**Scientific Journals**
**Maritime University of Szczecin**

**Zeszyty Naukowe**
**Akademia Morska w Szczecinie**

**2009, 18(90) pp. 43–47**

**2009, 18(90) s. 43–47**

# The research on Świnoujście ferry crossing traffic in terms of modernization stand no. 6 of sea ferries terminal

# Badanie ruchu promów na przeprawie miejskiej w Świnoujściu w aspekcie modernizacji stanowiska nr 6 Bazy Promów Morskich w Świnoujściu

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**Key words:** safety of maneuvering, ferry crossing, risk of navigation

**Abstract**
The paper presents research on the actual ferry crossing traffic in Świnoujście by using laser measurement system. The aim of this study was to determine safety of coexistence crossing ferry and modernized ferry stand No. 6 of Sea Ferry Terminal in Świnoujście and verification simulation studies carried out in 1996 by Marine Traffic Engineering Institute.

**Słowa kluczowe:** bezpieczeństwo manewrowania, przeprawa promowa, ryzyko nawigacyjne

**Abstrakt**
W artykule przedstawiono badania rzeczywiste ruchu promów na przeprawie miejskiej w Świnoujściu z wykorzystaniem metod laserowych. Celem pracy było określanie bezpieczeństwa współistnienia przeprawy w aspekcie modernizacji stanowiska nr 6 Bazy Promów w Świnoujściu oraz weryfikacja badań symulacyjnych wykonanych w 1996 roku w Instytucie Inżynierii Ruchu Morskiego w Szczecinie.

## Introduction

Świnoujście ferry crossing was established in 1997 on the basis of research conducted at the Maritime University of Szczecin. Nowadays, ferries operate approximately 910 000 cars per year and is supported by 4 ferries of the type Bielik: $L$ = 49.9 m, $B$ = 15.6 T, $m$ = 2.25 m.

Sea Ferry Terminal which adjacent to the ferry crossing has plans to support more and larger units. That's why in 2008 appeared the concept of modernization of ferry stand no. 6 and extension of its mooring line so that it can operate ferries to 207 m in length.

The paper is presenting the problem of safety coexistence the ferry crossing and modernized stand no. 6 of sea ferries base in Świnoujście.

## Navigational conditions on the Świnoujście ferry crossing

Ferry crossing is located between 2.5 km and 3 km of the Świnoujście-Szczecin waterway. Connection between the city center – Passenger quay, and its district – Warszów, located directly on the east bank of the river Swina between Bosmański dock and Portowców quay is provided by "Bieliki" ferries. Ferries cross the waterway Świnoujście–Szczecin at the height of the peninsula Kosa, where a southern turning area with a diameter of 320 m and depth of 11.4 m is located.

### Hydro-meteorological conditions

The average observed water level is 500 cm. Strong northeast storms cause to raise the water

level to 1.4 m and the south storms to approximately 1.3 m in relation to the average. Fluctuations are on average about 0.6 m in relation to the average state. Before entering the port a current direction is west at the east winds or east at the west winds. Output current is prevailing at light winds. It can reach speeds up to 4 knots during strong south and the southwest winds. Input current occurs at strong northwest wind; the north wind will increase the speed of the current to approximately 2 knots. The ferry is susceptible to the current action (input or output) when mooring or unmooring to the berth.

#### Navigational marks

In the area of ferry crossing only navigational marks for longitudinal traffic Świnoujście-Szczecin is available. Because of the dependency "Bielik" ferry crossing to the main traffic flow this passage has no distinct navigational marks. The most important marks for ferry crossing are illuminating beacon "Kosa-N", light on the position of the northern corner of stand no. 6 SFT and navigational-warning light on the positions on both ferries stations.

