

# Development tendencies of the new generation classification rules for ecological floating docks in the PRS conceptions

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## ABSTRACT

*This paper presents main differences between an ecological floating dock and classical one. The differences will find their appropriate representation in the Rules for the classification and construction of floating docks in the form of requirements to be fulfilled by the dock. They consist in fitting the ecological dock with systems for collecting the contaminations generated during ship repair work on the dock, storing them in tanks, as well as with tight closing the dock's working space by means of roofing.*

**Keywords :** ecological floating dock, dock's hull structural strength, dock's roofing, pollution discharged from docks.

## INTRODUCTION

The Polish Register of Shipping participated in a team of enterprises performing the EU EUREKA „Ecological dock” project. The aim of project was to design an environmentally friendly floating dock.

The PRS task was to develop up-to-date and environment protection-oriented rules for classification and construction of floating docks. Meeting the environment protection requirements will be marked by an additional symbol in the dock class notation.

At present there are no rules in the world including requirements of the environment protection against pollution from floating docks.

The ecological quality of a floating dock may be ensured by :

- Dock hull structure :
  - dock structure integral tanks for collecting the ship repair waste liquids
  - tight „closure” of the dock space for the repaired ships.
- Dock equipment and systems :
  - collecting the ship repair solid waste.
- Dock power systems :
  - additional installations for feeding the environment protection equipment.

The respective solutions are discussed in detail further in this paper.

## Part I. Dock hull structure and strength

(Author : Marian Bogdaniuk, D.Sc.)

The ecological quality of a floating dock hull means the following differences in relation to the classic floating dock structure :

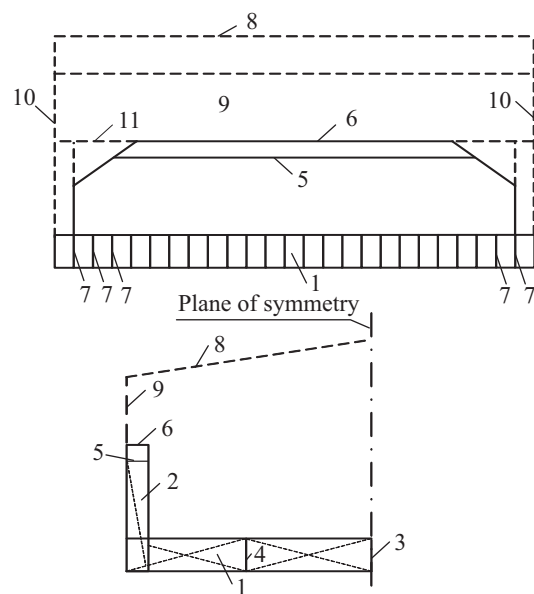
- \* dock structure integral tanks for collecting the ship repair waste liquids
- \* tight „closure” of the dock space for the repaired ships by the roof, side walls and front walls, in order to prevent air pollution in the dock vicinity from the repair technological processes (sandblasting, welding etc.).

The above mentioned problems have been taken into account in the Rules for the classification and construction of floating docks [2] developed by PRS.

### THE FLOATING DOCK STRUCTURE

A typical floating dock structure is shown in Fig.1. The dock is closed by walls and roof, as it is required for ecological docks.

The necessity of separating the technological waste liquid tanks in the dock hull has little impact on the dock structure and its operational loads. The dock closure has a significant impact on the dock stability and the hull strength.



**Fig. 1.** Ecological floating dock : 1 – pontoon, 2 – dock side wall, 3 – longitudinal bulkhead in the dock PS, 4 – side longitudinal bulkhead, 5 – safety deck, 6 – upper deck, 7 – transverse bulkheads, 8 – roof, 9 – side walls, 10 – front walls, 11 – running rails .

The side walls and roof have relatively large windage area and therefore a negative impact on the dock stability. The need to fulfil the stability criteria given in the Rules [2] may cause a greater dock width in relation to a classic solution. Also greater displacement of the ecological dock will be required to achieve the design lifting capacity.

The walls and roof of the dock consist of several separate segments sliding along the dock on special rails. The weight of those segments positioned in the middle or at the ends of dock will have a significant influence on the bending moments in the dock hull transverse sections, induced in the general bending conditions.

The main dock structure elements are presented in Fig.1.

