Prospects of ship design in Tunisia

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Abstract: Maritime infrastructure plays a fundamental role in the Tunisian economy. Nightly-five percent of Tunisia's trade is shipped by sea. Some thirty million tons of goods are shipped via the seven commercial maritime ports. However, and despite its situation in the heart of the Mediterranean, and the north of Africa and the length of its coasts (1300 km), Tunisia does not have enough maritime infrastructures to play its naturally potential role as an international maritime centre. The lack of expertise and knowledge about naval architecture and ship design is one of the major impediments to the development of the said maritime infrastructure. Most of the ships and ferries used in Tunisia are built in other foreign countries. Their costs and maintenance fees represent a quite significant percentage of the operating coast. Ships are capital intensive, complex assets of advanced technology, capabilities and earning potential. Their values, both of new and second-hand, critically depend on such characteristics. A good understanding therefore of marine technology and innovation is a prerequisite for efficient shipping operations, sound investments, and competitiveness.

In general, for the design of a new ship, it is necessary to satisfy several kinds of conditions such as the owner's requirement, rules, and regulations. At the design stage, several factors should be considered such as, hull form and structure, ship's propulsion and resistance, ship's seakeeping and stability, building coast etc. It is also important to know a ship's manoeuvring characteristics from both ship performance and navigation safety viewpoints. From the viewpoints of ship manoeuvrability, when checking the ship's manoeuvring characteristics according to the manoeuvring standards, several methods are being used such as the method based on a database, the method based on model test experimental data and the method based on numerical simulations using a mathematical model. In this paper, a better understanding of ship design and the different methods used for predicting ship manoeuvrability will be described. The prospects and future implantation opportunities of maritime technology and infrastructure in Tunisia will be further discussed.

Key words: Ship hydrodynamics; Ship's manoeuvring characteristics; Maritime infrastructure in Tunisia.

1. Introduction:

Transportation is the most important link in economic relations. It is involved in creating products and delivering it to consumers, provides the link between production and consumption, between different industries, between countries and regions. It affects the development of the economy as a consumer of metal, energy, timber, rubber and other products. More than 100 million people in the world work in the system of transport.

Maritime transportation is used for external economic exchange. It carries more than 80% of the foreign trade goods. It is the cheapest mode of transportation. Modern ships can carry cargo of any size and weight . The main condition for safe operation of the world's mercantile fleet is its constant renewal, increase of the tonnage of vessels, increase the engine power, increase the ship's speed, automation, and improving environmental performance. The Average of vessels aged over 10 years are more than 1 / 3 of the world fleet. In developing countries ,such as Tunisia, there is a tendency to increase the usage of older vessels, which consequently increases the risk of the shipping procedure.

Recently, the usage of cargo container ships is in a significant boom. However, the development of this mode of transportation is a little bit hampered in Tunisia due to some lack in the port infrastructure. New facilities planned would have to be coordinated with the construction of road and rail networks, to ensure interface between different modes of transportation.

2. Ship hydrodynamics:

The three central areas of ship hydrodynamics are ship's powering, seakeeping and manoeuvring. The field of powering is divided into two related issues: resistance, the study of forces opposed to the ship's forward speed, and propulsion, the study of the generation of forces to overcome resistance.

The modern term "seakeeping" is used to describe all aspects of a ship's performance in waves, affected primarily by its motions in six degrees of freedom (as shown in fig.1).

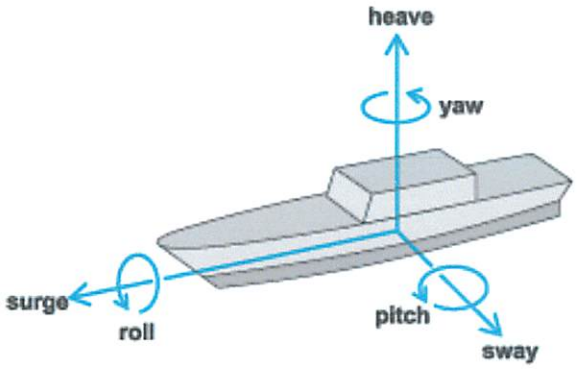

Figure 1 Ship motion degrees of motion

Seakeeping issues are diverse, including the motions, accelerations, and structural loads caused by waves. Some are related to the comfort of passengers and crew, some to the operation of ship systems, and others to ship and personnel safety.

Manoeuvring (more generally, ship controllability) includes consideration of turning, course-keeping, acceleration, deceleration, and backing performance. The field of manoeuvring has also come to include more specialized problems of ship handling, for example, the production of sideways motion for docking or undocking, turning in place, and position-keeping using auxiliary thrusters or steerable propulsion units. Predictions of ship-manoeuvring performance have been one of the most challenging topics in ship hydrodynamics research because of its highly complex unsteady and non-linear nature.

