**SPIN- TN, Working Group 3**

**Innovative Transport Vehicles on the Danube and its Tributaries**

Comments by Prof. Michael Doubrovsky

The paper is rather interesting and useful for the Danube navigation and shipbuilding. Author is quite right, indicating that the main characteristics of ships for internal waterways are completely determined by the passage conditions (navigation depths, sluices, berths and bridges). Therefore it is impossible to perform the optimum (in classic comprehension of marine design) selection of main particulars (length, breadth, depth, draught).

Research on the containership particulars and the author's considerations concerning designing of perspective ships of Ro-Ro type seem rather interesting.

However and it is our opinion, particular attention should be given to such self-propelled vessels for transportation of containers and trailers, which are able to perform straight-line transitions over Danube – Main – Rhine systems for carrying out cargo transportations without overload from Western Europe to the East of Europe.

It seems, that comparatively small attention is given to non-self-propelled transport ships. Since in 1999 on the Danube river there worked 309 self-propelled and 3492 non-self-propelled cargo ships, and also 760 pushing and towing tugboats. Non-self-propelled fleet prevails amounting 91,5% of total cargo capacity. The majority of ships is adapted to pushing. Their tonnage makes 69% of total cargo capacity.

The author is right, by showing that for small Danube depth the conventional Rhine solution - single – shaft vessel, - is not effective, and at such $B/T$ rations the two-shaft installation is optimal.

Besides the author submits very interesting materials on modern propulsors and main engines. We absolutely agree with the author that it is possible to recommend application for prospecting ships both customary cargo ships and pushing tugboats Rudder Propeller, Azimuthing thruster with mechanical transmissions, and for special and passenger ships – electric pod propulsion.

The author's remark about rather small variability of steelworks for customary transport ships, intended for operation on the European internal waterways is completely fair. However it is not worth to expect broad application of other materials for conventional ships.
We agree with the author's proposal on the necessity of the direct strength calculations while designing of hulls of the inland waterways ships, but $L/H$ ratio for the Danube ships rarely exceeds 35 (see Tab. 1).

Thus it is necessary to bear in mind, that the author possibly had not in his disposal the new Rules of the Russian Register for Danube, issued in 2000, which were exposed to cardinal re-treatment. Given in table 2 comparison of the results of calculations performed by special techniques and according to rules of different classification societies: RS – Rules of the Russian Maritime Register for ships of the Danube Region, RRR - Russian River Register, GL, BV demonstrates, that the thickness of part of an outside skin is to be determined under the criterion of secure perception of loads from a contact with floating objects, which is well agreed with the thickness of a sheer strake demanded by the rules of GL.

Minimum thickness values of a side skin in the rules of RS and BV are well agreed with the criterion of operational strength at acting of load in channels and sluices, but in the rules of GL they are a little bit above.

The minimum thickness value of an inner-bottom plating is explicitly determined by the criterion of operational strength under the loads from the dropping cargo, and the requirements of RS are characterized by a larger reserve, than, for example, requirements of GL.

The thickness of a deck plating is determined by the requirements of sufficient operational rigidity. Thus for ships of small length the criterion is based on static rigidity under the movement of people, and for self – propelled ships with $L > 76$ m on the dynamic rigidity when mechanical plant is operating (vibration).

The attention is drawn to the fact that thickness values demanded by the Rules of RRR, are a little bit smaller, that those of another societies. However, according tour information, ships being under the supervision of RRR and exploited on Danube river, have higher classes of RRR, than it is required for this region so the actual thickness value are close to the requirements of the rules of RS for ships of the Danube region.

As a whole, demanded thickness value first of all characterize a degree of ecological fears, and also permitted order of cargo handling (loading in one pass or in two).

The examples of existing and perspective push-boats and also dry-cargo self-propelled vessels, introduced by the author are of a great interest. It is necessary to stress specially the idea of the push-boats from Bilet and Zerial, which takes into account specific features of operation on the Danube river, including necessity of service both in a maneuverable mode, and in a march mode (with this, both downstream and against).

Obviously it is necessary to supplement the information on ships, which are useful for the Danube Region, such ships, as tankers – chemical carriers and liquefied gas tanker, and also ships of the river-sea sailing.

As a whole, it is possible to mark good quality of the introduced work.