The longitudinal bulkhead in the dock PS is a boundary for the dock pontoon ballast tanks. It is also a strong structural element, directly taking the keel block reaction forces. The side longitudinal bulkheads subdivide the hull space into ballast tanks. They are adjusted to take the side bottom shoring reaction forces. Transverse bulkheads installed every 10 to 12 frame spaces transmit the docked ship weight loads to the dock side walls, which provide the dock general bending strength. The transverse bulkheads subdivide the dock hull space into ballast tanks. Most often there are 6 rows of ballast tanks along the dock and 4 tanks across in a row (Fig.1).

Usually between the transverse bulkheads, in the structural frame stations, are the pontoon bottom and deck transverse stiffeners (below the safety deck). Those stiffeners are supported by the pontoon bottom and deck and the side wall tee-bar longitudinals. In the pontoon vertical connecting bars are usually inserted between the bottom and deck tee-bar longitudinals.

Side walls above safety deck and the upper deck are usually longitudinally stiffened, in order to secure an optimum dock adjustment for bending moment compensation in the general bending conditions.

## THE DOCK HULL STRENGTH

The rules [1] and the ecological dock draft rules [2] contain traditional structural strength criteria on three levels :

- ✦ general strength
- ✦ transverse strength
- ✦ local strength.

The rules define the calculational loads, admissible structural stress values and the structural element stability criteria.

The dock pontoon structure load from the docked ship weight has a form of forces transmitted by keel blocks and the side bottom shoring. The load depends on many random character factors. The most important factors are the following :

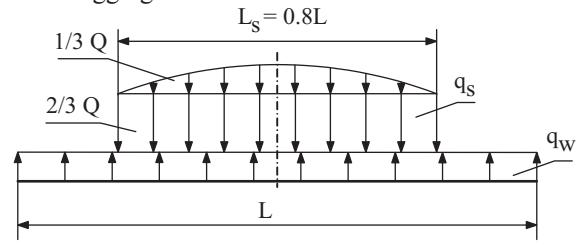
- ❖ weight distribution (light ship, stores, ballast etc.) along the ship
- ❖ keel unintended non-rectilinearity.

Therefore, some conventional calculational loads are used corresponding to the maximum values of actual loads.

The general bending strength of the dock hull should be assured in two conventional cases of the ship weight load transmitted to the pontoon longitudinal bulkhead by keel blocks, as shown in Fig.2. Those loads determine the traditional dock minimum general strength standard.

In the case of an ecological dock, additionally the weight of walls and roof in their most unfavourable position with a given length of the segments as well as configuration and operation of the sliding system. In the variant „a” in Fig.2 it will be the middle position, in variant „b” the end of dock position. A simple beam calculation model is adopted.

a) dock in sagging condition



b) dock in hogging condition

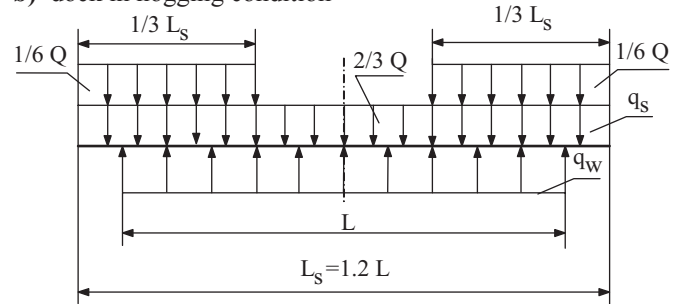


Fig. 2. Dock general bending loads :  $Q$  – dock lifting capacity,  $L$  – dock length,  $q_s$  – load from ship weight,  $q_w$  – load from buoyancy force.

In order to fulfil the Rules criteria [2] of the transverse strength, stresses in the dock transverse bulkheads must be calculated. A beam bulkhead model may be used. The beam cross section includes the bulkhead with flanges in the dock pontoon deck and bottom. Beam has pivot bearings at the ends (in the middle of the dock side wall width) and is loaded in the middle of its length (dock PS) with a concentrated force :

$$P = 1.5 \frac{Q}{L} d \quad (1)$$

where :

$Q, L$  – see Fig.2

$d$  – distance between bulkheads.

Additionally the beam is loaded with a continuous load from the buoyancy pressure and the pressure from ballast in the dock tanks.

The 1.5 multiplier in formula (1) allows to take approximate account of the earlier mentioned uncertainties of keel block reaction force values.

At the ends of the dock pontoon, the transverse bulkhead bending will be coupled with the longitudinal bulkhead bending. The reason is that the end keel block under the ship stern is usually at a distance of several to several dozen meters from the dock end. Verification of the dock pontoon structure strength in that area requires the use of FEM calculations.

