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PRELIMINARY STUDY REGARDING THE POSITIONING OF THE BATHYMETRIC SYSTEM ON A RESEARCH SHIP

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ABSTRACT

The topic of this preliminary study comes from the need to analyze the positioning of the multi-beam bathymetric system on a research vessel on the Danube River. Starting from the variants of bathymetric echo sound systems, they were discussed in advance with the supplying company and the construction shipyard to ensure the most advantageous cases of positioning the bathymetric equipment. The results of this preliminary study provide the researchers and the shipyard with several options for positioning the bathymetric system to choose a constructive solution that will ensure the requested operation conditions for recording the most relevant waterways bathymetric data regarding the safety of navigable channels on the Danube River.

Keywords: research ship on the Danube River, multi-beam bathymetric system preliminary positioning.

1. INTRODUCTION

The severe climate changes that have occurred in the last decade have imposed an intensification in the control and measurement of navigable channel profiles for operational data evaluation [1].

In periods of drought, it is very important to analyze the depth of the navigable channel and the banks. To the same extent and in the situation of periods with a lot of rain, in which strong torrents are formed, they carry with them large amounts of alluvium that also end up modifying the navigable channel operational conditions.

All these measurements are made with the help of bathymetric systems and that is why the present preliminary study proposes the analysis of the efficiency of mounting these systems on a research vessel.

The purpose of these measurements is to create maps, based on transversal scanning, that serve the administrators of these navigable channels to carry out dredging operations. These actions must ensure safe navigation conditions for the ships.

The importance of the analysis of the best positioning of the bathymetric transducers comes from their required measuring angles. Bathymetric measurements are made with

one transducer or a multi-beam system of transducers. To cover as large as possible a section from the bottom of the navigable channel, they must be placed in such a way as to ensure, on the one hand, that the two records do not overlap, as well as that they do not leave unmeasured spaces.

2. PRELIMINARY POSITIONING OF THE BATHYMETRIC SYSTEM

The preliminary study proposed in this paper refers to the positioning of a bathymetric system on a Danube River research vessel, REXDAN, with the following characteristics: length 43.60 m, breadth 9.40 m, depth 3.20 m, and maximum draught 1.80 m [4].

The bathymetric systems can be positioned externally or inside the ship's hull. For this ship, by design, the bathymetric system [3] is positioned inside the hull. This preliminary study analyses the bathymetric system positioning so that a large scanning area is ensured to obtain by software processing the best waterway profile map.

The positioning variants of the multi-beam bathymetric system are analyzed, offering opportunities for designers to decide the best solution. Also, according to the construction plan [4],[5],[6], the designers must find the proper space for the location of the equipment.

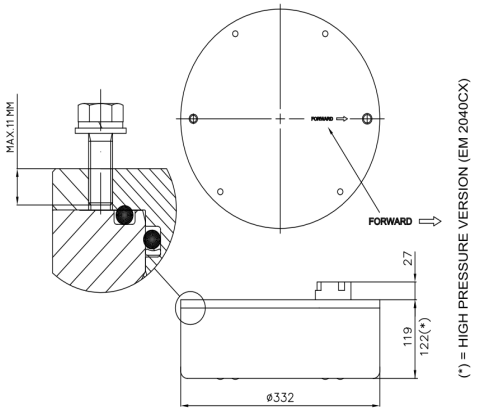

Fig.1 Echo sound dimensions [3].

This preliminary study has as input data the dimensions of the bodies of the multi-beam bathymetric system [3], with two sensors, which are presented in figure 1. The purpose of this study is to check out the bathymetric system operation range for the research vessel.

The geometric analysis presents variants of the positioning of the bathymetric system taking into account the particularities of the ship's hull shape.

Case 1 shown in figure 2 is the one in which the two sensors are near the ship's keel, positioned at an angle of 74 degrees.

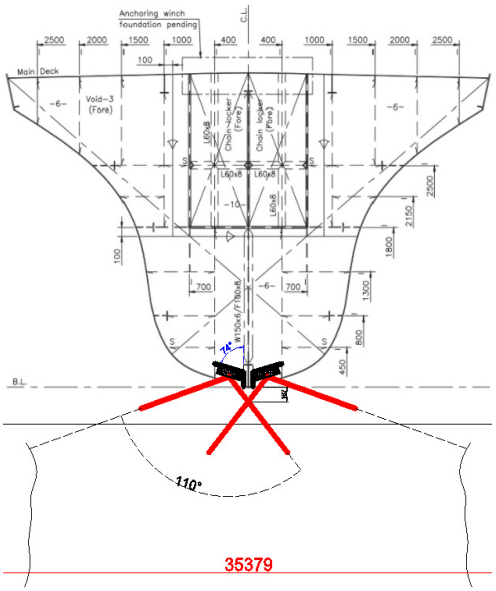

Fig.2 Case 1, two sensors near the ship's keel.

The variant of positioning the axis of the two transducers right in the diametrical plane was excluded for the reason of not affecting the structural strength. The constructive solution proposed for this case is to include caissons on both sides, near the ship's central longitudinal girder, for better local strength.

In case 2, shown in figure 3, the positions of the two bathymetric sensors are located in the transversal area between vertical references Z=0 and Z=450.

