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Traffic and safety of inland ships in Szczecin Port in the aspect of new investments in this area

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Abstract
The paper presents several issues concerned with safety of inland ships navigation in Szczecin Port area. Additionally the analysis of inland ships movement has been performed which is necessary to full picture of safety analysis. The problems related with safety of inland ships on the area of deep sea ports is often omitted in safety analysis, which could be the reason of lowering safety level or neglecting important issues related to port safety.

Introduction

The issues concerned with coexistence of inland and deep sea traffic and aspects related to navigation safety, have not been previously the subject of studies in the literature. This paper should be treated as a problematic contribution for further discussion on this topic.

Port of Szczecin is the commercial sea and river port, which is located on the Odra River and its Eastern leg of Regalica, and further in the lower Valley of the Odra River and Międzyodrze. It is one of the most extreme located of polish ports on the west. Its geographical location plays an important role in the development of the region. Indisputable advantage is the availability for inland waterway transport, which is considered by the European Union as the most friendly environmental. Attention should be paid to the fact, that in this case has huge impact on waterway system. In the Port of Szczecin operates 8 cold stores, river passenger steamers, cruise ships seagoing ships and cargo vessels are served there. The Port of Szczecin in 2006 capturing 1st place in handling operations of grain-cargo turnover amounted to 1.692 million tons, it was 44.9% of the turnover of all seaports in Poland.

In the Port of Szczecin, the vessels traffic is increasing slightly in recent years, although you can see the tendency to reduce the size of supported [1]. Table 1 shows the vessels traffic in Szczecin in the last 4 years.

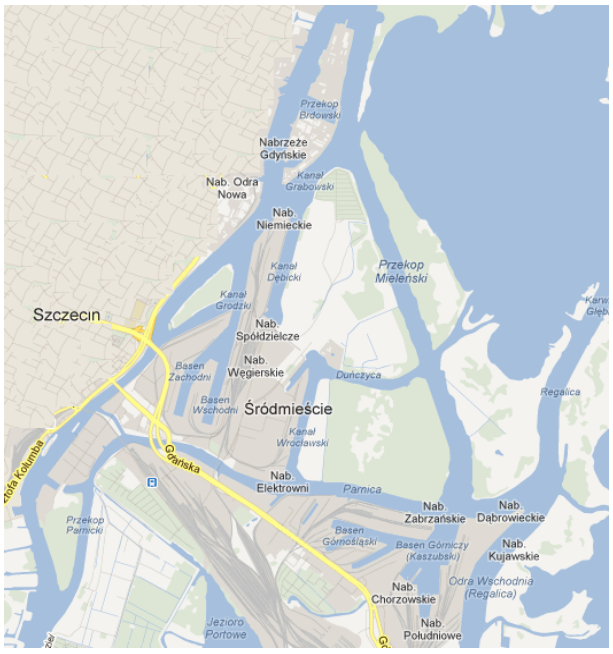

Fig. 1. Layout of analyzed area [https. maps.google. com]

Table 1. The traffic of sea vessels in the Port of Szczecin [2]

Port	Years	A total of		
		number of vessels	net tonnage (NT)	gross tonnage (GT)
Szczecin	2008	3313	4249.6	8743
	2009	2775	4231.9	8575.9
	2010	3185	5033.8	10459.4
	2011	3084	4689.5	9804.9

Traffic and accident rate of inland ships in the Port of Szczecin

The Port area of Szczecin in presented analysis of the safety of inland waterways was divided into 3 following routes:

Route 1 – from Basen Górniczy to up the river. This section, where the inland ship navigate from the up of the East Odra river (Regalica, Parnica) or directly with Basen Górniczy stirred and next Mieleński Canal. In the vicinity of Orli Przesmyk and Gnieźnieńskie quay on the opposite side of the North Island cape in Ostrów Grabowski on the crossroads, where one channel leads towards to the south-westerly direction, further Grabowski Channel and the West Odra river up of the river and next to the Castle Route. The section marked on figure 2 as a yellow route.

