Simulating Method of Ship's Turning-basins Designing

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ABSTRACT: The paper presents one of the methods of ship's turning-basins designing. The simulating method is more and more often used to the defining parameters projected turning-basins, testing of existing turning-basins and the improving of the manoeuvring practice on the particular manoeuvring basin.

1 INTRODUCTION

The manoeuvre of ships turning is executed every time during the ships presence in the port and it is one of the often port manoeuvres. The influences on the size of turning basin during the manoeuvre have the large quantity of factors.

The turning basin has two meanings. First meaning is the manoeuvring basin delimited by the manoeuvring ships, second is the hydro-technical building artificial or natural with suitable horizontal and vertical dimensions, where the considerable alterations of the course of the ship are executed. Obviously, the turnings over are practices „in the place". This should be understand as the change of the course of the ship whose linear speeds, during the manoeuvre, are close to zero. Turning the ship over is done on the turning basin as a result of the planned tactics of manoeuvring and can be done on itself or in co-operation with tugs or use of anchors or spring lines. All dimensions of turning basin as the hydro technical building has to be larger than the turning basin understood as the manoeuvre basin to avoid the collision with bottom or bank (Kornacki 2007).

The simulating method of designing the parameters of turning basins are based on series of tests in comparable conditions on prepared model of reservoir and the model of the ship planned to use the turning basin. The results of tests are subjected the statistical processing. Effect of that kind of research is delimitation of the area of manoeuvring on the turning basin according to the various foundations of

hydro meteorological conditions, various parameters of ships and various levels of the trust. Characteristic feature of the simulating method is that simulating models of the ship manoeuvring are especially designed to the solved problem.
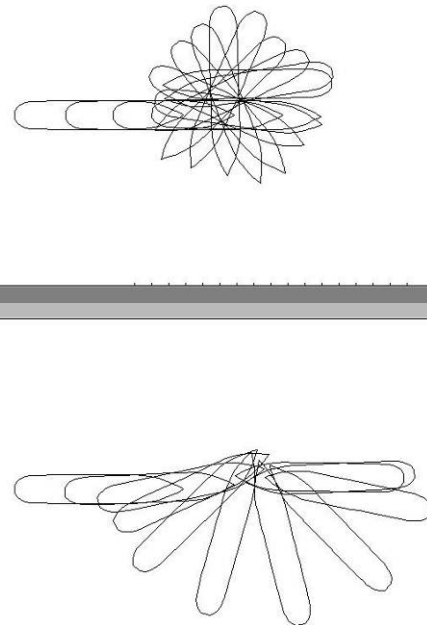

Figure 1. The example of tests of simulating of turning manoeuvres.

The material in the result of simulating investigations comes into very large sizes, which is subjected

far processing. The application of the methods which will let process got results to the form enabling making far analysis necessary is. The area of manoeuvring of the ship is the basic criterion of the analysis of the results of simulating testing's, and the dimensions of this area are it numerical coefficient. The variety of the elements of the system of the port and narrow waters causes that various methods are applied. These methods are characterized limitations and conditions. The method of parallel sections, sector method and polar method are complies with marking the dimensions of the basins of manoeuvring of the ship in simulating investigations (Guziewicz & Ślączka, 1997).

2 DELIMITING THE BASIN OF MANOEUVRING OF THE SHIP ON THE TURNING BASIN

The methods of delimitation of the area of manoeuvring of the ship are based on the suitable division of the water areas of manoeuvring and the engagement of suitable point or the axis of the reference. For the needs of delimitation of the manoeuvring area on the turning basin and during the manoeuvres of the turning of the ship the polar method is engaged. This method differs from the method of parallel sections that the sections are replaced by sectors and the axis of the reference is replaced by the point of reference. The difference in the relation to the sector method depends in the engagement of the point of reference not outside but inside the area of manoeuvring and the division of the manoeuvring basin on sectors hugging the round angle.

