of the hull to the current is directly proportional to the square of the wetted area Ω, i.e. 10L for the first vessel and 14L for the second;

(ii) Increasing the ratio B/T increases the wave resistance because most of the underwater volume is located closer to the free surface water when the breadth of the vessel is increased and its displacement remains constant.

10. Consequently, the combined mass of the anchors on the second vessel should be greater than those on the first.

11. Additionally, the formula does not take account of the dimensions of the superstructure and possible deck cargo (containers, timber, etc.), and thus it would be highly problematic to use it as a basis for calculations relating to passenger vessels, pusher tugs and pushed convoys of various kinds.

12. The following indicators cannot be used as initial parameters for the choice of anchor equipment: power, especially for passenger vessels with heavily developed superstructures; cargo capacity, which is not a characteristic of passenger vessels; and displacement, which might seem more suitable, but it too can yield incorrect results depending on the actual displacement at any given time; the formula used by the German Democratic Republic is overly complicated.

13. In the light of the foregoing, it appears that the index figure adopted in a number of European countries (Bulgaria, Hungary, Poland, Russian Federation, Slovakia, Ukraine and Yugoslavia) should be taken as the initial parameter. This takes account of the underwater and above-water dimensions of the vessel and does not depend on the class of vessel: cargo, passenger, cargo with attachment, pushed convoy, engineering vessel, etc.

14. There is a well-known formula for this:

$$N_a = L \cdot (B + H) + k \cdot \Sigma l \cdot h \qquad (2)$$

where N_a is the index figure in m^2;

L, B, H are the principal dimensions of the vessel in metres;

K is the coefficient used in accordance with the overall length of deck structures;

l is the length of individual deck structures and wheelhouses in metres;

h is the average height of individual deck structures and wheelhouses in metres.

15. What are the advantages of this formula? First, it has been tried and tested on many thousands of ships in the Russian Federation, on rivers with different flow velocities and beds, duly adjusted, of course, for certain rivers or sections of rivers.

16. Second, it takes account of the impact of both hydrodynamic and aerodynamic forces and makes allowances for the dimensions of the underwater and above-water parts of the vessel.

17. Third, the product *L(B+H)* is a fairly simple formula for estimating the area of the wetted surface of the underwater part of river vessels, to which the value of the resistance of the vessel to the current when lying at anchor is directly proportional.

Choice of mass of bow anchors

18. It is equally important to establish the law governing the ratio between the combined mass of bow anchors and the index figure N_a.

19. If, for example, the breadth of the side B and the height of the side H remain constant while the length L is doubled, the index figure also doubles, but the resistance of the hull will not follow this law, i.e. the value of the Froude number $v/\sqrt{g \cdot L}$ will be different for these vessels.

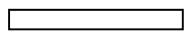
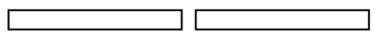
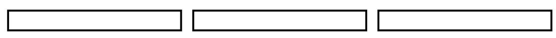
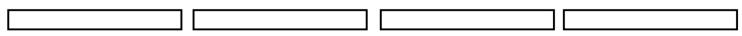
20. An even more striking example is the resistance of the hull, since the coefficient of assembly K_c of the tandem formation is always less than 1:

$$K_c = R_c / \sum_i^n R_i < 1 \qquad (3)$$

where: R_c is the resistance of the convoy;

R_i is the resistance of an individual vessel in the convoy.

21. Below are the results of research carried out in the Russian Federation to establish the values of the coefficients of assembly K_c for pushed tandem formations.

Form of convoy	K_c
	1
	0.73
	0.64
	0.57

22. Analysing all these data, and also the information in the compendium of existing regulations, it would be sensible to operate on the following assumptions when determining the combined mass of the anchors:

(i) When the index figure is less than 114 m^2, the following formula should be used:

$$M_a = \frac{K \cdot N_a^{0.67}}{2} \qquad (4)$$

where: M_a is the mass of the anchor in kilograms;

K is a coefficient determined by the berth conditions (area of navigation, flow velocity, nature of river bed, etc.).

23. Vessels with this index figure can be equipped with one anchor. In this range of N_a, we cannot go far wrong if we assume:

$$M_a \approx N_a \qquad (5)$$

(ii) When the index figure is greater than 115 m^2, two bow anchors should be fitted, the combined mass of which is calculated by the formula:

$$\sum M_a = K(N_a - 100)^{0.67} + 100 \qquad (6)$$

where $\sum M_a$ is the combined mass of the two anchors in kilograms.

24. The graphs in figure 2 can be used to determine the combined mass of bow anchors for values of the coefficient K between 6 and 10 when N_a is between 100 m^2 and 1,000 m^2 and between 1,000 m^2 and 10,000 m^2.

25. In order to harmonize anchor equipment requirements, it is indispensable to establish a single principle for determining the argument N_a and the single form of the function $\Sigma M_a = f(N_a)$.