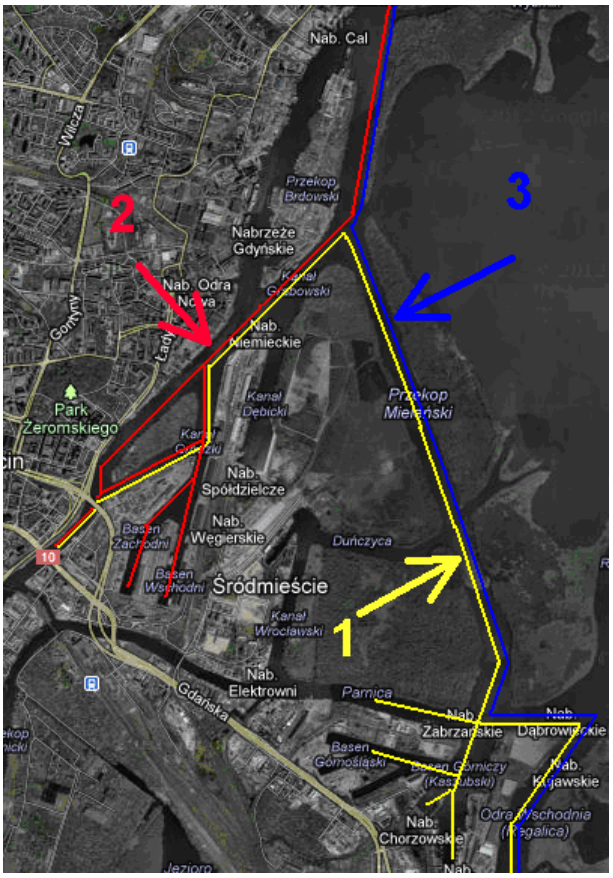

Fig. 2. Map with presented routes [https.maps.google.pl]

Route 2 – from up the river to down the river (dock No. 5). This section where the vessels navigate from up of the Odra Western river or directly moved from the Castle Route and next Grabowski Channel. In the vicinity of Orlego Przesmyku and Gnieźnieńskie quay on the opposite side of the North Island cape in Ostrów Grabowski in direction of North Mieleński Canal, farther down the river to the sea or to the next ports or harbours on the North of Szczecin. This route is marked red (Fig. 2).

Route 3 – from Basen Górniczy to down the river (Dry Dock No. 5). In this section, the inland ships navigate from up of the East Odra river (Regalia and Parnica) or directly with the Basen Górniczy stirred, and next Mieleński Canal and further down the river to the sea or to the next ports or harbours on the North of Szczecin. This route is marked blue (Fig. 2).

The paper examined only selected, but dominant inland waterway fleet. Self-propelled barges and push sets are usually used for the carriage of goods on a polish inland waterways. Barges without propulsion could be towed, which is rare or pushed by pusher creating so-called inland sets. Such sets consist of pusher with 1, 2 or more seldom 3 or even 4 barges without own propulsion.

The traffic on inland ships in the Port of Szczecin

Inland ships in the majority are not equipped with automatic identification system (AIS) and are not tracked or archived by VTS Świnoujście–Szczecin system. The acquisition is carried out only manually on the basis of written reports, obtained by VHF from VTS centre in Szczecin. On the basis of the documentation carried out by the services of the VTS 3 months of the year 2011 (April, May and June) have been analyzed. In total, during these three months inside the Port of Szczecin, it was recorded 1872 inland ships movements. The table 2 shows an approximate number of inland ships on selected three routes in the Port of Szczecin referred to 1 calculation year. It can be observed, that the intensity of traffic of inland waterways is more than twice bigger than the deep sea vessels.

