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# SURVEY AND REHABILITATION OF THE DRY-DOCK MAIN FLOATING GATE

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## ABSTRACT

*The paper is a theoretical and practical approach to the uncommon way of rehabilitation of the dry-dock main gate of Damen Shipyards Galați. Most of the water tight system of the gate being under water and considering the improper condition of work in the Danube water, the taking out of the gate bottom became a must. The applied method considered the gate inclination of about 90° under floating status by particular actions based on theretical calculation.*

**Keywords:** watertightness, gate, inclination, solid ballast, stability calculation

## 1. INTRODUCTION

The outstanding local history and traditions made it possible for the town of Galați to become the "cradle" of the Romanian shipbuilding industry. The shipyard, the Mechano-Naval Institute and ICEPRONAV (the ship research and design institute) created the perfect framework for the academic study of naval architecture, the application of knowledge in a professionally adequate environment and the continuous research and improvement of know how.

Under such circumstances, it was natural for a wealth of initiatives, innovations and "premieres" to come into being in this part of the world.

Moreover, after the privatization of the shipyard, the tradition of cutting-edge shipbuilding projects all over the world has continued its progress. Of the latest strategies of navy projects and outfitted hulls for yacht were included in the shipyard portfolio. In addition to these achievements, which meant the adoption of new technologies, the Damen Shipyards Galați has also resorted to a series of innovative methods to ensure the proper operation of all its facilities.

One of such uncommon methods was the **Survey and rehabilitation of the underwater part of the main dry-dock gate**. The innovative style of the method lied in the carrying out of the work by the controlled inclining to abt 90° under floating conditions.

The method was the result of the very fruitful collaboration between Ship Design Group Galați and Damen Shipards Galați.

## 2. DOCK DESCRIPTION

The building of the dry-dock started in 1972 based on IPTANA București design. The main floating gate was constructed by the shipyard as per ICEPRONAV Galați design and it was launched in 1975.

Ship in the dry-dock

The launching of two ships

As the hull building platform is higher than the average Danube level (+4.1m), it was a must to choose the lock-system dock. The dry dock consists of two components, i.e. the ship construction chamber and the ship launching chamber. Filling both chambers with water at + 10.0m level allows launching the ship (Figure 1, Figure 2). The floating main gate provides the separation and tightness between the dock level and the Danube level.

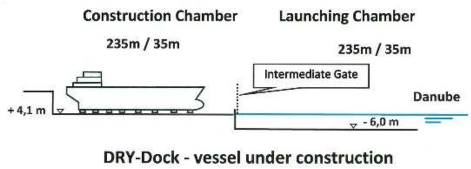



**Fig**. 1

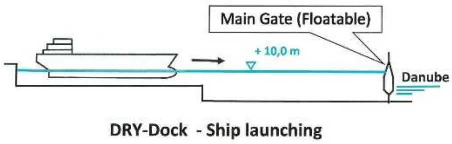



**Fig**. 2

## 3. APPROACHING IDEAS

The gate sealing role is vital for dock operation. We noticed that the dock pumps and additional pumping system could hardly keep the water level in dry-dock during the vessel launching. After so long years of operation (over 35 years), the sealing system was worn out. The inspection and particularly the repairs of the sealing system became a compulsory task by the day. Because most of the system lay under water and because of the scarce visibility in the Danube waters, the taking of the gate bottom out of water was the most difficult of the challenges.

Over the years, several solutions were taken into account. The rather high gate draught (6.3m) could not permit its docking in any Danube yard (Brăila, Tulcea or Navrom Galați). As the transport to Constanța Shipyard or to Mangalia Daewoo Shipyard was excluded ab initio, the shipyard had to solve the problem locally, in the launching chamber of the dock.

Under such circumstances, with the help and good will of Associate Professor Ovidiu Ionaș, the shipyard concluded a collaboration contract with Ship Design Group Galați (SDG).

The functionality of the gate is presented in the following paragraphs.

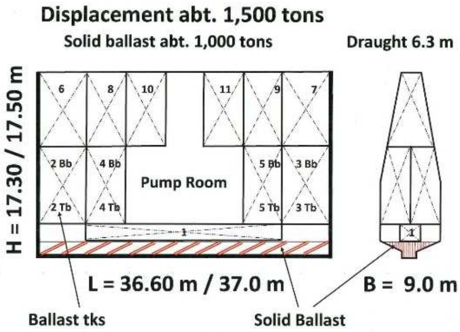


**Fig.** 3

The gate is a floating steel construction with a total displacement of approximately 1,500 tons of which the lower area contains nearly 1,000 tons of solid ballast (Figure 3). The solid ballast was made of 900 tons of poured concrete/steel scraps mixture and 100 tons of movable packages. It also contains 15 ballastable tanks whose filling/emptying is carried out depending upon the level of the Danube at the time of the dry dock filling with water. The sealing between the dock and the Danube is ensured by a "P" rubber gasket placed on the gate opposite the pressure side (Figure 4, Figure 5, Figure 6).

