A design concept of ecological tourist – – passenger ship intended for Berlin-Królewiec (Kaliningrad) inland waterway service

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ABSTRACT

This paper presents a design concept of a novel passenger segment ship intended for navigating on Berlin--Królewiec (Kaliningrad) inland waterway route, characteristic of application novel structural materials and engineering processes which make it possible to design structures in an innovative way and provide high operational merits for inland waterways ship. Conceptual, functional and technical assumptions for the designed ship as well as its service program was described. Exceptional features of the designed ship are : the general architectural concept which makes the ship free passing under small-clearance bridges and navigating in narrow and shallow waterways, possible, manufacturing technology of its hull structure made of „sandwich" panels as well as its combustion-electric engine (or combustion-hydraulic engine) propulsion system working on alternative ecological gas fuels.

Keywords : ship designing, inland waterways ships, passenger ships.

INTRODUCTION

European Union allocates significant funds for conducting active policy aimed both at development of shipping goods by using inland waterways and at their use for other transport services (tourism, passenger traffic). Growing road traffic flow, especially that of cars, has become tedious for public and noxious for the environment; it generates high costs of transport, ecological hazards as well as leads to traffic accidents. The above mentioned phenomena justify in a sufficient degree to undertake efforts and bear costs associated with searching for, elaborating and implementing alternative transport solutions including those aimed at directing a significant part of transport volume into sea shipping routes and inland waterways. Traffic capacity of the existing European highways is, in some spots, already close to their extreme limits, and the building of next ones becomes more and more problematic.

An intention of EU countries and international organizations dealing with water transport is to extend eastward the developed waterways systems of West Europe – including also Polish inland waterways – in such a way as to connect the EU system of inland waterways with sea ports and thus to get connections between :

- Baltic and North Sea ports and Mediterranean ones
- Baltic and North Sea ports and Black Sea ones
- inland ports of EU countries and the region of Gdańsk, Vistula and Kuronian Bay
- inland ports of EU countries and inland waterways of Wight Russia, Ukraine and Russia.

It is expected that further development of economy of EU extended by ten new countries since 1 May 2004, will be based on the development of Euro-regions by strengthening their competitive position. Hence it is necessary to prepare society to active taking part in socioeconomic processes orientated towards developing such human features as : enterprise, innovation, easy inter-personal communication, or skill in using informatics technology.

The regions of Noteć Primeaval Forests, Warmia, Mazury, Podlasie and Polesie, the rapids of Drawa, Wda and Brda river and old valleys of Vistula river represent unique nature merits, especially attractive for tourists from EU countries. Moreover on the territories are located unique historic monuments of world class such as sacred buildings, fortifications as well as medieval municipal complexes. For this reason the specified regions are predestined to serve as a tourism centre and in consequence to lead to livening up their economy and reducing unemployment by absorbing a workforce surplus by such sectors of services as gastronomy, hotels, shipping, yachting etc.

A contribution to realization of the above mentioned target is the concept of livening up the inland waterways tourist traffic realized by means of a fleet of safe high-standard passenger ships. This work is devoted to identification and formulation of functional and technical assumptions for designing the ship intended for realization of aims of the project.

AIM OF REALIZATION OF THE PROJECT AND APPLICATION MODE OF THE SHIP

The design study of a novel ecological passenger ship elaborated in the frame of **Eureka InCoWaTranS E!3065 Program**[4] is aimed at making a proposal for development of tourism and passenger traffic along common inland waterways of Poland and other EU countries – in east – west direction. These are benefits possible to be obtained as a result of realization of the project in question :

- decreasing unemployment in northern regions of Poland, having poorly developed industrial infrastructure
- social activation of the regions crossed by the shipping route in question
- development of tourist services in the regions of unique nature merits

1. Architect of ship accommodations
2. Principal designer of the ship
3. Coordinator of the EU InCoWaTranS E!3065 project
4. Environment-friendly inland & coastal ships for Polish east-west waterways.

- ❖ integration and livening up cooperation of the border regions
- ❖ technological development of Polish shipyards and implementation of novel techniques to inland waterways transport by using environment-friendly ships
- ❖ revival of building – by Polish shipbuilding industry – the inland waterways ships having good export prospects to EU countries.

