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Jan Obić
E-mail: jan.obic@uljanik.hr
Uljanik brodogradnja 1856, Flaciusova ul. 1, Pula, Croatia
Marko Hadjina
E-mail: marko.hadjina@riteh.uniri.hr
University of Rijeka, Faculty of Engineering, Vukovarska 58, Rijeka, Croatia
Alen Grijak
E-mail: alen.grijak@uljanik.hr
Uljanik brodogradnja 1856, Flaciusova ul. 1, Pula, Croatia
Anton Turk
E-mail: anton.turk@riteh.uniri.hr
University of Rijeka, Faculty of Engineering, Vukovarska 58, Rijeka, Croatia

Preparing the Ship and Slipway for Launching After a Long Period of Construction Downtime

Abstract

This paper presents the preparation of a ship and slipway for launching after a long period of construction downtime in the shipbuilding process. The research is based on the specific case of the vessel "Novogradnja 526" at the Uljanik shipyard, where construction was suspended for a prolonged period. This suspension required a detailed assessment of the ship's condition and its surrounding environment. Special attention was given to determining the ship settlement on slipway during the period of inactivity, positioning of the vessel on bilge blocks, launch calculations, and a technical overview of each phase of the process. Furthermore, the factors influencing the height of the ship's keel relative to the slipway line, i.e., the definition of the settling curve, have been analyzed. The need for additional ballasting and work on the bilge blocks system has been presented in order to enable launching operation that will prevent phenomena such as bow dipping or impact with the slipway. Based on the results, it was concluded that launching process can be successfully executed if newly defined technological guidelines are followed. Furthermore, the study confirmed that prolonged construction delays primarily affect the ship sections most exposed to external conditions.

Keywords: shipbuilding delays, ship launching, livestock carrier, ship settlement curve, slipway equipment

1. Introduction

Various delays in shipbuilding can create multiple challenges specifically within ship construction and outfitting, [1]. In this paper in particular, the case of vessels that remains for extended period on the slipway without further construction progress is researched. Such vessel is subject to degradation, both of the ship's structural components and equipment and of the slipway and its equipment itself. Slipway equipment used for launching the vessel is also prone to damage or deterioration due to inactivity. The vessel, exposed to environmental conditions and lacking regular maintenance, is particularly vulnerable to the adverse effects of corrosion. Furthermore, additional issues may arise from a potential change in the vessel's position on the slipway, which can result in launch-related safety risks. When a vessel is prepared for launching after a prolonged construction downtime, it is critical to carry out a thorough inspection to identify all potential hazards that could compromise the safety of the launch. As part of the launch preparations, it is necessary to assess the condition of the slipway equipment, inspect the vessel's structure, and take specific measures to ensure its stability and safety during the launching operation. It is essential to evaluate onboard conditions, such as the extent of corrosion, structural weaknesses, and damage to navigation and control systems, and to implement the required remedial actions. Another challenge lies in determining the vessel's degradation/settlement curve on the slipway during the construction delay. This degradation curve enables monitoring of the vessel's condition over time and forecasting of potential issues that may arise as a result of the prolonged standstill. It is also necessary to analyse the operational constraints imposed to ensure a safe launch process, which involves consideration of all technical parameters such as vessel weight, slipway balance, and structural integrity. If, during preparations, it is determined that the vessel does not meet the conditions for a safe launch, additional remedial measures must be undertaken, such as weight redistribution, reinforcement of structural elements, or repairs to the slipway.