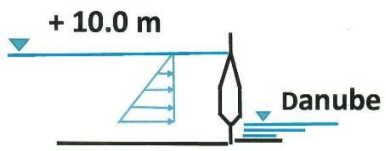


**Fig.** 4  Water pressure on the gate

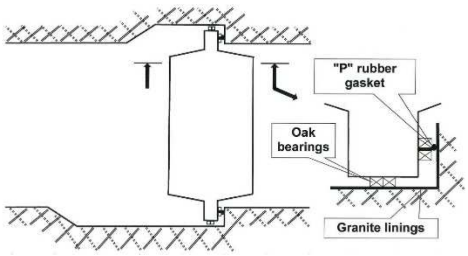


**Fig**. 5  Dock Recess

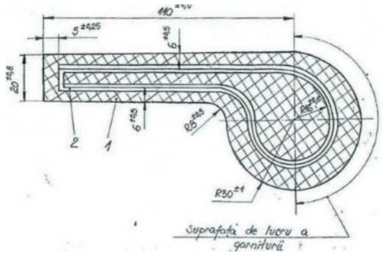

**Fig**. 6  **"P"** sealing gasket

Prior to the analysis of the scenarios meant ot solve our problem, an inclining test was carried out to identify with accuracy the gate weight and particularly the accurate position of the gravity centre (KG). Such info became reliable input data on scenarios calculation. For the inclining test, additional draught scales were provided (Figure 7).


**Fig.** 7

Several scenarios were issued and analyzed. All scenarios were calculated with CARENA software, which was developed by Associate Professor Ovidiu Ionaş and Associate Professor Ionel Gavrilescu.

Because of such a big weight placed on the gate bottom, any inclining scenario **did not** result in getting the sealing system out of the water. Figure 8 and Table show the result of the maximum heeling moment scenario with the ballast only in the upper tanks.

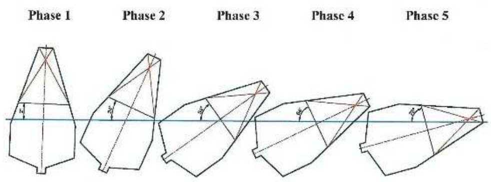


**Fig.** 8

**Table 1**

| Phase | Ballast | Tons | List |
|---|---|---|---|
| 1 | Tk 6+7 full | 2x189t | 2° |
| 2 | Tk 6+7 full | 2x189t | 24° |
| | Tk 10+11 6% | 2x10t | |
| 3 | Tk 6+7 full | 2x189t | 54° |
| | Tk 10+11 66% | 2x110t | |
| 4 | Tk 6+7 full | 2x189t | 64° |
| | Tk 10+11 full | 2x165t | |
| 5 | Tk 6+7 full | 2x189t | 75° |
| | Tk 10+11 full | 2x165t | |
| | Tk 8+9 full | 2x165t | |

One of the scenarios considered the use of an additional ballastable floater which should have been placed under the gate after its partial inclination. Such a solution was abandoned because it was very costly and it required a water depth of minimum 11.5 m (Figure 9).

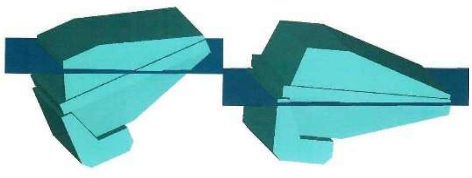

**Fig**. 9

Another scenario considered the replacement of the floater by lifting the bottom of the gate with the winches of a 600-700 tons total capacity.

## 4. IMPLEMENTED METHOD

The project which determined the final resolving solution of the problem was the fruitful collaboration between the teoretical and practical expertize of both parties, Ship Design Group and Damen Shipyards Galați. Nonetheless, each scenario was based on the inclination of the gate on both sides (PS and STB).

The applied solution took into consideration the following achievable hypotheses (Figure 10, Figure 11):

- The temporary removal of the 410 tons of solid ballast (100 tons of movable packages + 310 tons of concrete/steel mixture);
- The decrease of the bouyancy by cutting holes on ballast tank no. 10 and 11;
- Getting the initial slight list (abt. 1,5°) with the help of temporary additional blocks on deck, is needed because the tanks are located on the gate center of gravity line;
- The ballasting of the tanks no. 6 and no. 7, only;
- The placing of an additional weight (abt. 70 tons) on the upper part of the gate.