The building of inland waterways ships is the field of industrial activities in which Far East shipyards do not compete much as compared with the case of large sea-going ships, however a competition from the side of shipyards in EU countries should be taken into account. In the case of passenger ships intended for recreational service the following factors will decide on their success :

- ➢ Technical level of built ships
- ➢ Investment profitability
- ➢ Environment-friendly technical solutions
- ➢ High-standard aesthetic merits of ship accommodations and voyaging comfort
- ➢ Quality of organization and attractiveness of tourist-recreational programs.

SERVICE PROGRAM OF THE SHIP

The presented concept of ship service program, which constitutes the basis for rational formulation of the design assumptions, both functional and technical, is a development of the concepts presented in [1].

It is assumed that the ship and accompanying tourist infrastructure will operate in summer season, i.e. from the beginning of May to the end of September, by offering :

- ✪ The trips, mainly addressed to EU tourist, on the route: Berlin-Bydgoszcz-Toruń-Malbork-Gdańsk-Elbląg-Królewiec (Kaliningrad); two kinds of such trips are provided for, namely Berlin-Królewiec-Berlin round trip and Królewiec--Berlin trip combined with coach transport to and from Królewiec.
- ✪ Fortnight tourist trips along inland waterways on board the new - generation high-standard ships, organized in cooperation of a group of professional tourist firms having at their disposal appropriate floating units and social living bases fitted with relevant tourist land-based infrastructure (hotels, harbours, coaches, forest clearings, mashroom picking areas, angling spots, water sport facilities, horse riding terrains etc); the trips will be connected with excursions to unique nature regions (Noteć Primaeval Forests, Warmia and Mazury, flood waters of Biebrza river etc) and visits to places of interest of historic, artistic and recreational merits.

Beyond summer season the ship in question is assumed to operate by organizing :

- ☆ The trips -mainly addressed to Polish tourists – along closed inland waterways routes with a departure point in e.g. Szczecin or Berlin – and orientated onto the regions of South-West Europe, attractive for tourists, and having a climate milder than in Poland; the routes should be selected on the basis of prior performed marketing studies and investigations.
- ☆ The cyclic fortnight periods spent on tourist trips in inland waters onboard the new-generation ships of high-standard living conditions, organized by a professional firm ensuring appropriate living conditions and relevant tourist infrastructure - leasing or reservation of hotel rooms, providing marinas or harbours, coaches etc, and programs of visiting the places of interest of historic, artistic and recreational merits.
- ☆ The extension of the ship's service is aimed at maximization of effectiveness of the funds invested in the project in question.

DESCRIPTION OF THE TOURIST TRIP ROUTE

The data concerning the technical parameters of Berlin-Królewiec (Kaliningrad) trip route are presented in Tab.1.

SHIP'S HULL CONFIGURATION

It was decided to choice the ship's hull configuration in the form of a push train consisted of one-, two-, or several segments. The solution has a number of operational advantages in view of the considered waterway with many small-size sluices, narrow canals, and the very rich tourist program. As compared with one-segment ship the advantages of the selected solution justify the made choice – as the push train consisted of the pusher fitted with social and recreational facilities and the hotel segment, makes it possible:

- ⇨ to fully use traffic capacity of the considered waterway limited by dimensions of its sluices and meander radiuses because the segment push train can be much longer than the usual ship, therefore passenger shipping capacity of the push train can be much greater
- ⇨ to reach a much greater flexibility in scheduling the trips.

Among significant drawbacks of the stiff-connected push trains their sensitivity to damaging action of waves can be numbered. However the considered route of the ship concerns mainly river waterways of a low state of waving. And, the coupling of segments will be realized by applying the novel devices which make it possible to change geometry of the train coupling in three degrees of freedom (yaw, pitch, heave).

ARCHITECTURAL AND FUNCTIONAL CONCEPT OF THE DESIGN

Results of the performed analyses and the description of the assumptions for the accepted functional concept of the ship, are included in [1,5]. From the design studies has resulted the ship (object) of the following characteristic features.

- ➡ A segment passenger ship comprising innovative engineering solutions, fitted with cabins and intended for inland waterways shipping; characteristic of a high care paid for ecological merits during ship service, providing for high voyaging comfort and living standard as well as personal safety for passengers; intended for multi-day holiday-recreational trips on Berlin-Królewiec route; consisted of one propulsion segment (pusher) and one (or several) pushed segment(-s) (hotel barges)
- ➡ The propulsion segment equipped with developed social and dining facilities, can be also used independently as a daytime excursion ship which makes strolling trips in the time when the hotel segment stays in a stage tourist base harbour, if only its owner deems such variant of the ship's operation justified
- ➡ The pushed segment, without any own propulsion system, fulfills hotel and recreational functions
- ➡ Such configuration of the ship in question makes it possible to flexibly arrange design solutions of the pushed segment (or segments) by using the same hull as a basis – if a need justified by the market arises – for realization of some special functions e.g. by adding a swimming pool, mud or brine bath facilities, solarium etc.