2. Consequences of construction downtime on ship and slipway structure

Visual inspection of the structural elements revealed significant corrosion activity affecting both primary and secondary members. The most severe damage was observed in the aft section and machinery spaces, where rainwater had accumulated for extended periods. The consequences of such conditions are evident in pronounced manifestations of both general and localized corrosion. A particular concern is related to welded joints. Although no visible cracks were initially detected, closer examination revealed rust formation and pitting marks, indicating the onset of pitting corrosion in these critical areas [2]. In addition to conventional corrosion, the inspection identified the influence of biological factors such as moss, fungi, and lichens. By retaining moisture and creating micro-environments, these organisms further accelerate metal degradation and promote microbiologically influenced corrosion. As a result, the condition of plating and joints has further deteriorated, although it should be emphasized that despite extensive surface degradation, no deformations of the shell plating were detected, meaning that the vessel's basic form and the arrangement of primary structural elements remain intact. The inspection was not limited to visual observation, ultrasonic testing was also employed for precise thickness measurements of plates at critical locations. This enabled comparison with IACS and AMSA requirements, which clearly define the limits of acceptable imperfections and deficiencies [3]. In cases of material delamination, the installation of insert plates is foreseen. Weld defects and their susceptibility to corrosion are of particular concern, as they directly affect load transfer capacity. In addition to structural elements, the installed equipment was also inspected. It was established that nearly all pipelines located within 500 mm above the tank top had suffered such extensive corrosion that their replacement is mandatory. Corrosion had also severely damaged pipe flanges, valves, and pressure gauges, necessitating complete dismantling and installation of new connections.

Compounding the technical issues, regulatory changes introduced between 2016 and 2024 pose significant additional challenges. New AMSA and classification society requirements, in this case Bureau Veritas, mandate further safety measures, such as the installation of a watertight and fireproof bulkhead between the engine room and the AMSA compartment, the use of stainless-steel rings on feeder and deck joints, and additional protection of the potable water system. Requirements were also introduced for increasing the dimensions of wells in the livestock feed silos [4].

Figure 1. Condition of the hull [1]

Figure 2. Condition of slipway equipment [1]

3. Analysis of ship settlement on the slipway

The settlement process is defined as the vertical distance from the vessel keel to the line of the slipway while it is still supported by keel blocks and not by the sliding ways, i.e., before it has fully transferred to its final support. Settlement begins with the placement of the first section on the slipway and continues until the vessel is completely seated on the sledges, establishing a continuous contact between the hull and the supporting surface. The numerical definition of settlement starts with the collection and processing of data on changes in the height of the flat keel relative to the slipway line, resulting in a measurement table [2]. Based on these tables, settlement plans and curves are produced, enabling visualization of vertical displacement of the vessel as a function of the weight of installed sections and the time progression of construction.

Settlement is observed through several phases:

◊ **Phase_1**: Represents the state after installation of all bottom sections, with a mass of 3213 tons, serving as the initial reference.

◊ **Phase_2**: Corresponds to the period after the construction delay, when the mass increased to 6317 tons. This phase is particularly significant as it illustrates the consequences of prolonged structural inactivity.

◊ **Phase_3**: Represents the current condition, with a mass of 8604 tons and measurements taken in June 2025. In this phase, a comparison was also made with the simulated curve

◊ **Phase_4**: Defines the predicted condition of the vessel prior to launching, with a total mass of 11060 tons. This phase is generated using approximations and serves for estimation of final values and potential risks.

The measurement results are presented graphically. The diagram *"Initial Reading and Actual Condition"* compares *Phase_1* and *Phase_2*, highlighting the changes caused by the construction halt. The diagram *"Keel Position Curve"* shows keel height by frames in all phases, clearly indicating risk areas where height drops below 1,300 mm, with a critical limit at 1,200 mm. The largest differences occur in the midship region, between frames 120 and 170, while the end frames show elevated values due to hull form and slipway curvature. Further diagrams illustrate in more detail the relationship between mass and settlement. It is demonstrated that with increasing mass, settlement progresses linearly, with frames outside the stopper area being the most sensitive. Special emphasis is placed on the installation of the main engine and machinery in the engine room, which will cause additional settlement. The largest deviations are observed at frames 150 and 203, while the stern shows minimal differences. Frame-by-frame settlement analysis shows that the greatest deformations occur at frames 56, 150, 164, and 179, with values ranging from –55 to –65 mm. The end frames exhibit smaller but still notable settlements, confirming that the midship region is the most heavily loaded. A reduction in stopper height of 42 mm was also observed, which remains within safe limits but requires continuous monitoring.