3. Prediction tools of ship-manoeuvring performance:

Due to the lack of analytical methods for ship manoeuvrability, manoeuvring predictions have traditionally relied on either empirical data base or experimental model tests. The empirical database methods usually use mathematical model and manoeuvring coefficients based on either empiricism or mixed semi-theoretical and semi-empirical methods[1] [2]. The empirical data-base methods are relatively simple and quick to use, however, typically theses methods are only effective when main dimensions of the subject ship are within the range of the data base and the accuracy of predictions is often limited by the sensitivity of the parameters used in the regressions. The experimental model test method is considered therefore to be a powerful tool for estimating the ship's manoeuvring characteristics. Experimental model test includes free and captive model tests.

- Free model test: Also known as free running test is using a scaled model that is self-propelled and –steered. For the test, the model performs definitive manoeuvres such as spiral, zigzag, or turning manoeuvres. Free model test is usually conceived as the closest to reality (except for scale effect) as no mathematical model or assumption is made. However, usually free model test yields only the final results/information, thus the test results may be less insightful to the individual manoeuvring factor.

Figure 2 Free model test in the manoeuvring pond of Osaka University

- Captive model tests[3]: Captive model tests in tanks are now carried out using straight-line tests in a towing tank, a planar motion mechanism (PMM) or a rotating arm, which is also known as circular motion test (CMT)[4] [5]. In either case the model is tested over a suitable range of important variables such as drift angle, yaw rate, sway acceleration, yaw acceleration, propeller rps and rudder angle, and the results are analyzed to obtain the hydrodynamic coefficients required in the ship's equation of motion. The experimental techniques necessary to measure the significant forces forces and

moments generated by a ship's hull are very much elaborate and sophisticated.

Figure 2 View from forward of a model ship fitted on the turntable during the CMT

2. Maritime infrastructure in Tunisia:

In ancient times, Tunisia's maritime trade was intense. Carthage, with its naval and merchant fleet, was above all a maritime power. The remains of the ports of Carthage, Kelibia (ancient Clupea), Hadrumete, Thapsus, Mahdia, Gyghtis ..., still show the importance of past maritime activity, which ceased with the Vandal invasions.

Nowadays and due to its strategic position in the Mediterranean region, between a European market marked by a rapid economic development and an African continent boosted by its emergent economy and its market of hundreds of millions of inhabitants, the Tunisian ports are one the most recommended sites for a competitive, reliable and secured transit of goods and ships. The Tunisian port chain is composed of 7 ports open to international trade. It spreads over a coast of 1300 km. The diversity of activities of these ports, their complementarities and their exceptional situation allow them to receive all types of ships and to handle all sorts of goods.

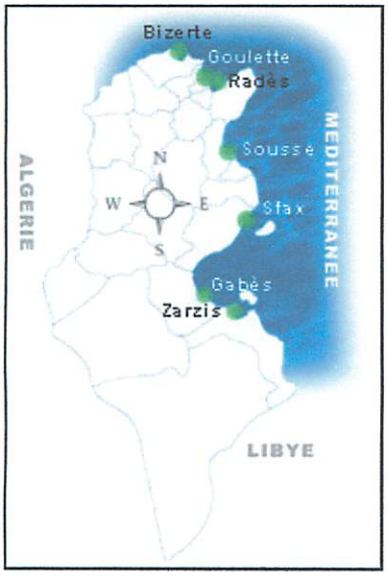

Figure 3 Tunisia's main ports

- Bizertre- Manzel bourguiba port: The port of Bizerte/Menzel Bourguiba is a multipurpose port with direct access to the sea and marine depths through an access channel with a depth of up to 17 meters. The average traffic of goods generated by the port of Bizerte amounts to 5 million tons per year. n addition to the 520 linear meters of ordinary docks, the port of Bizerte-Menzel Bourguiba comprises 5 docks that are specialized in the handling of hydrocarbons, cereals, steel, cement and clinker and metallurgic products ...Moreover, the proximity of the railroad network, the easy and rapid access to the highway Tunis-Bizerte and the expressway Menzel Bourguiba-Bizerte, and the proximity of the airport Tunis-Carthage (at 60 km) confer upon the site of Bizerte-Menzel Bourguiba all the assets of a modern port.
- La Goulette port: During 2010, the port of La Goulette recorded 708.443 passengers and 895.403 cruise tourists, reduction of 1% in passenger and an increase 19% in cruise passengers compared to the same period in 2009 . The port of La Goulette is one of the most popular destinations in the western basin of the Mediterranean. The port of La Goulette is the converging point of the main Tunisian road and railroad networks. It is the outlet for a region that is the richest historically, the most diversified culturally, and the most populated, since it comprises the city and the suburbs of Tunis.
- The port of Rades: The port of Rades occupies an important place in the national transport chain by virtue of its specialization in container traffic and rolling units (mainly trailer traffic). Thus, the port of Rades ensures 26% of the overall traffic, 87% of the tonnage of containerized goods, 80% of the tonnage of goods loaded in rolling units, 79% of EVP container traffic, 81% of the traffic of rolling units and 21% of the traffic of ships registered in the whole of the Tunisian commercial ports.
- The port of Sousse: Located at the very centre of Tunisia, the port of Sousse occupies a strategic position allowing it to dispose of a wide hinterland. The port of Sousse, at 35°49' latitude north and 10°39' longitude east, is specialized in the handling of various goods. The maximum