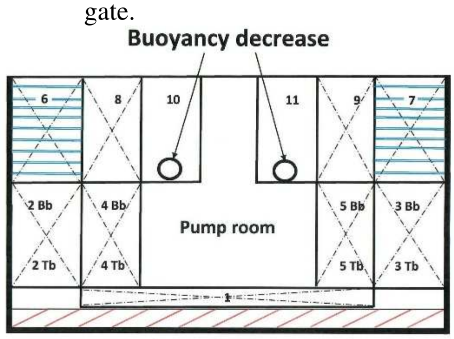


**Fig**. 10 Implemented scenario

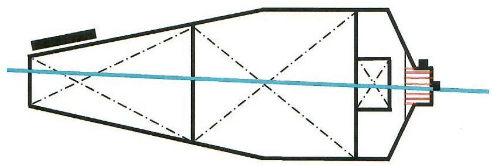

**Fig**. 11 Additional weight for the final inclination

The results of the simulation are presented in what follows:

**Table 2**

| Ballast tanks 6+7 | List |
|---|---|
| 0 | 1,5° |
| 2 x 5t | 8° |
| 2 x 10t | 14° |
| 2 x 20t | 22,5° |
| 2 x 30t | 29° |
| 2 x 50t | 48° |
| Full = 2 x 189 tons | 87° |

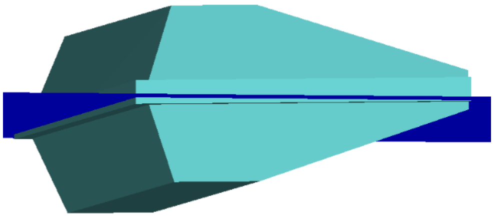

**Fig**. 12 Gate after ballasting of tk no. 6 and no.7

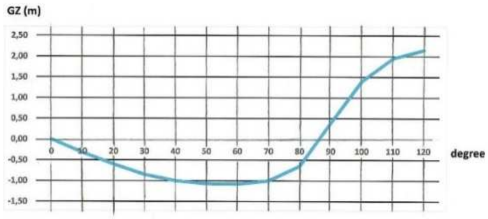


**Fig**. 13 Stability diagram

The removal of the 410 tons of solid ballast was the most difficult and time-consuming job. Temporary cutouts, containers, railways, ventilation ducts and trolleys were provided. In spite of these measures, the pick-hammering and removal of concrete was a very hard work in the double bottom narrow space.

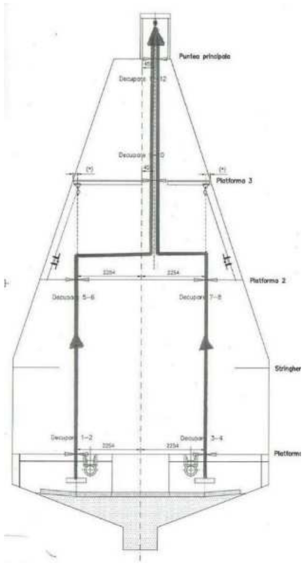

**Fig**. 14 The concrete removal route

**Fig**. 15 Narrow space in the double bottom

**Fig**. 16 Pick-hammering the concrete

**Fig.** 17 Debris container

**Fig**. 18 Discharge of concrete

At the end of this pains-taking operation, the gate got a 1,050ton displacement, a 4.93m draught and a 0.27m initial metacentric height, i.e. conditions which permitted the application of the method.

The theoretical issues of the scenario being solved and part of the ballast being removed, the project continued with the preparation of the gate for ballasting as follows:

- The ballasting of the tanks no.6 and no.7 was done with shore pumps (one pump of 60 cub m/h for each tank);
- The de-ballasting of the tanks no. 6 and no. 7 was done with deep-well pumps (30 cub m/h each) mounted in the tanks as per pendulum style for operation in vertical position, only; two pumps for each tank were provided for redundancy;
- The closing of all the openings on the main deck;
- The arrangement of an additional piping on both tank no. 6 and no. 7 (on the opposite side of inclination) for water supply and air venting both in the case of vertical and inclined position (Figure 19, Figure 20, Figure 21);
- Holes on shell tanks no. 10 and no. 11.

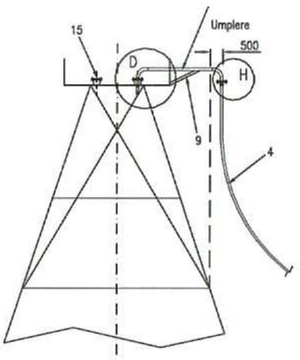


**Fig.** 19 Water supply piping

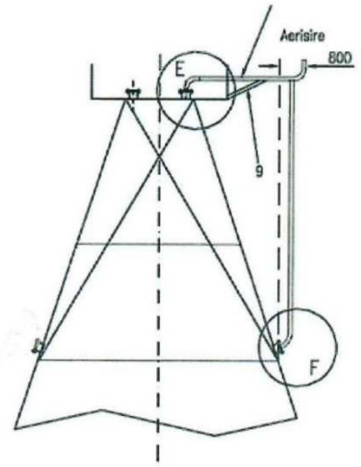


**Fig**. 20 Air venting

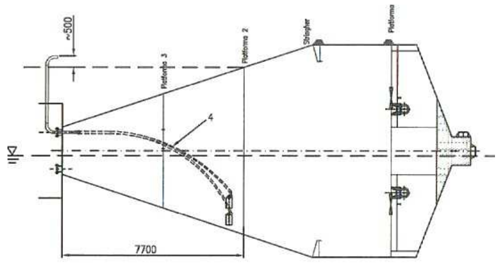


**Fig.** 21 De-ballasting deep-well pumps

The following photos show the **heeling of the gate**:

**Fig.** 22

**Fig.** 23

**Fig.** 24

**Fig.** 25

**Fig**. 26 Placing additional steel plates to get the sealing gasket zone out of water

The survey confirmed the ware out of the sealing gasket (Figure 27, Figure 28):

**Fig.** 27

**Fig.** 28

The following photo shows the gate tightening system rehabilitated (Figure 29).

**Fig.** 29

The whole project in the foregoing was carried out in 2012, being under the pressure of the strict observance of the milestone planning of the "KAREL DOORMAN" Joint Support Ship (JSS), i.e. the docking of the fore part at the end of April and the vessel launching on October 17.

Emphasis must be laid on the fact that any syncope during the gate project running would have perturbed the progress of the JSS, which could hardly be admitted in the case of the Damen-The Netherlands Royal Navy relationship. The removal of the solid ballast was the most time-consuming operation – almost three months.

## 5. IMPROVED AND LIGHTER GATE

As soon as part of the solid ballast was removed, we took the opportunity of getting a lighter gate with the following changes:

- The completion of the solid ballast with 275 tons only, against the removed 410 tons;
- A new ballast tank "0" with the capacity of 417 tons was created to cover the gap of 135 tons between the original ballast solid quantity and the new quantity;
- The arrangement of the additional tank "0" system, designated to ballasting (via tank no.1 by remote operated valves) and de-ballasting by pumps.

The photos below show the double bottom after solid ballast completion (partly poured, partly with removable packages).

**Fig.** 30

**Fig.** 31

New tank "0" with additional system is shown in Figure 32 and Figure 33.

 

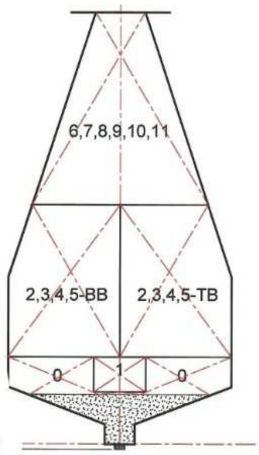


**Fig**. 32

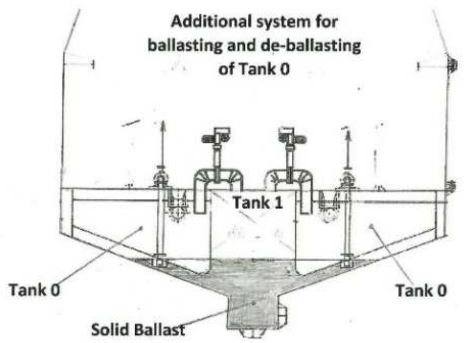


**Fig**. 33

Comparison of features:

**Tabel 3**

| Features | Original | New |
|---|---|---|
| Displacement | 1,500 t | 1,326 t |
| Draught | 6.30 m | 5.85 m* |
| Metacentric height | 0.89 m | 0.99 m |
| Total ballast capacity | 2,136 t | 2,553 t |

* The most valuable feature gain is the smaller draught (5.85m instead of 6.30m). This gives the opportunity of gate operation also in conditions of lower Danube level, about +0.80m.

Eventually, the up-dated operation instructions were released, considering the following:

- The sequence of tanks ballasting as per Danube level;
- The ballasting always starts with the lower tanks;
- The de-ballasting always starts with the upper tanks;
- The de-ballasting of the new tank "0" must be always done after the complete de-ballasting of all the upper tanks;
- During the transport of the gate between the stand-by/operation location, the tank "0" must be either full or completely empty so that the free water effect can be avoided.

## 6. CONCLUSIONS

It is obvious that the success of this project was especially due to the partners' expertise and constructive collaboration between Ship Design Group Galați and Damen Shipyards Galați.

We hope the above mentioned theoretical ideas confirmed by actual implementation will become an example and stimulation for any uncommon projects approaches.

*This paper was presented by its authors at Colocviile Constructorilor de Nave CCN (Colloquia of Shipbuilders), no. 112, which took place on February, 7, 2025, amphithea-tre D01 of the Faculty of Engineering "Dunărea de Jos" University of Galați.*

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