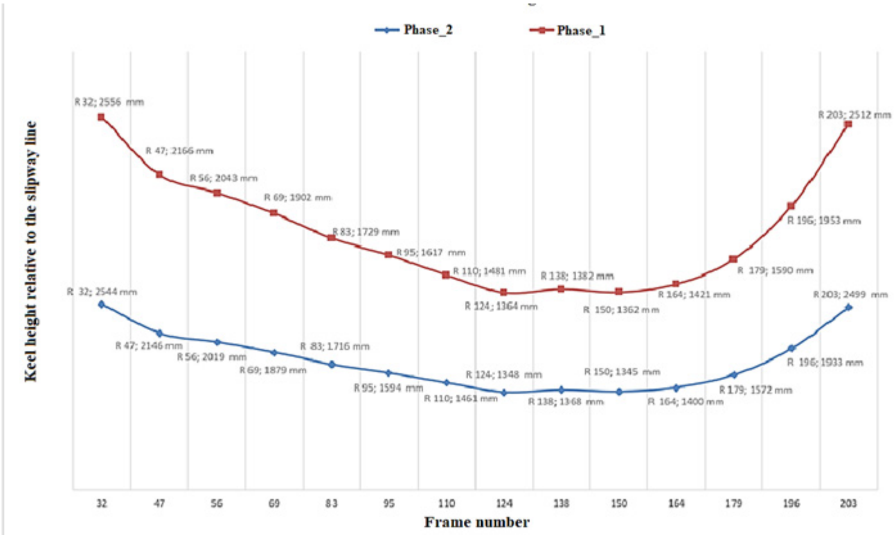

Figure 3. Detected settlement of the ship [1]

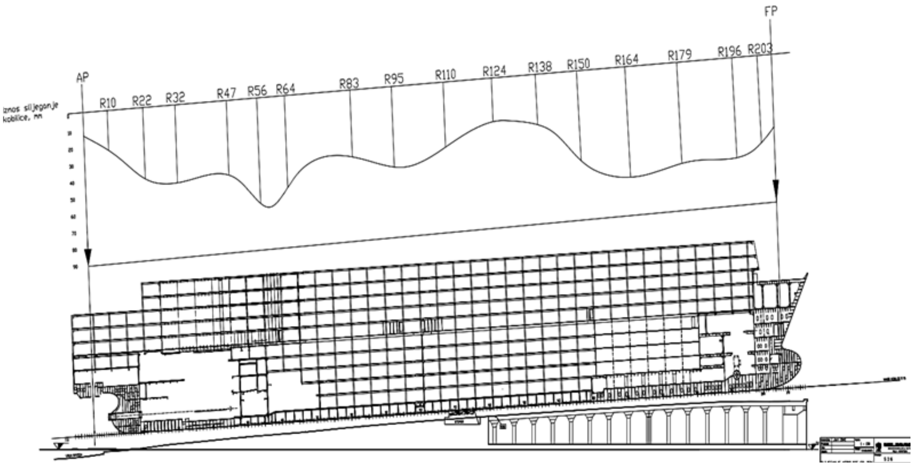

Figure 4. Ship settlement curve [1]

In order to enable continuous assessment of settlement for any combination of frame positions and hull mass within the experimental range, the settlement domain is divided into three logical regions, based solely on the initial height readings. For a more accurate description, a cubic regression model with two variables is used, and bilinear interpolation Accordingly, the initial heights are grouped as follows [5]:

- group with initial height readings above 1900 mm,

$$y = 5360.6 - 54.066\,x_1 - 0.47895x_2 + 0.21339\,x_1^2 + 0.011661\,x_1x_2 + 3.0301 \times 10^{-6}x_2^2 \quad (1)$$

- group with initial height readings between 1500 mm and 1900 mm,

$$y(x_1,x_2) = \frac{1}{(x_{1,2}-x_{1,1})(x_{2,2}-x_{2,1})}[y_{1,1}(x_{1,2}-x_1)(x_{2,2}-x_2) + y_{2,1}(x_1 - x_{1,1})(x_{2,2}-x_2) + y_{1,2}(x_{1,2}-x_1)(x_2-x_{2,1}) + y_{2,2}(x_1-x_{1,1})(x_2-x_{2,1})] \quad (2)$$