The polar method in the principle is the change of the sector method. Co-ordinates of points mark the area of manoeuvring ship are qualified in the polar co-ordinates. Then, knowing the exact position of the point of the reference, they are easy to proceeding in the far analysis. Wanting delimit the manoeuvring basin in the polar method, the studied manoeuvring area should split on the sectors of the delimited width $\Delta\alpha$.

The selection of the proper width of the sector essential is. The width of the sector simplifying should fulfil dependence (Guziewicz & Ślączka, 1997):

$$\Delta\alpha \rangle \frac{L_{OA} \times \sin\beta \times 180}{(i-1) \times R \times \pi} \ [^{o}] \qquad (1)$$

where:

$\Delta\alpha$ - width of the sector [°],

L_{OA} - length over all [m],

β - acute angle contained among the longitudinal axis of the symmetry of the ship and the secant of definite sector [°],

i - the number of extreme points on one board describing the waterline of floatation [-],

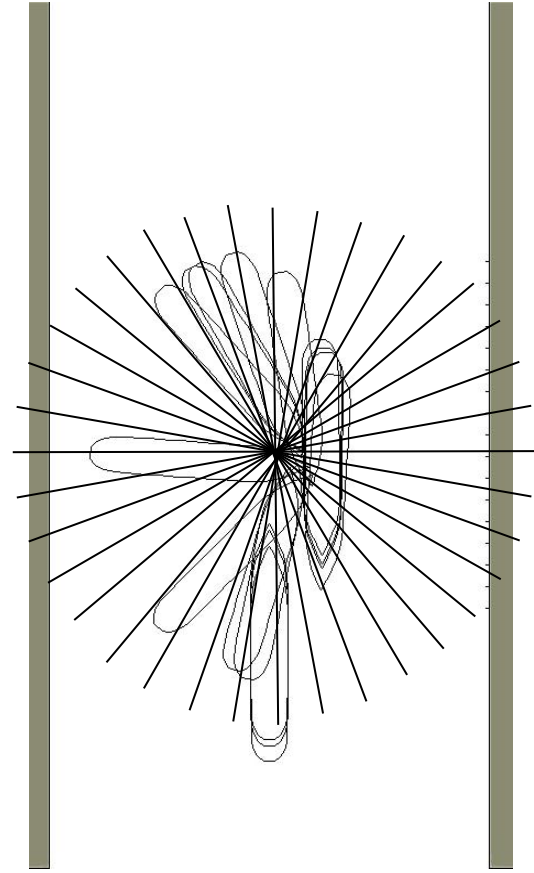R - the ray of the projected turning basin [m],

Figure 2. The split of the manoeuvring area in the polar method.

The selection of the width of the sector is dependent from the received suitable number of the extreme points of the ship. This influences on the size the error steps out among the delimited area of the manoeuvre and real manoeuvring area left by the ship.

One can express this error in the approximation (Guziewicz & Ślączka, 1997):

$$\delta_{Si} = \Delta\alpha \times R_i \times \cos\beta \times \frac{\pi}{360} \ [m] \qquad (2)$$

where:

δ_{Si} - error of delimiting manoeuvring basin [m],

$\Delta\alpha$ - width of the sector [°],

R_i - the ray of the projected turning basin [m],

β - acute angle contained among the longitudinal axis of the symmetry of the ship and the secant of definite sector [º],
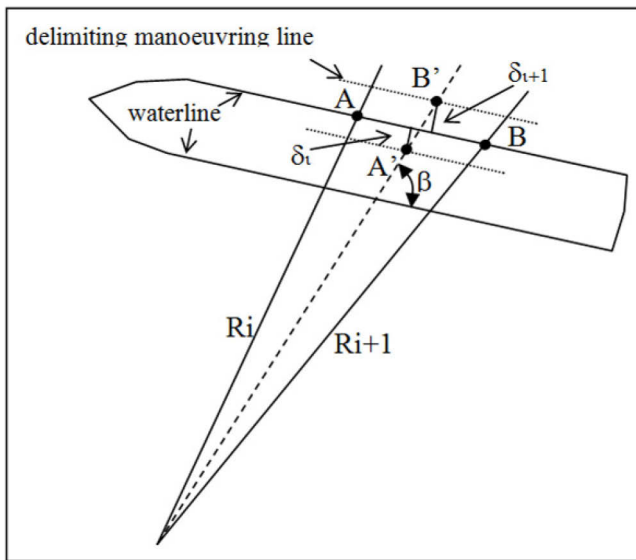

Figure 3. The error of delimiting manoeuvring basin.