Table 1 – The characteristics of the existing ships of Danube river

| Type | *L*, m | *B*, m | *H*, m | *T*, m | $c_B$ | $L/H$ | $L/B$ |
|---|---|---|---|---|---|---|---|
| Tugs and pushboats N=150-3000 kW | 19.8-66.5 | 6.3-13.0 | 1.60-3.70 | 1.10-2.30 | 0.60-0.80 | <25 | <8.5 |
| Non-self-propelled cargo ships | 38.2-90.4 | 9.0-16.5 | 1.90-5.30 | 1.20-3.80 | 0.80-0.96 | <32.8 | <8.1 |
| Self-propelled cargo ships N=230-1850 kW | 40.0-135.0 | 9.0-22.8 | 2.50-5.50 | 1.40-3.55 | 0.70-0.90 | <38 | <8.6 |

Table 2 – Comparison of calculated thickness for classical dry cargo barge “Europe 2B” type according to different sources ($L$ x $B$ x $H$ x $T$ = 76 m x 11 m x 3,2 m x 2,7 m)

| № | Name of unit | $S_c$ | RS, 1978 | | | RS, 2000 | | Russian River Register | GL | | | | Rhine rules | BV | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $S_{calc}$ | | $S_{calc}$ | | | | | | | | | | | $S_{calc}$ | |
| | | | $S_{min}$ | Zone2 | Zone3 | 1[st] shear | 2[nd] shear | $S_{min}$ | Point of rules | $S_{min}$ | Point of rules | $S_{calc}$ | $S_{min}$ | Point of rules | $S_{min}$ | Point of rules | Zone 2 | Zone 3 |
| 1 | Sheer strake | 20.0 | 10.25 | | | 14.64 | 14.64 | 6.44 | 14-B-5.3 | 12.00 | 14-B-5.2 | 17.43 | 5.73 | 9-23.21 | 20.16 | 9-23.21 | | |
| 2 | Side skin | 8.0 | 7.42 | 5.1 | 4.9 | 8.11 | 8.11 | 5.31 | 14-B-1.5 | 7.41 | 14-B-4.4 | 7.52 | 5.73 | 9-22.51 | 8.16 | 9-22.51 | 6.86 | 6.51 |
| 3 | Bilge | 10.0 | 7.64 | 5.1 | 4.9 | 10.55 | 10.02 | 6.44 | 14-B-2.1 | 10.89 | 14-B-2.1 | 10.89 | 7.16 | 5-22.52 | 11.55 | 5-22.52 | 8.86 | 8.51 |
| 4 | Bottom skin | 8.0 | 7.42 | 5.1 | 4.9 | 10.55 | 8.11 | 5.31 | 14-B-1.5 | 7.41 | 14-B-1.3 | 7.89 | 5.73 | 9-22.21 | 9.55 | 9-22.21 | 6.86 | 6.51 |
| 5 | Flat keel | 8.0 | 7.42 | 5.1 | 4.9 | 10.55 | 8.11 | 5.31 | 14-B-1.5 | 7.41 | 14-B-1.3 | 7.89 | 5.73 | 9-22.41 | 9.55 | 9-22.41 | 6.86 | 9.55 |
| 6 | Double bottom plating | 10.0 | 10.91 | 6.5 | 6.5 | 9.96 | 9.96 | 9.67 | 14-B-3.1 | 8.72 | 14-B-3.1 | 8.72 | | 9-63.41 | 5.51 | 9-25.11 | 9.55 | |
| 7 | Deck stringer | 10.0 | 8.29 | | | 8.96 | 8.72 | 6.44 | | | 14-B-7.4 | 9.03 | | 9-23.11 | 11.73 | | | |
| 8 | Deck plating | 10.0 | 8.29 | | | 8.96 | 8.67 | 5.89 | | | 14-B-7.4 | 9.03 | | 9-23.11 | 11.73 | | | |
| 9 | Longitudinal bulkheads | 8.0 | 6.55 | 4.9 | 4.9 | 6.96 | 6.96 | 6.44 | 14-B-6.4 | 7.41 | 14-B-6.2 | 8.27 | | | | 9-25.21 | 9.55 | 9.55 |
| 10 | Side coaming | 12.0 | 10.91 | | | 1.21 | 10.21 | 8.03 | 13-A-2.6 | 8.72 | 13-A-2.3 | 11.43 | | 9-23.32 | 11.73 | | | |

Nomenclature:
“$S_c$” – prototype thickness, mm;
“2[nd] or 3[rd] zone” – operational zones according to European classification, the corresponding wave heigt is 1,2 m (0,6 m);
“1 or 2 shears” – loading in two shears.