Tab. 1. *Itinerary of the trip on Berlin-Królewiec (Kaliningrad) inland waterways route.*

Acronyms	Section of waterway	from [km]	to [km]	Length [km]	Passing depth		Sluices			Bridges	
					SNW [m]	SW [m]	Number [-]	Length [m]	Breadth [m]	Breadth [m]	Clearence [m]
	Variant I										
	Berlin-Havel-Oder river	0	90	90	-	-	-	-	-	-	-
	Oder river - Cedynia - - Warthe river	90	140	50	1.40	2.50	-	-	-	-	5.33
	Variant II										
	Berlin - Spree - - Canal	0	104	104	-	-	-	-	-	-	-
	Oder - Warthe - Przybrzeg	104	167	63	1.40	2.50	-	-	-	-	-
SW – mean water state	**Przybrzeg - Warthe - - Noteć river**	167	235	68	1.30	2.00	-	-	-	14.00	5.15
	Free - flowing part of Noteć river	235	334	99	1.20	2.00	-	-	-	10.00	4.14
	Canalized part of Noteć river	334	472	138	1.40	1.60	14	57.40	9.60	11.50	4.09
	Bydgoszcz Canal	472	497	25	1.40	1.60	6	57.40	9.60	11.70	4.04
	Canalized part of Brda river	497	511	14	1.40	1.80	2	57.40	9.60	10.85	3.87
	Vistula river - Bydgoszcz - Toruń	511	553	42	1.00	1.20	-	-	-	-	5.17
SNW – mean - low water state	**Vistula - Włocławek (option)**			(57)							
	Vistula - Toruń - - Bydgoszcz	553	595	42							
	Vistula - Bydgoszcz - - Nogat	595	747	152	1.80	3.10	-	-	-	-	-
	Vistula - Nogat - - Gdańsk (option)			(42)							
	Nogat - Jagellonian Canal	747	794	47	2.70	3.50	4	56.00	9.60	9.60	5.25
	Vistula Bay -Królewiec (Kaliningrad)	794	844	50	2.70	2.70					

- The proposed configuration of the passenger ship makes it possible to flexibly arrange service schedules of the push train – depending on current needs of its owner and an expected economic situation on the tourist traffic market
- It is assumed that during recreational trip the passengers will be able to make use of several stage land bases prepared to providing for and arranging attractive cultural and recreational events, deliveries necessary for continuation of trips, as well as receiving from ship the wastes to be utilized. Additionally, the passengers will be given opportunity to spend the night in the land hotel bases.

SHIP'S HULL STRUCTURE AND ITS MANUFACTURING TECHNOLOGY

It is assumed that the steel hull structure of the ship will be manufactured with the use of the *HiTech panel technology based on the assemblies built of laser-welded flat sandwich structural elements. From the preliminary estimations it results that this is the only concept to obtain a very light ship hull structure which makes it possible to fulfill the assumed design task, acceptable in the technical and economical sense.*

This results from the condition of simultaneous fulfillment of the following limitations dealing with :

- the maximum permissible service draught equal to 1.0 m
- the maximum permissible total height of the ship
- expected commercial effects (incomes depend on a number of places in passenger cabins on the ship and offered living comfort)
- the ensuring of ecologically safe operation of the ship.

If the classic structural solutions and traditional technology were applied the ship in question having two-tier configuration satisfying the above mentioned technical requirements, would be practically infeasible, which results from the required minimum height of the passenger accommodations, limited maximum permissible total height of the ship, as well as due to excessively high depth of stiffeners of typical deck and bottom structures.

The hull structure made of panels constitutes a more favourable solution both in the structural – technological sense and in the sense of quantity of hull mass and ship displacement.

SHIP'S POWER PLANT AND PROPULSION SYSTEM

Within the frame of the accepted research assumptions for the project in question the following solution variants of ship's propulsion system were selected for design study analysis, namely :

1. typical combustion engine propulsion system
2. combustion-electric engine propulsion system
3. combustion-hydraulic engine propulsion system
4. turbine-hydraulic engine jet propulsion system
5. an option of magnetic propulsion has been analyzed in advance.