During the test data with the course of the ship, shape of the waterline of floatation and the co-ordinates of geometrical centre of the waterline of floatation are recorded. The co-ordinates of extreme points of the ship are calculated in the polar co-ordinates.
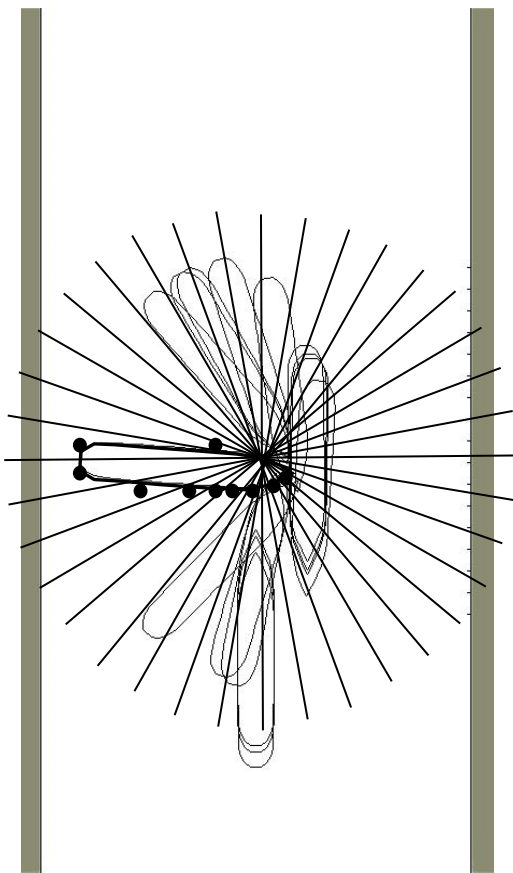

Figure 4. The extreme points of the ship on one particular waterline.

Distances d_i of the extreme points of ship from the point of the reference are calculated, where i is the number of the extreme points of the ship describing the waterline of flotation. The table of the distance $D_S [k, s, d_i]$ in which counted distances d_i are assigned to sectors s for individual simulating tests k is created.

Based on the table of the distance $D_S [k, s, d_i]$ the tables of maximum distances $D_{S\ max} [k, s, d_{i\ max}]$ and minimum distances $D_{S\ min} [k, s, d_{i\ min}]$ of extreme points of ship waterline from the point of reference in every sector of basin for every simulating test are created. This makes possible the assignment the line of movement of the ship in the single test.
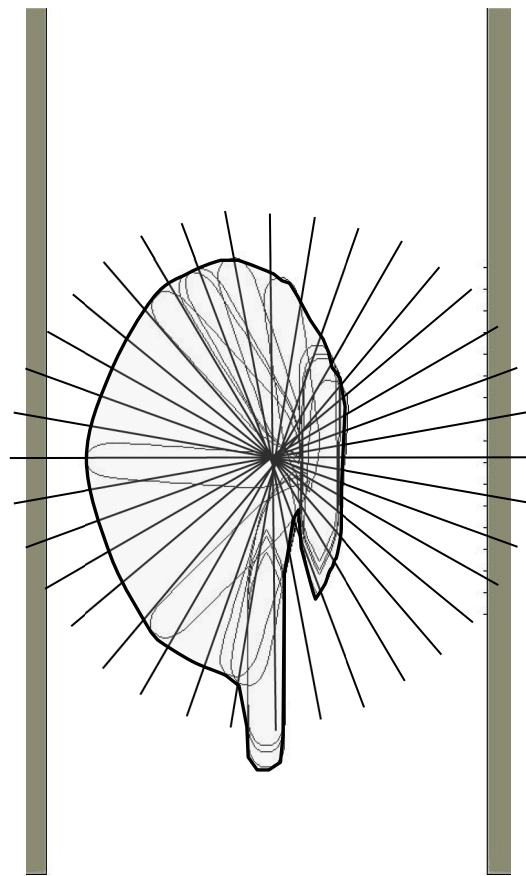

Figure 5. The line of movement of the ship in the single test.