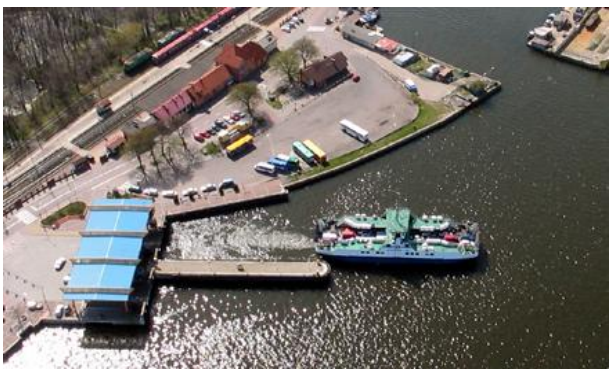

Fig. 1. "Bielik" ferry crossing – east station
Rys. 1. Przeprawa miejska w Świnoujściu – stanowisko wschodnie

## Computer simulation for ferry crossing

Computer simulation studies for sea ferry in the region of Świnoujscie ferry crossing were carried out on several times in the years 1987–1996, in the Marine Traffic Engineering Institute (Maritime University of Szczecin). The aim of this study was to determine if the sea ferries mooring and unmooring maneuvers from the ferry stand no.6 in vicinity of ferry crossing are safe and got any affect on accepted modernization concept of the Świnoujście Center Crossing in terms of hydro and meteorological conditions [1]. Additionally review of impact stand no. 6 SFT and ships mooring at for the ferry crossing traffic has been carried out.

Computer model of the new built ferry was used for this study:

- LOA $l$ = 49.00 m,
- Width $B$ = 14.20 m,
- Draft $T$ = 3.70 m.

The present types of ferries "Bielik" are:

- LOA $l$ = 49.9 m,
- Width $B$ = 15.6 m,
- Draft $T$ = 2.25 m.

Simulation researches are based on performance of manoeuvring trial series of significant number for detailed variants. These variants determines given problem. Comparing of results for each variant is done with use of navigational safety criteria. In researches the worst wind and current conditions were taken into consideration:

Input current 2 knots and output current 1.5 knots.

Wind during the mooring to the east harbor N, S, W, speed 10 m/s.

On the basis of the conducted simulation determine how berthing ferries at stand no. 6 influence on crossing ferry traffic in south approach area of east station. Summary traffic lane width in approach area for all mooring simulation is presented in figure 2. Based on these data, it was found that the approach maneuvers in Świnoujście Central ferry crossing are safe taking into account maximal ferry berthed on the quay (ferry type "Pomerania") [2].

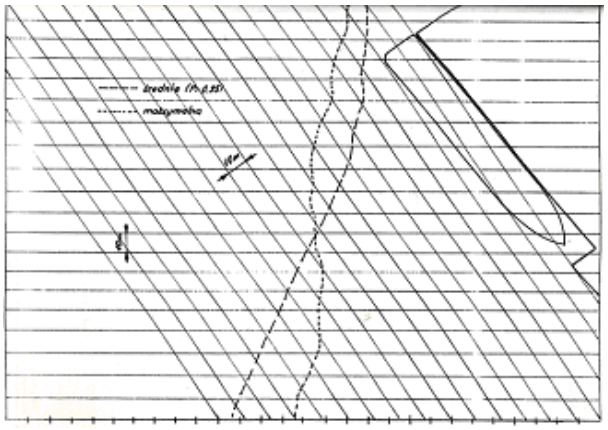

Fig. 2. Summary traffic lane of ferry "Bielik" based on research (max. output current, wind S/N/W 15 m/s), [1992]
Rys. 2. Sumaryczny pas ruchu jednostek typu „Bielik" na podstawie badań (warunki: max. prąd wychodzący, wiatr S/N/W 15 m/s), [1992]

New concept of modernization stand no. 6 of SFT occurred in 2008. It was necessary to carry out next computer simulation for the new maximum ferry mooring at the quay. Berth expansion project

provides an extension of the quay mooring lines so that it can be operated ferries to 207 m in length. At the same time, problem of safety maneuvering of ferries "Bieliki" in vicinity of stand no. 6 and Świnoujscie crossing ferry eastern stage appeared. The analysis showed that the extended quay no. 6 SFT does not limit the safety unmooring and mooring "Bielik" ferries to eastern station 1 and 2 of ferry crossing [3]. Also, ferries berthed at no. 6 stand on parameters: length $L = 207$ m, width $B = 30$ m, draft $T = 7.5$ m does not limit the safety of "Bielik" ferries mooring and unmooring maneuvers at the east no. 1 position of ferry crossing. Only berthing of ships length 195–207 m may limit the unmooring maneuver of ferry "Bielik" from no. 2 station at the wind from the directions: NW-N-NE, speed above 10 m/s and input current with a speed above 1 kn [4].