The usefulness analysis of the variant solutions was aimed at providing the knowledge necessary to select an optimum solution of propulsion system for the designed ship under the accepted assumptions and assessment criteria. As a result of the comparative analyses the alternatives of variants 2 and 3

Fig. 1. *Architectural concept of the segment ship „EUREKA" – in its tourist – hotel functional version.*

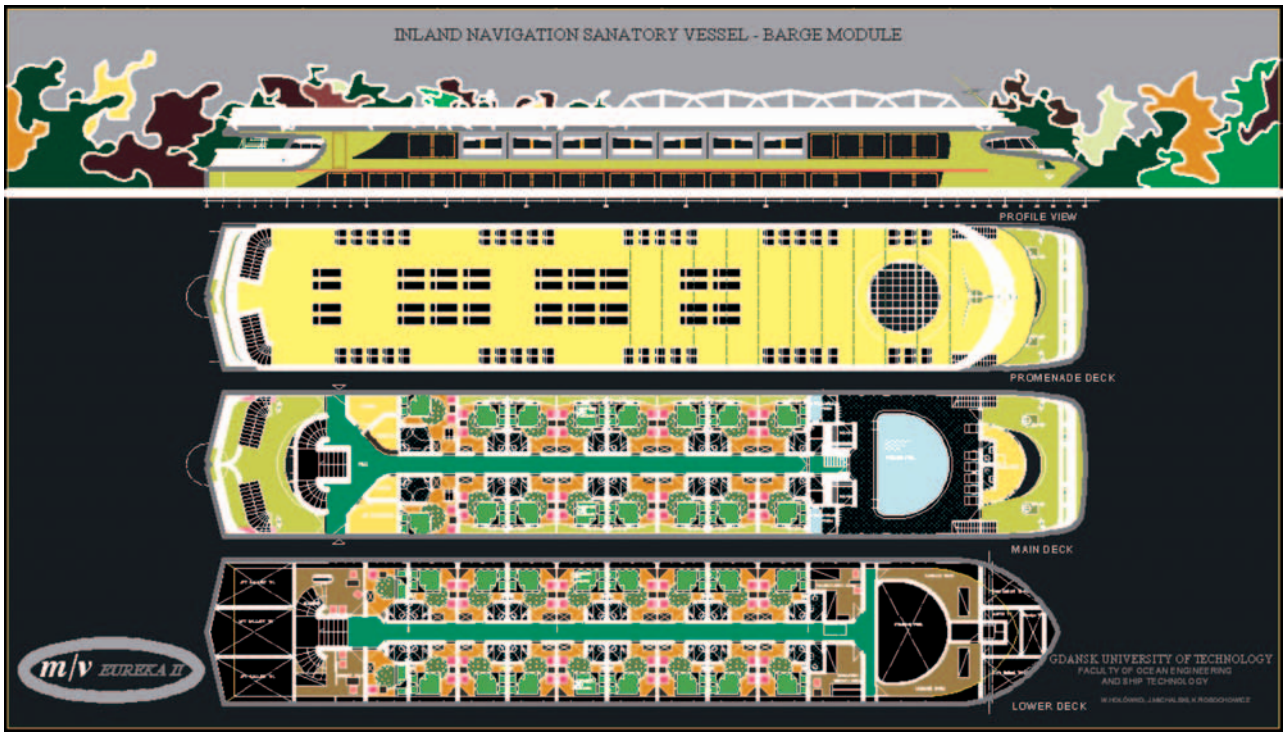

Fig. 2. *Architectural concept of the segment barge of the ship „EUREKA II" – in its tourist – sanatorium functional version.*