The dock structure local strength criteria in the Rules [1] have a form typical of the floating structures. The bent plate model is used for the shell plate thickness determination and a single-span beam model for the stiffener required section modulus value determination.

The Rules [2] contain also requirements to be fulfilled to protect the dock against operational overload. A „load control device” is required for a dock. This is usually a dock deflection or hogging measurement instrument. Determination of an admissible value of that deflection or hogging protects the dock against general bending overload. Also required is a „dock operational instruction” document.

It contains admissible values of various dock load parameters (e.g. admissible pressure on the keel and bilge blocks, admissible difference of water level in adjacent dock tanks etc.) as well as an appropriate ship docking procedure.

## DOCK ROOF

A feasible dock roof structure has a form of steel hall positioned on the dock upper deck and consisting of at least two slidable (along the dock) segments and opened (e.g. raised) front walls or elastic blinds.

The segments must be movable along the dock in order to allow access to ship by cranes or docking of ships with exceptionally high superstructures or specific upper deck installations. It will be a hall of very large dimensions (see Fig.1).

The hall carrying structure consists of several meters-spaced transverse frames joined together by diagonal braces. The frame elements may be fastened in the roof ridge by rigid or articulated joints. The hall carrying structure is covered with profile plate.

A serious technical problem is gas tightness between the segments or between segments and front walls (or blinds).

In Rules [2] it is assumed that a dock roof should meet the steel hall strength criteria in accordance with the civil engineering standards [3], [4], [5], [6].

The structure load is composed of the own weight, wind pressure or snow weight. In comparison with the land-based halls, additional internal force components may appear caused by the dock structure deflections. In accordance with the requirements [2], those additional forces should be added to the above mentioned load components and the structural safety evaluation criteria should be used as for a land-based structure.

## Part II. Dock equipment and systems

(Author : **Edmund Bastian**, M.Sc.)

The classification society rules for docks most often include only the ballasting system requirements whereas requirements for other equipment and systems are taken, as appropriate, from the rules for classification and construction of seagoing ships.

The PRS dock rules will contain the present requirements and additionally requirements on the environment protection against pollution from the ship repair work in a floating dock.

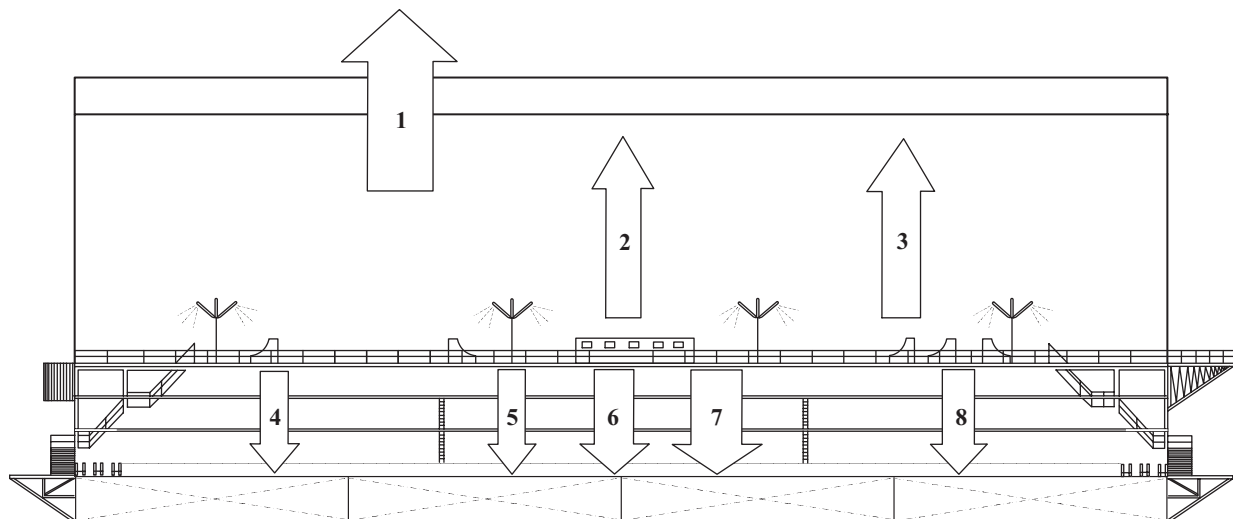
In view of the progressing natural environment degradation, its protection against pollution becomes a more and more important problem, both for individual countries and for the world as a whole. The marine community has long been aware of the problem, hence many existing environment protection legal acts. Therefore, requirements of the natural environment protection against pollution from bilge waters, sanitary sewage and rubbish need not be widely discussed in this paper. Besides,

in the Polish yards using floating docks the mentioned pollution problems are being satisfactorily solved.