## Real research on ferries traffic

To verify simulation experiments and to assess the safety of the location, real experiment with using a reflectorless laser measurement system and short-range set distance measurement was conducted. Diagram of the measuring method is shown in figure 3. Two characteristic points on the bow and stern of the ferry were chosen. Distance and angle between two recorded points were being measured. Other data was determined later on the basis of the relevant mathematical relationship.

### Performance of tests

Tests were carried out by using handheld reflectorless laser measurement system LaserAce MDL-300. Parameters of this system are shown in table 1.

Table 1. Laser measurement parameters
Tabela 1. Parametry urządzenia pomiarowego

| Type of laser | GaAs Laser Diode |
|---|---|
| Type of measurement | Measurement of the signal transmition time |
| Wave length | 905 nm |
| Range | 300 m (5 km with reflector) |
| Accuracy | ±10 cm (average) |
| Time of gaining the measurement | 0.3 s |

The width of traffic lanes was determined using dynamic method. Distance and bearing to the two characteristic points of the ship's hull using a single laser rangefinders and connected device for measuring the horizontal angle were measured. Apparatus for electronic measurement of horizontal angle is the encoder allowing determine relative angles. After calibration encoder in relation to the actual meridian, it is possible to determine a real bearing on the observed object. The maximum reach of measurement is conditioned by the rangefinders range.

As characteristic points extreme forward and aft points of the ferry "Bielik" were selected. Measurements were recorded by computer in real time. Measurement bench has been set on the quay in a fixed position (fig. 4). Testing was conducted in two series, in different hydro-meteorological conditions (data specified in Świnoujście Traffic) in order to assess the safety of this maneuvers (table 1). In each series 8 maneuvers of mooring

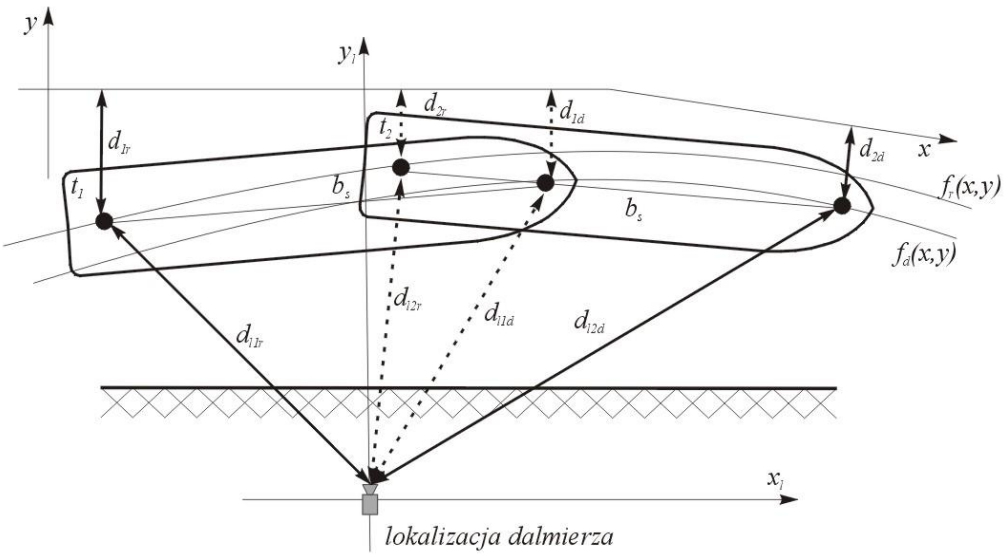


Fig. 3. Method of alternating measurement
Rys. 3. Metoda pomiaru naprzemiennego

and unmooring were recorded. Measurements were made in both cases between 09.00 and 12.00 o'clock.