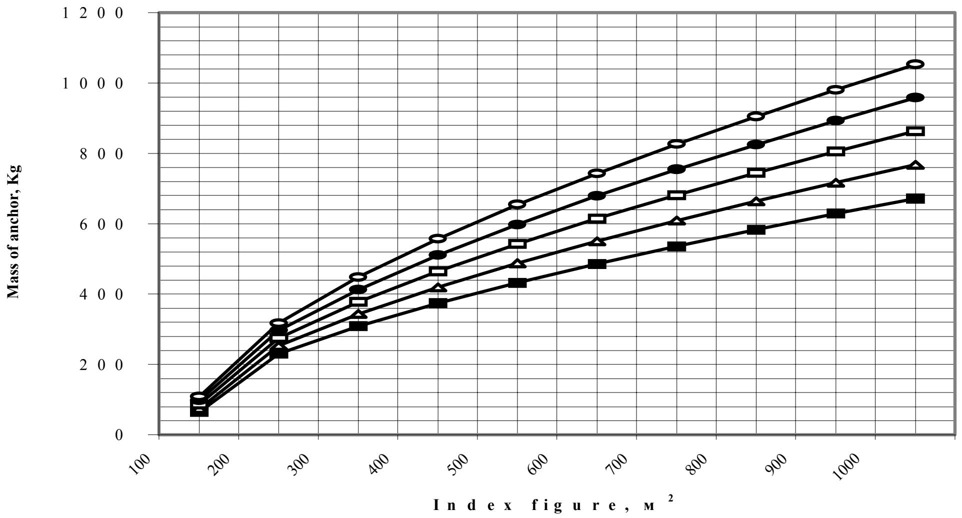
26. If these proposals are adopted, basin administrations will need to establish the value of the coefficient *K* for all water basins of interest for international navigation.

27. The experts consider that the value of the coefficient *K* can be taken as follows:

Zone of navigation 3: (7÷8),

Zone of navigation 2: (8÷9),

Zone of navigation 1: (9÷10).



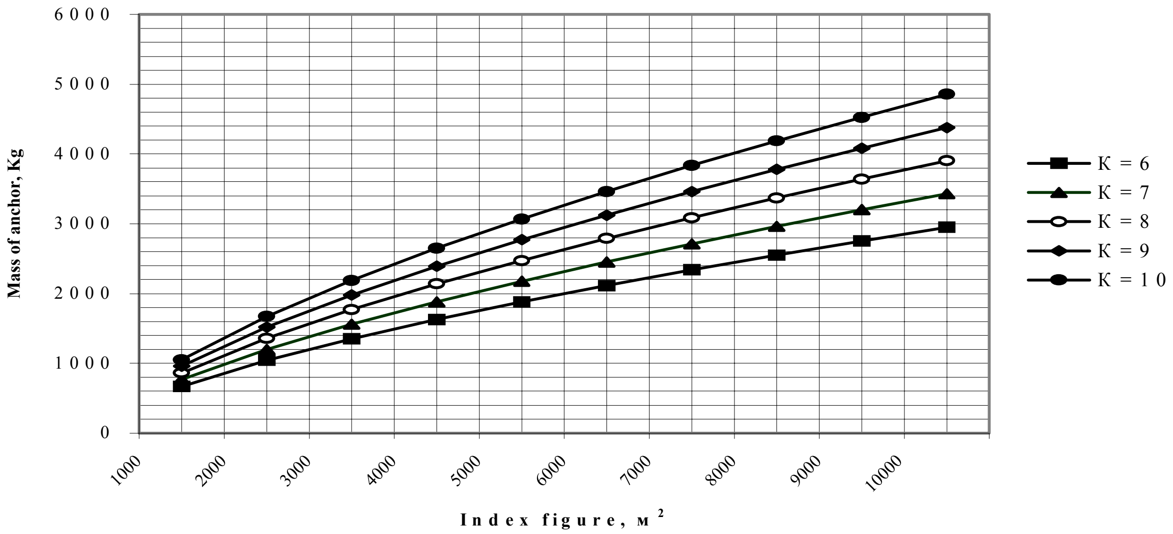


Fig. 2

28. It cannot be ruled out that, for certain basins, such as Lake Ladoga and Lake Onega, the coefficient K could have the value 11÷12.

Choice of mass of stern anchors

29. The experts believe that the mass of stern anchors should be chosen according to the following criteria:

(i) Self-propelled vessels less than 70 m long, except for pusher tugs, may be exempted by the Administration or competent body from complying with the requirement to be fitted with stern anchors;

(ii) Self-propelled vessels more than 70 m long must, in addition to a bow anchor device, be equipped with a stern anchor device if:

- The zone of navigation of these vessels includes sections with no current or a sluggish flow velocity. The mass of the stern anchor for such vessels should be at least one quarter of the combined mass of the bow anchors;

- The zone of navigation of these vessels includes numerous navigation sections whose width does not enable a vessel to go about or berth against the current using bow anchors. In this instance the mass of the stern anchor should be at least 0.4÷0.5 of the combined mass of the bow anchors;

- The combined mass of the bow anchor(s) of a pusher should be taken to be equal to 0.8÷1.0 of the value of the combined mass of the bow anchors of the lead barge (section) of a given pushed convoy.

Choice of length of chain

30. As a basis for choosing the length of bow and stern anchor chains, the experts are of the view that the requirements contained in the annex to resolution No. 36 are acceptable.

31. The length of stern anchor chain(s) of pusher tugs may be taken to be equal to the combined length of the pusher plus one barge (section) of the convoy, but no less than 50 m and no greater than 150 m.

Calibre of anchor chain

32. The experts are of the view that there is no need for a table to determine anchor chain calibre.

33. Depending on the mass of the anchor, the calibre of the chain d in mm can be calculated by the formula:

$$d = c_1 \sqrt{M_a} \qquad (7)$$

where c_1 is the dimensionless coefficient designated according to the strength category.

For example, for chains in strength category 1, the value c_1 can be taken to lie within the range 0.90÷1.00. For chains in strength categories 2 and 3, the problem may be resolved by selecting additional correction factors.

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