Table 2. Number of inland ships in the Port of Szczecin referred to 1 year in analyzed tracks

Types / Route	Barge with own propulsion	Pusher	Pushed set with one barge	Pushed set with two or more barges	Together
Route 1	784	1424	596	1972	4776
Route 2	704	676	200	524	2104
Route 3	184	176	64	184	608
Together	1672	2276	860	2680	7488

The entries listed on the table 2 shows, that in general pushed inland sets dominates in all routes, while route 1 leading from Basen Górniczy upstream to the Castle Route and still is the most common and most traveled by inland waterways.

Accident rate of inland waterway fleet

The following classification is applied to the test cases used by navigation Maritime Authority in Szczecin for sea-going vessels:

- *collision* it is every in contact with another ship, regardless of whether any of the ships was by boat, floated or moored etc.;
- *striking* it is coming into contact with any ship other than a ship floating and fixed, both surface and submarines;
- *grounding* is each contact of the hull with sea bottom regardless of whether it was fitting on the bottom of the vessel;

The table 3 shows the statistics of accidental events in 2011, involving sea-going vessels within VTS Szczecin, broken down by the collision, impact, shallows, technical failures and others.

Table 3. Accidents and incidents of deep sea ships based on investigations in 2011 [3]

No.	Description	The number of accidents	The number of investigations of the Marine Office
1	Striking	19	2
2	Collision	3	3
3	Grounding	7	4
4	Marine equipment failures	41	0
5	Various accidents	104	1

The table 4 presents, overview of accidents for sea-going vessels in the area administered by a VTS in Szczecin.

Table 4. Accidents of deep sea ships during 2002–2011 [3]

No.	Accident kind	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.	Collision	2	4	1	2	7	11	6	3	7	3
2.	Grounding	7	5	8	2	3	3	8	8	3	7

The table 5 shows, the recorded incidents and accidents in the Port of Szczecin officially reported to VTS service involving inland waterway fleet. It could be noticed that, during the analysis period (10 years), there has been one crash and two collisions reported of inland ships.

In 2011 the registers of shipping accidents of inland ships carried by Inland Waterway Transport Office in Szczecin 5 incidents are recorded, while in 2010 there were 9 of them. None of them was related to the transport of dangerous goods [4].

Table 5. Accidents and incidents of inland ships during 2002–2011 [3]

Date	Event description
11.2004	Break up the rope on the barge that was moored at the Snop quay, consequently, what the barge is starting to drift in the direction of the fairway Świnoujście – Szczecin
07.2005	Pusher witch 4 barges striking in BON quay
08.2005	Break up the rope on the barge that was moored at the Bytomskie quay, consequently, what the barge is starting to drift in the direction of the Pier quay
07.2007	Break up the rope on the barge that was moored at the Huk quay, consequently, what the barge is starting to drift in the direction of the fairway Świnoujście – Szczecin
10.2007	Leaving the shoulders of barge on the quay , which is located in the immediate vicinity of the fairway Świnoujście-Szczecin
07.2008	The German barge Vineta collision with passenger Penny Queen and with ship Hela which was moored at the Starówka quay
08.2008	Collision two ships of inland waterways
03.2009	Intoxicated skipper on the pusher witch 2 barges
09.2010	Engine failure on the pusher witch 2 barges
04.2011	Break up the rope on the barge that was moored at the Snop quay, consequently, what the barge is starting to drift in the direction of the fairway Świnoujście – Szczecin

The initial comparison of the numbers above (Tables 3, 4 and 5) gives the impression of a small number of accidents in the Port of Szczecin of inland ships in relation to the number of deep sea-going vessels or inland waterway craft within administered by Inland Ships Regional Office. The reason for this might be as follows: the deficiencies and problems in the documentation of incidents and accidents of inland ships or a tendency of not reporting or even hiding the accidents with fewer consequences.

Selected problems of inland ships collision with bridges in aspect of building Brdowski Bridge

In the Port area of Szczecin, it is planned to build the bridge which will join Ostrów Brdowski Island with Szczecin Port in the vicinity of Gryfia Shipyard. It will be the fixed bridge with parameters enabling navigation of inland ships under its span (vertical clearance of abt. 5 m and navigable width of 50 m). In following part of this paper it is presented several issues, concerned with navigational safety in case of enabling inland ships to navigate under the bridge. The bridge localization is presented in figure 3.