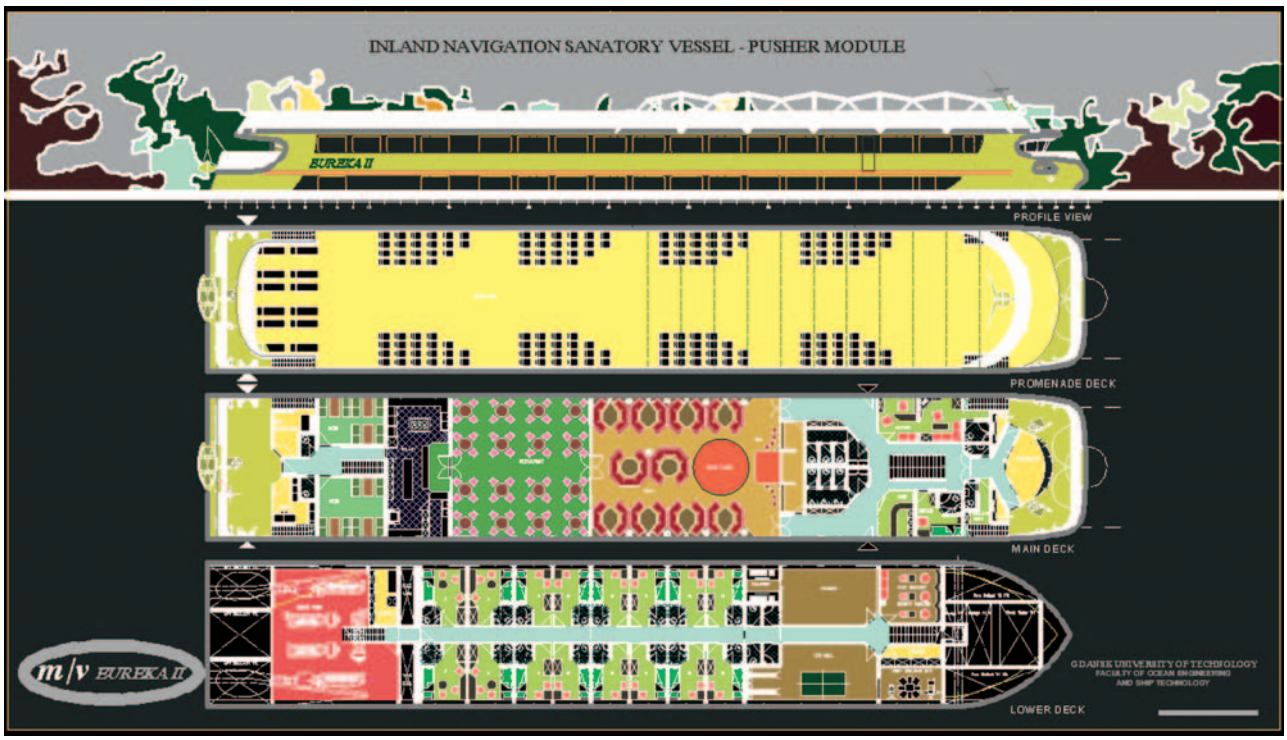

Fig. 3. *Architectural concept of the pusher of the ship „EUREKA II" – in its tourist – sanatorium functional version.*

have been finally deemed the most promising. It is expected that the ecological aspect of the ship's operation will constitute an important element of usefulness measures applied to the selected variants of propulsion system.

In view of the small draught of the ship and necessity of ensuring good manoeuvrability qualities for the push train, it was decided to apply two fixed screw propellers ducted in rotatable Kort's nozzles and fitted with reversing devices or the propulsion system with two vertical-axis propellers of pod type. The selection of the fixed screw propellers was based on the service experience gained by Polish inland navigation ship owners [6], that is mainly associated with good reliability, low production cost and easiness of repair (many failures due to ship stranding) of such propellers.

In the bow part of the barge a thruster has to be installed. Within the frame of the considered design variants of the ship's propulsion system, preliminary analyses of feasibility, rationality and profitability of application of ecological combustion engines working on alternative fuels, i.e. bio-fuel, LPG or LNG, were made.

SUMMARY

- The technical, functional and operational assumptions presented in this work concerning the passenger ship intended for making comfort tourist trips along attractive Polish inland waterways, ensure – to a potential tourist – an opportunity to commune with nature of unique worldwide merits. There are many premises that the project, if appropriately supported and inspired, may turn out a hit in the sense of investment, economy and politics
- The elaborated design study made it possible to identify possible drawbacks of the preliminarily taken decisions concerning the functional program of the ship's service, and it also helped in verifying the technical design assumptions for the ship; their further analysis planned to be carried out along with development of the research and design work, constitutes a subject of the further research realized within the scope of the project
- A fortnight round trip variant was presented. In another variant the ship's operator can offer one-way trips combined with coach transport of passengers. Final choice of a concept of operation of the ship and scheduling its trips will depend on demand for such services called on the tourist market of EU countries.

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