Based on the table of maximum distances $D_{S\ max} [k, s, d_{i\ max}]$ and minimum distances $D_{S\ min} [k, s, d_{i\ min}]$ and the suitable statistical model of the expansion of maximum and minimum distances, the co-ordinates of points of the area of manoeuvring with the assumption of level of the trust are appointed in separate sectors.
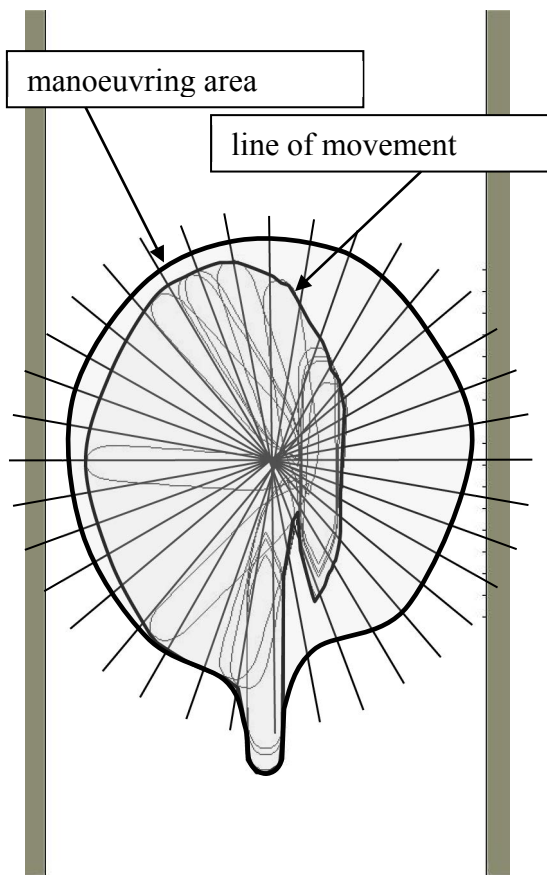
Figure 6. The line of movement and manoeuvring area of the ship.

3 THE PRACTICAL USE OF THE SIMULATING INVESTIGATIONS

3.1 *The practical use of the polar method*

The polar method can be applied to the preparation of the measuring data to the statistical processing during real investigations. Error resulting from the applied method of delimitation the line of movement in this case is enlarged by error resulting from the measurement and error resulting from the preparation of the measuring data to the use of the polar method becomes.

In the case of use of the polar method, while delimiting the manoeuvring basin of ship in simulating investigations, the results are burdened the only error the applied method.

In the practice, the simulating method complies in two aims. First, it complies in the qualification of sizes of the planned turning basin. Second, it complies in the qualification of maximum permissible sizes of ships can safely use the turning basin.

The turning basin is safe for the ships manoeuvring, if every her sizes in the horizontal plane and perpendicular plane are larger than the sizes of the manoeuvring area traced by the manoeuvring ship. It is mean that on the whole area the safe under keel clearance and the safe distance from banks and slopes has to be kept.

The analysis of the results of simulating tests leads to measuring the parameters of manoeuvring area, which means the qualification of the parameters of the horizontal safe manoeuvring area.