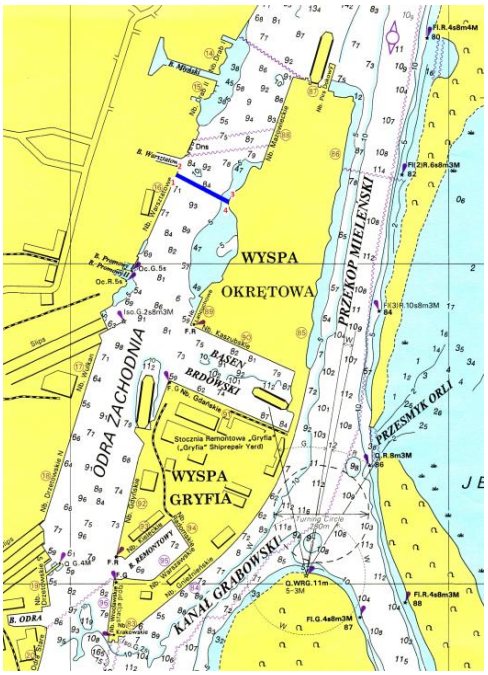

Fig. 3. Planned localization of Brdowski Bridge (blue)

The bridges located on navigable waterways are particularly safety-sensitive infrastructure due to three main reasons [5]:

– limits the waterway parameters horizontally and vertically;
– human traffic on the bridge could be threatened in case of ships collision;
– the cost of bridge is usually higher than the cost of ship.

Based on literature studies [6, 7] it could be stated that the ship collision with the bridge is one of the most important reasons of the bridge catastrophes and could be the reason of up to 30% of all accidents.

United Stated Cost Guard accident databases [8] reveals that majority of ships collisions are the reason of accidents with relatively small consequences. In the years between 1992 and 2001 it have been reported 2692 accidents of which only 61 (2.2%) with consequences of more than 0.5 mln USD. In 1702 cases (63%) it was not necessary even to repair the bridge. Further analysis reveals that 78% of them happen due to the human error and 12% of the other operational factors.

The accidents on inland waterways are more frequent, but due to the lack of detailed statistics including consequences of accidents it is difficult to assess its probability.

In Poland, the problem with ships collisions is connected with an old fashion inland infrastructure. In the area, governed by Szczecin Regional Inland Waterways Authority (RZGW Szczecin), it is recorded one such accident per year. The most serious case was destroying due to the collision with bridge of guiding fenders of Kolejowy Bridge in Szczecin which forced necessity of its removal and replacement in 2001.

Based on RZGW Szczecin database, it was collected and analyzed all cases of the ship-bridge collisions (Fig. 4). Total number of accidents is 17, during 16 years. Happily, there were no fatalities recorded in this time. The navigator (human) error dominates and equals approximately 90%. The percentage of collision with the bridge spans is very high and equals 65%. Some of them are ended with serious ship damages. Such kind of accidents are usually the reason of navigation error and the lack of knowledge of actual state of water and vertical clearance of the bridge or ship airdraught.

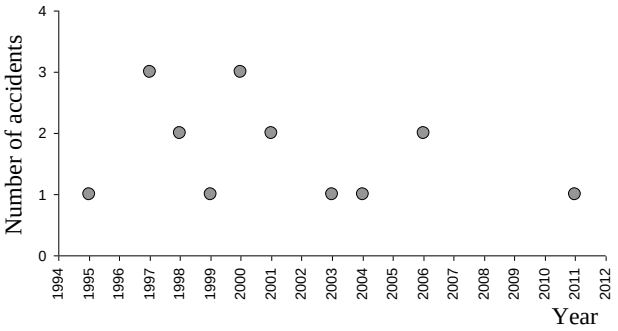

Fig. 4. Number of accidents with bridges in RZGW Szczecin administrated area [5]

Some interesting statistics were presented by Proske [9]. They include intensities of the ship-bridge collisions in given European inland waterways (Table 6). For known traffic intensities, the probabilities of collision in single passage have been presented.