A still unsolved problem is pollution generated in the ship repair process. For instance, in the area administrated by the Maritime Office in Gdynia the Order No. 6 of Director of the Maritime Office in Gdynia is in force, which in § 5 clause 1 item 10 requires that a dock should meet requirements of the water protection against various contaminants produced during the ship repair in dock. The order does not indicate how this requirement could be fulfilled and does not give any admissible pollution limits.

The problems of marine environment protection against the ship repair in dock-generated pollution are dealt with in the currently being developed PRS Rules for classification and construction of floating docks [2].

### POLLUTION SOURCES IN A DOCK



**Fig. 3. 1.** Exhaust gases : electric generating sets, boilers, incinerators, 2. Ship hull painting, 3. Ship hull cleaning, 4. Ship hull painting, 5. Ship hull cleaning, 6. Sewage from dock's living accommodations, 7. Sewage from dock's living accommodations and machinery compartments, 8. Oil spills on the pontoon deck .

In the Rules [2] the pollution sources are subdivided in the following way :

1. contaminations from the dock machinery operation
2. sanitary sewage from the dock crew accommodations (if any) and the repaired ship crew living compartments
3. rubbish produced in the dock
4. contaminations from the ship repair process.

**Ad 1.** The contaminations are :

- a) oiled bilge water from the dock machinery compartments  
The dock should be equipped with :
  - permanent or temporary retention tanks of a sufficient capacity to collect all the oiled water
  - oiled bilge water disposal installation in order to empty the tanks into the shipyard waste water receiving system
- b) oil residues (sludge) - remnants of the oil centrifugal separation process, oil leaks, drains of settled oil, dewatering of oil tanks and also all kinds of used oil. Procedure as in a)
- c) nitric oxides ( $\text{NO}_x$ ) emitted from the dock combustion engines. The combustion engines should meet the requirements of Appendix VI to the MARPOL 73/78 Convention, rule 13
- d) sulphur oxides ( $\text{SO}_x$ )  
Fuel used on the dock should meet the requirements of Appendix VI to the MARPOL 73/78 Convention, rule 14
- e) contaminations generated by the dock incineration processes. The dock incineration processes should meet the requirements of Appendix VI to the MARPOL 73/78 Convention, rule 16.

**Ad 2.** Sanitary sewage should be collected in the dock permanent or temporary retention tanks of a sufficient capacity to collect all sewage. Besides, the dock should have a disposal installation in order to empty the tanks to the shipyard waste water receiving system.

**Ad 3.** Rubbish from the dock crew accommodations and machinery compartments should be collected and kept in metal containers until it is delivered to the shipyard receiving system. The rubbish disposal procedure should meet the requirements of the MARPOL 73/78 Convention, Appendix V.

**Ad 4.** The most serious environment protection problem are contaminations from the ship repair process. The contaminations may be generated by the following work :

- ship hull cleaning
- ship hull painting
- shaftline repairs
- bilge tank repairs
- fuel tank and lubricating oil tank repairs.

### ***Ship hull cleaning and painting***

It is recommended to close tightly the dock repaired ship space by means of roof, side and front walls (the dock space closure – see the **Dock hull structure and strength** chapter), also an efficient ventilation with appropriate filters should be installed as the most effective protection against volatile pollutants from cleaning or painting of the ship hull.

Also portable roof structures may be used for shielding only the currently cleaned or painted ship sections. This solution also

requires the use of efficient ventilation with appropriate filters.

The following waste material is produced during the ship hull cleaning process :

- ★ preliminary cleaning waste – removing the hull fouling and paint remnants with hydraulic monitor; it is recommended to collect the waste from the dock or the repaired ship deck and to put it into properly marked tight containers and then deliver it to the shipyard waste store
- ★ the shotblasting process waste; it is also recommended to collect the waste from the dock or the repaired ship deck and to put it into properly marked tight containers and then to deliver it to the shipyard waste store for utilization and recycling.

The ship repair process-produced contaminated waste accumulates on the repaired ship decks and on the dock pontoon deck. The dock pontoon deck should be adequately framed in order to prevent pollution of the shipyard basin waters. Before submerging the dock, the pontoon deck must be thoroughly cleaned. Liquid contaminants may be removed through piping and wells installed under the pontoon deck. Solid waste may be removed by means of special vacuum cleaners, suction devices or manually from some ship areas.