Figures 7 and 8 present the vertical and the horizontal section view of turning basin.
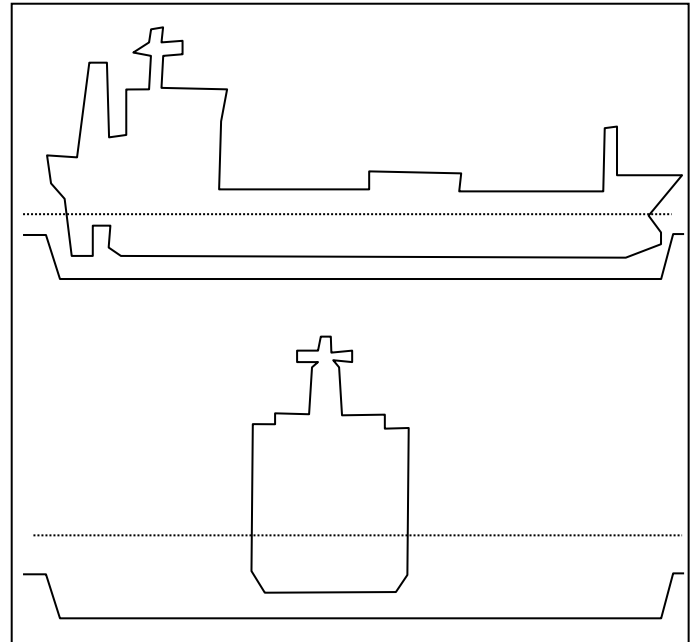

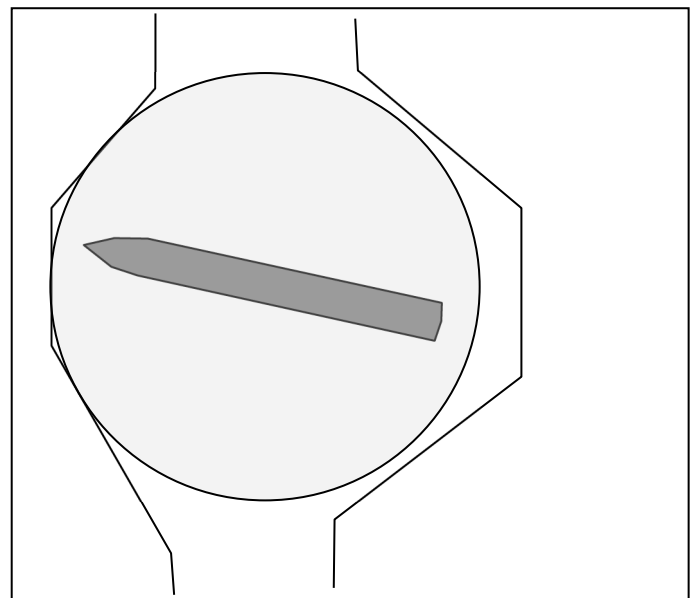Figure 7. The turning basin – the vertical view.

Figure 8. The turning basin – the horizontal view.

During simulating investigation relevant to the turning basin, it is important to take into consideration also the expansion of the speed of propeller streams, the expansion of directions of propeller streams, and influence of the every kind of hydrotechnical buildings, slopes and banks on the ship (Galor, W. 2002).

3.2 *The examples of use of the simulating investigations*

Figures 9, 10 and 11 present the examples of results of simulating investigation of typical turning manoeuvre.
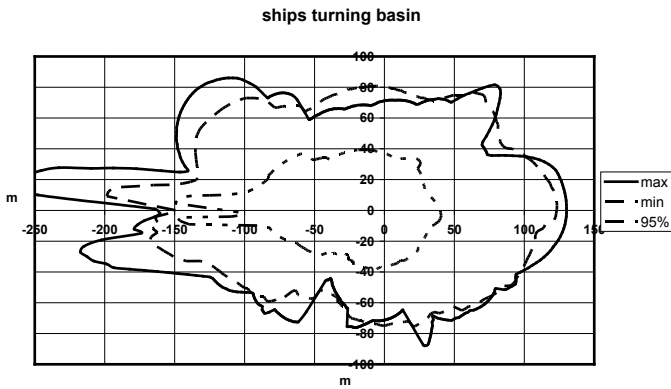