Table 6. Mean intensities of ships collision on different European inland waterways [9]

Research area (river)	Collison per year	Collision per single passage
Thames (UK)	0.23	$10.7 \cdot 10^{-6}$
Seine (France) – study 1	0.0313	–
Seine (France) – study 2	0.0556	$15.7 \cdot 10^{-6}$
Main (Germany) – study 1	0.0088	$0.7 \cdot 10^{-6}$
Main (Germany) – study 2	0.016	$61.0 \cdot 10^{-6}$
Main (Lohr – Germany) – study 3	0.0351	$21.0 \cdot 10^{-6}$
Mozel (Germany)	0.037	$0.7 \cdot 10^{-6}$
Duna (Vilshofen – Germany)	0.158	–
German inland waterway – study 1	0.021	–
German inland waterway – study 2	0.0095	$0.5 \cdot 10^{-6}$
Elbe (Drezno – Germany)	0.038	–
Mean	0.058	$1.58 \cdot 10^{-5}$

Taking into account mean of probability of ship-bridge collision in Europe as $1.6 \cdot 10^{-5}$ (Table 6) and

assumption, that the inland ships traffic on route No. 2 (up the river – Trasa Zamkowa, down the river – Dok No. 5) presented on figure 2 will be directed under planned bridge with intensity 2000 ships per year. It could be calculated expected yearly intensity of ship-bridge collision as 0.032, which gives one accident per 31 years. With assumption of tolerable accident intensity as 0.07 accident per year [10] it is reasonable to move inland traffic to this route and thus reducing the inland traffic intensity on Grabowski Canal.

Conclusions

Assuring safety of water transportation is high task priority. In case the Port of Szczecin it is more important due to the specific character of navigation conditions and difficulties, which comes with combining deep sea and inland traffic. It should be remembered, that navigation in this area is performed not only by knowledge of sailing directions, but mostly with local sea area or inland pilot knowledge. High intensity of traffic, together with frequent turning and mooring operations, makes navigation even more difficult in compare to other regions nearby. It should be also noticed, that the Port of Szczecin has quite complicated navigational infrastructure with various depths and widths of waterways and any accident could block other movement in this area.

In this paper it was shown that problem of inland ships safety in sea ports is important, despite, it look not significant at the first glance due to the small number of registered accidents. The previous accident, in which inland barge was sunk, due to the collision with deep sea ship in 2003, caused a blockage of waterway Świnoujście – Szczecin for nearly two weeks.

In this paper, it was shown, that it does not exist clear and consistent system of inland ship accident reporting in the Port of Szczecin and responsibilities of different actors overlaps. Such situation makes even impossible to made serious diagnosis of safety of inland ships in this area.

It is recommended to perform serious analysis of neglecting of inland ships accident, reporting of all especially those of minor consequences and also propose new legal solutions in this area. The newly established Polish Maritime Accident Investigation Commission could enhance the safety of ships navigation in this field.

The problem of navigational safety should be treated in complex way also by new methods and tools for training of seafarers and inland ships operators. The example in this field is integrated bridge simulator created in Maritime University of Szczecin called INSIM. This is first in Poland and one of the few in Europe inland ship manoeuvring simulator [11]. This simulator enables to perform any kind of inland ship related navigation exercises, also in the Port area of Szczecin, which have been fully modeled in this simulator. This simulator could be use in training of inland captains and performing exercises concerned with cooperation of ships with VTS systems and deep sea ship traffic.

It is proposed to conduct deeper discussion of inland ships safety on deep sea waterways and in further step perform full diagnosis of safety of inland traffic and analysis towards its enhancing.

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