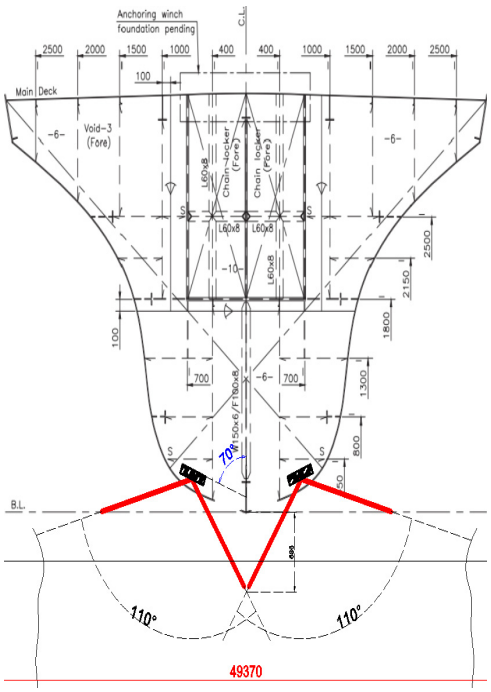

Fig.3 Case 2, angle 70 degree.

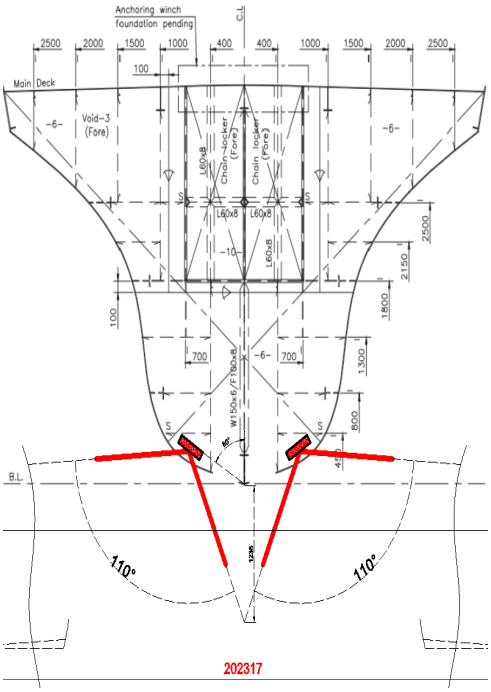

Fig.4 Case 3, angle 60 degree.

They have an angle of the location to the Z axis (of the ship's diametrical plane) with a value of 70 degrees. It is found that the minimum data recording depth (for relief of the map of the bottom of the signal is 686 mm). The scanning width for this positioning is 49370 mm.

Case 3 of the analysis consists in changing the location angle of the two bathymetric sensors by 10 degrees (60 degrees) compared to the diametrical plane of the ship (figure 4).

The results are expressed in the same two values, depth and width of the river bed scan depth 1236 mm and width 202317 mm.

It is found that with a 10-degree change in the position of the transducers compared to the diametrical plane of the ship, the scanned surface increases by 4.09 times. Regarding the minimum measurement depth, it is found that it increases by 1.8 times.

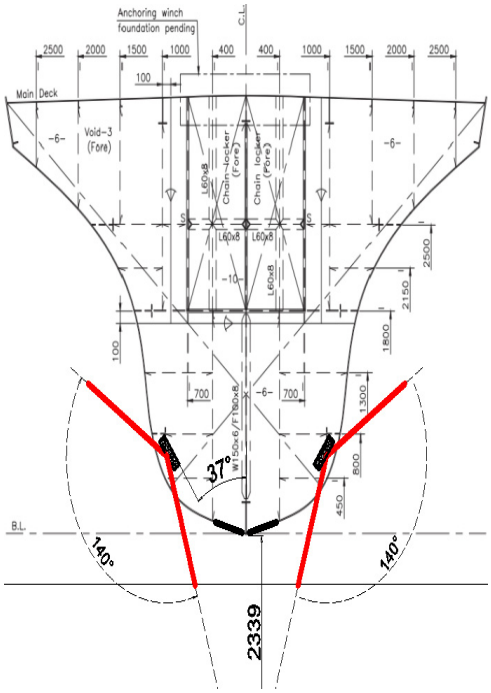

Fig.5 Case 4, angle 37 degree.

Case 4 analyzes the positioning of the bathymetric system in a different height position and with a different angle of inclination. In this case, the maximum scanning angle of the bottom of the bed and the banks was considered, namely 37 degrees compared to the diametrical plane of the ship. The geometry is presented in figure 5, from which the minimum scanning depth results, namely 2339 mm. The width is practically up to the banks of the river.

3. CONCLUSIONS

This preliminary study is made available to specialists in bathymetric measurements to decide the best options for the location and positioning of the multi-beam bathymetric system [3], in order to improve the ratio between the depth and the scanning width of the sensors' signal (table 1). Equally, the preliminary study offers options from a constructive point of view for the shipyard that builds the vessel.

Table 1. Parameters for scanning

Parameters for scanning	CASE 1	CASE 2	CASE 3	CASE 4
Z minimum measurement depth (mm)	167	686	1236	2339
Scan width (mm)	35379	49370	202317	completely
Positioning angle (degrees)	74	70	60	37

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REFERENCES

[1] **Orymowska, J., Sobkowicz, P.**, "Navigational safety of inland vessels in the Międzyodrze and Szczeciński Węzeł Wodny area", Scientific J. of the Maritime Univ. of Szczecin 49 93-99, 2017
[2] **Nechita, M., Popescu, G.,** "A comparative study of the barge's geometry under impact loads" 2020 IOP Conf. Ser.: Mater. Sci. Eng. 916 012073, 2020
[3] **Kongsberg**, EM2040 C-Multibeam Echosounder
[4] **ATG Shipyard Giurgiu** LINESPLAN
[5] **ATG** Shipyard Giurgiu Longitudinal Section
[6] **ATG** Shipyard Giurgiu Cross Sections FR 64 FR 67

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