Figure 9. The manoeuvring areas with different trust levels during turning manoeuvres.
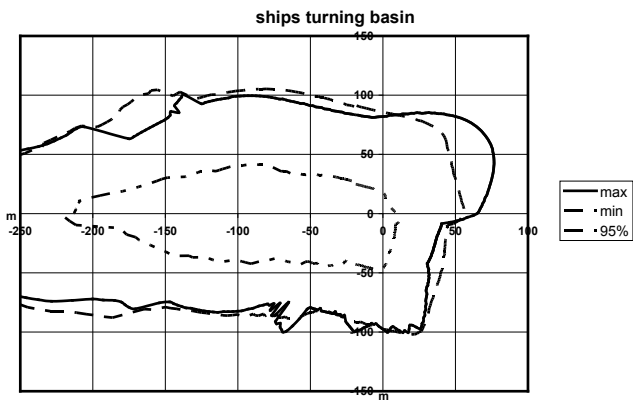

Figure 10. The manoeuvring areas with different trust levels during turning manoeuvres.
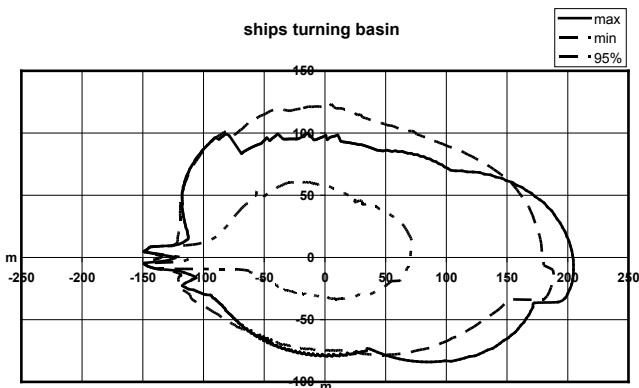

Figure 11. The manoeuvring areas with different trust levels during turning manoeuvres.

Figures 12, 13, 14 and 15 present the examples of results of simulating investigation on real port water areas (Kornacki, J.& Galor, W. 2007).
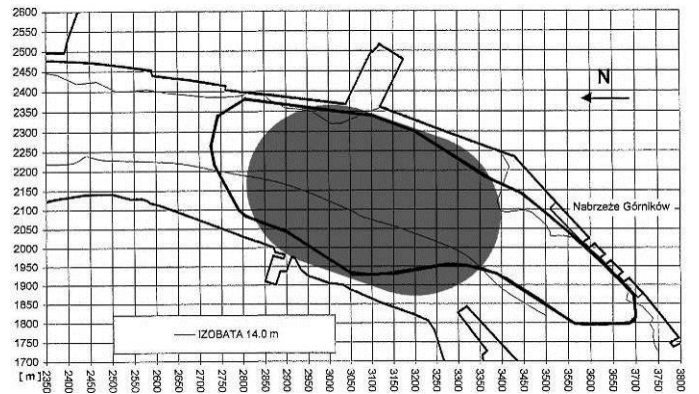

Figure 12. The north turning basin investigation in port of Świnoujście (The unpublished report 2000).
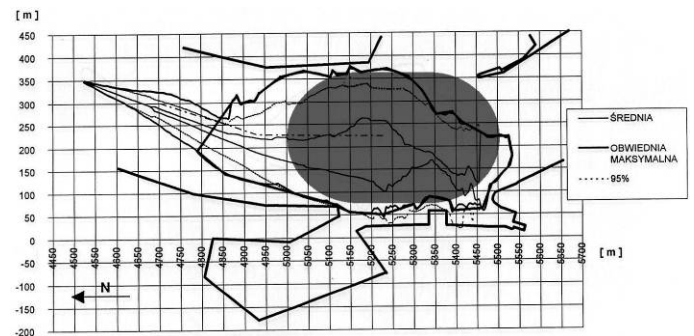