### ***Shaftline repair***

Special attention should be paid during the shaftline repair to a possibility of pollution by leaking lubricating oil. The lubricating oil leaks should be gathered in properly marked tight containers. Oil spills on the pontoon deck must be absolutely avoided. If an oil spill happens then the oil must be thoroughly cleaned from deck before the dock is submerged. Containers should be delivered to the shipyard waste receiving system.

### ***Repairs of bilge water tanks, fuel tanks and lubricating oil tanks***

Before starting the bilge water tank repairs, the tanks must be checked for possible bilge water residues. Any remaining bilge waters must be delivered to the shipyard waste receiving system. Discharging bilge waters to the shipyard basin is strictly prohibited.

A similar procedure should be followed with the repairs of fuel tanks and lubricating oil tanks.

## **CONCLUSIONS**

- The PRS Rules [2] contain the requirements, in the above described scope, for environment protection against the ship repair pollution.
- However, the following question arises: are the domestic, European or world repair yards, using floating docks, (or will they be) interested in investing large sums in the natural environment protection systems when there are no legal regulations to enforce such behaviour.
- Every action should be taken to improve the natural environment protection. Appreciating the importance of the matter, PRS has developed the corresponding Rules [2].

## Part III. The power generation, remote control, automation and monitoring systems

(Author : Edward Szmit, Eng.)

The ecological floating dock electrical installations, apart from the power generation system, are not much different from the installations of any other large floating unit. So, the classification society electrical installation requirements contained in the *Rules for Classification and Construction of Floating Docks* should be similar to those contained in the *Rules for Classification and Construction of Seagoing Ships* or in rules or codes for the offshore units. The principles are similar, details may be different.

### THE FLOATING DOCK POWER GENERATING SYSTEM

As it was mentioned, the floating dock power generating system differs considerably from a ship power installation. Moored all the time at a shipyard quay, floating dock for its normal operation needs large amounts of electric energy, most often delivered from the shore power network. The floating dock power system should be fed by at least two circuits - main and reserve circuit, in order that the dock energy receivers can operate reliably, in particular the mechanisms and equipment connected with safety of people and the unit as well as with the clean environment inside and outside the dock. The new edition of Rules reads: **The main circuit should be designed for the full electric energy demand. The reserve circuit for emergency feeding of the power network should be designed to feed at least 33% of the total number of ballast (water extraction) pumps, gate valve mechanisms, lighting and the necessary auxiliary equipment and also at least one fire pump.**

Another rule requirement allows feeding from the shore power network by one circuit, on the condition that an own generating set is installed in the dock, capable of ensuring normal operation of one ballast (water extraction) pump, gate valve mechanisms, lighting and the necessary auxiliary equipment and one fire pump.

Other requirements contained in the *Dock feeding* chapter determine the dock power system organization, e.g. the necessity of installing reserve feeder cables, laid between the dock side wall main switchboards and ensuring 100% power circuit reserve and 20% control cable reserve. Besides, the chapter contains also requirements of the shore feeding terminal and the admissible short-circuit power level.

### THE CONTROL, AUTOMATION AND SIGNALLING AND MONITORING SYSTEMS

Another very important requirement of the ecological floating dock submerging and lifting mechanism and the tank filling level measurement control and signalling systems is compliance with the PRS Publication No. 9/P – *Requirements of the computer systems*. The aim is to ensure reliability of operation of the dock safety and environment protection equipment.

### THE ELECTRIC ENERGY EMERGENCY SOURCE

As in every other floating unit, the emergency source of electric energy is designed to provide, for 2 hours i.e. until an external rescue action is undertaken, emergency lighting of the escape routes, steering stations and fire equipment locations as well as operation of the warning lights, internal communication means, general alarm and fire detection systems as well as the ballast tank water level measurement system.

Generally speaking, the emergency source is provided in order to ensure safety of the floating dock, the docked ship and people on the dock in the case of main feeding system failure.

### ADDITIONAL CONDITIONS AND CONCLUSION

- Other requirements connected with the dock safety and environment protection include installation of an internal communication, general alarm and fire detection systems as well as a link with the shipyard or public telephone exchange.
- Question may arise: why a stationary telephone, when almost everybody have a mobile phone? Because stationary telephone is always in the same place which everyone knows.
- In conclusion one may say that the electrical installations have no specific ecological functions, but they feed and support the environment protection installations.

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