The results of the measures are presented in table 2 where can be found the two cases: wind NW 2 m/s and input current of 0.5 knots and the wind NW 15 m/s and 1.5 input current.

Table 2. Weather conditions during measurement
Tabela 2. Warunki pomiarów

| Series from: | Wind | Current |
|---|---|---|
| 04.02.2009 | NW 2 m/s | Input: 0,5 kn |
| 11.02.2009 | NW 15 m/s | Output: about 1–2 kn |

Fig. 4. Measurement bench (in the foreground rangefinder MDL in the background ferry "Bielik")
Rys. 4. Stanowisko pomiarowe (na pierwszym planie dalmierz MDL, na drugim badany prom)

Presented south sides of maximum traffic lanes are boundaries of outermost points of the ferry (maximum moved away from the pivot of a traffic lane) recorded during series of maneuvers [5].

Taking into account the results of simulation studies carried out by a team of MTE for new built ferry 207 m length, it is concluded that the berthing at the stand no. 6 ferries with a length of 195–207 m is limited only by unmooring maneuver of the ferry "Bielik" from the eastern no. 2 station of the ferry crossing at wind from NW-N-NE only at speeds above 15 m/s and input current $Vp > 1$ knot [4]. Station of sea ferries up to 207 m at the no. 6 stand shall not affect the safety of the "Bielik" ferry mooring and unmooring for the no. 1 station of the eastern ferry crossing.

## Ferries safety in the aspect of modernization stand no. 6

The ferry stand no. 6 is designed to operate passenger-car ferries, passenger vessels and vehicles and ro-ro. Modernization of this stand is bound up to the plans of exploitation of a new 207 m length ferry. Safe maneuvering conditions for the ferry have been identified for the assumption that the dolphin line was extended and modernized.

This is a heavy type quay. Before reconstruction the quay length is 130.0 m. It is planned to build on a quay section of 65 meters length. The depth of berth on mooring lines and the area of strengthening the bottom is 9.5 m with an average water level [6].

Analyzing the results of the real tests can be noticed that hydro-meteorological conditions have a substantial effect on the size of the maneuvering area. In conditions of the crosswind about strength 15 m/s maneuvering area is moving on about width of the vessel (15 m). It can therefore be considered that the wind directions from north of 15 m/s is the maximum wind for the safe coexistence of the "Bieliki" crossing ferry and berthed maximum ferry. Ferries "Bieliki" should use northern station when winds are greater than 15 m/s.

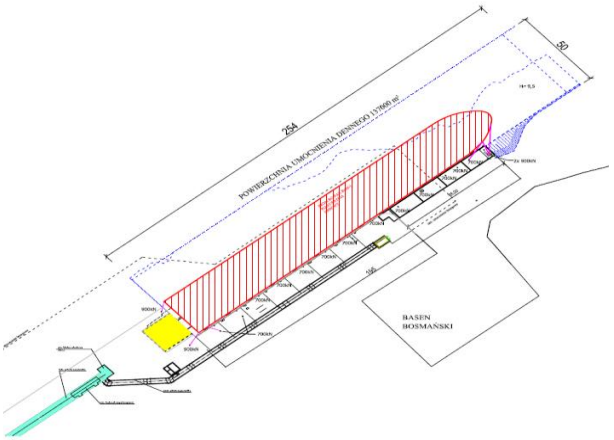


Fig. 5. 207 m long ferry moored at stand no. 6
Rys. 5. Prom o długości 207 m zacumowany przy stanowisku nr 6

There is great similarity between the results obtained in simulation research in 1996 [2] and these days. Extreme left boundary of determine maneuvering area carried about 40 m from the

north end of the existing stand no. 6 for both simulations and real trials.

## Conclusions

The article presents author's method of determining the actual movement of ferries using laser systems. This method is cheap and do not interfere in the subject of research.

The research results helped determine the extreme conditions of the landing operation and coexistence with the proposed stand of no. 6 of SFT in Świnoujście.

Verification of simulation studies carried out in 1996 in order to determine the conditions for the construction and operation of ferries crossing in Świnoujście confirmed their compliance with the reality in terms of the size of the maneuvering area.

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