Figure 13. The south (BPP) turning basin investigation in port of Świnoujście (The unpublished report 1995a).
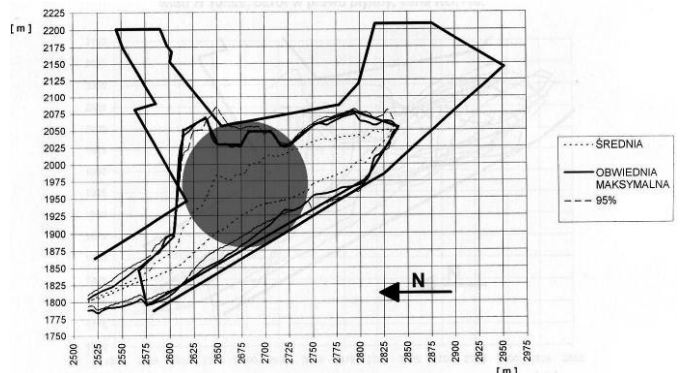

Figure 14. The turning basin investigation in port of Kołobrzeg (The unpublished report 1995b).
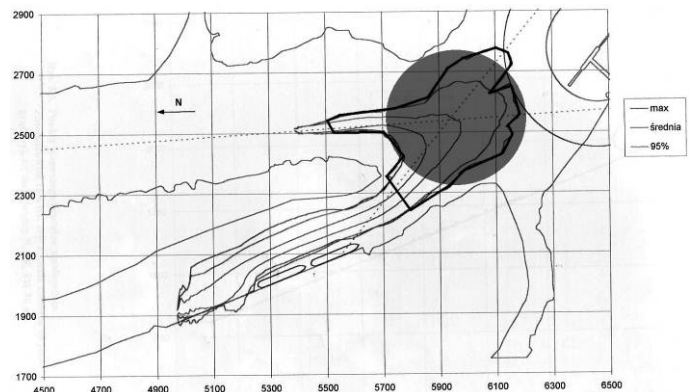

Figure 15. The turning basin investigation in port of Police (The unpublished report 1998).

These examples are showing scale of use of the simulating investigations. Base on the northern turning basin in Świnoujście, the problem of the analysis of the turning basin can be present.

The northern turning basin in Świnoujście was investigated several times, usually in the context of considerations on the subject of the possibility of manoeuvring in the harbour of the "maximum" ships. Problem this came back because of the development of the harbour in Świnoujście and the ambitions of the service larger ships. In the years 1995-97 was made one of first analyses in the aspect of the possible modernization of the northern turning basin. The investigation was made then to qualify possibilities of the entry the ships about the total length 255 m into the harbour. The qualification of the possibility of the safe turn of ships on the northern turning basin was one of the elements of these investigations. The eventuality of the increase of the sizes of the turning basin was taken into the consideration then so that ships do not violate the infrastructure of the western bank of Świna. In the year 2001, the problem was returned when the possibility of entering into the harbour of the ships of total length 260 m were study again. The investigations were led with the assumption that the existing bathymetry of the port's reservoir will not be changed. In the year 2003, the possibility of the entry the ships of total length to 280 m with new tugboat „Uran" was analysed.

4 CONCLUSIONS

The methods of delimiting the area of manoeuvring basin of the ship depend on the suitable split of the manoeuvring area. Polar method should be applied to marking manoeuvring area on turning basin.

The polar method is based on the suitable split of the manoeuvring area, the engagement of the point of reference and proper random variable to assignment of this basin. The distance of points describing the waterline of the ship from the point of the reference is the applied universally random variable.

The taken value of the width of the sector in the polar method has the direct influence on the value of the error among the real line of the movement of the ship and the line of movement of the ship delimited the polar method.

Main advantage of the simulating method is the possibility of the exact qualification of the manoeuvring area. Through the far statistical analysis of many tests, the ready information of the sizes of the basin which the ship needs to the realization of the manoeuvre of the turning is available.

Very important advantage of the simulating method is relatively low cost of investigation.

Often, navigational obstructions mark the accessible manoeuvring basin. It has the influence on the way of manoeuvring. The use of the simulation allows optimizing sizes of such basin or the way of manoeuvring.

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