authorized ship length in the port is 165 meters. The maximum authorized draft is 8.50 meters on the north bank and 8.20 meters on the south bank.

- The port of Sfax: The port of Sfax is a multipurpose port. Its main traffic consists in solid bulk (phosphate and by-products, sea salt, cereals ...). The average goods traffic generated by the Sfax harbour is 5 million tons/years. The man-made lakes of the port of Sfax are naturally protected by the small depths around the port and by the banks situated between the Kerkennah Islands and the coast.
- The port of Gabes: The commercial port of Gabes, which main activity is characterized by an industrial purpose, is essentially intended for the transit of chemical products on behalf of the neighbouring factories set up in the industrial estate of Gabes. This bulk traffic comprises above all sulphide and ammonia for import and phosphoric acid and phosphate fertilizer for export.
- The port of Zarzis: The Port of Zarzis is located in the southernmost part of Tunisia, where the diversified economic activity consists mainly in farming, fishery and aquaculture, a renowned tourist centre, an emergent industrial network, craft industries and various small-scale trades. The port of Zarzis takes charge of the commercial exchange of the region, consisting mainly in exporting sea salt and crude oil and importing pure oil products.

2. Proposed research facility:

Although Tunisia is considered to be one of the most important coastlines for maritime transportation in the southern part of the Mediterranean sea as it was shown in the previous section, there is still not enough academic knowledge about naval architecture and ship design. The only existing institution in this field is the maritime and navy school of Bizerte. The main purpose of this school is to educate and graduate merchant marine officers and leaders of honor and integrity who serve the maritime industry and armed forces. Authors would like therefore to introduce the idea of a possible construction of a ship's hydraudynamics research facility, which with the support of the Japanese authorities and their great expertise in the field would help to settle down a new and very necessary research field in Tunisia which is the naval architecture and Ocean engineering field.

The research facility consists in a manoeuvring and seakeeping basin. This facility is intended for tests to determine hydrodynamic characteristics of ship models, as well as for calm water, wave and dynamic positioning tests of radio-controlled self-propelled models. The basin should have appropriate dimensions, preferably, 70 x 30 x 3 m which would be suitable for ship models up to 4m in length. The seakeeping and manoeuvring tank will be used for investigating the seaworthiness and manoeuvrability of ships and wave-induced motion and loads on offshore structures. The tank should be equipped with a system for towing the model ships and wave generators along two adjacent sides. The towing system should have a main carriage travelling in a lengthwise direction and a secondary one breadthwise installed with a turntable. The ship model can therefore be towed on any desired course in the tank with this system.

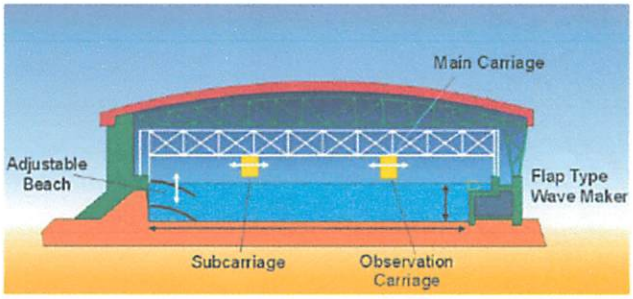

Figure 4 Cross section of a typical seakeeping and manoeuvring basin

Variety of tests can be carried out in this basin such as: turning test, Spiral and zig-zag maneuver tests, captive model test, motion response tests in regular and irregular waves, forced oscillation test, wave-induced force test...

4. Conclusion:

It can be said as a conclusion of this study that unlike a market economy in which new design is a response to a perceived market need, ship design is typically in response to an expressed need coming from such sources as the advent of new technologies, changes in world politics, new strategies and, lessons learned from previous ship development. This need is identified by Naval planners in the form of a design brief, which will be the basis for subsequent development.In this paper, a brief introduction to ship's hydrodynamics and to ship's manoeuvring research was discussed, the existing maritime

infrastructure and the future prospects of the naval architecture research field in Tunisa were proposed.

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