- group with initial height readings below 1500 mm.

$$y = 4517.7 - 46.940\,x_1 - 0.54426\,x_2 + 0.17426\,x_1^2 + 0.012847\,x_1x_2 + 4.3965\,\times 10^{-6}\,x_2^2 \quad (3)$$

Where the variables are:
x_1 – Frame position of the observed group of sections
x_2 - Erected mass of the ship's hull on the slipway
y - Estimated height of the keel line from the slipway line

4. Definition of main problems

The most critical consequence, creating the greatest uncertainty, is the insufficient keel height of the vessel relative to the slipway line. This may result in a situation where the ship does not meet the required launching conditions and cannot be launched without hull damage [5]. During the placement of the vessel on sledges and grease, problems of improper longitudinal and transverse bearing occur. This refers to the situation in which the hull is not evenly supported on the blocks and therefore cannot rest uniformly on the sliding ways. Such uneven bearing may cause localized stresses and increase the risk of damage during launching, particularly in the double bottom structure. Since the launching process itself represents the phase in which the vessel is exposed to the highest stresses, it is necessary to install structural reinforcements at critical locations. In this case, reinforcements are arranged as brackets on longitudinals in the stern and in the bottom of the cargo hold, and as transverse brackets on frames in the bow area. The most hazardous consequence is the phenomenon of so-called *bow slamming*, which arises from a combination of the unfavorable position of the pivoting sledge, the amount of ballast required, and the lower initial bow height on the slipway [7]. In order to prevent bow slamming, 250 tons of ballast are applied to the aft section tanks. A very important parameter in launching calculations is the height of the sledges with their complete packing and preparation. The settlement of the vessel i.e., the final hull height before placement on sledges, must be greater than the calculated sledge height in order to ensure a safe launch. If the calculated sledge height exceeds the final vessel height on the blocks, bow slamming against the slipway end and subsequent structural damage is likely.

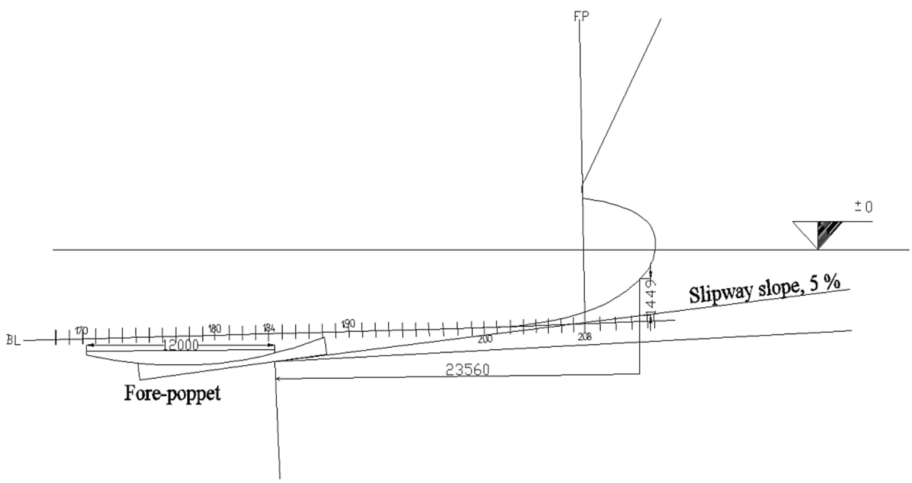

Figure 5. Ship departure from the slipway [2]

Technological, bilge blocks on quartz sand, which are not functional, present the greatest difficulty, their removal must be adapted to the new conditions. Improper removal increases stress on the structure and may lead to extrusion of the grease from the sliding ways. Furthermore, the 48 hour time limit applies, ensuring that the grease retains its primary characteristics. Another potential issue is *tripping* during launching. This is verified by checking whether the buoyancy moment curve at the end of the slipway lies above the mass moment curve at the same position. The risk can be mitigated by loading ballast in the forward part of the vessel to shift the center of gravity forward. However, in this particular case, due to pronounced bow slamming, ballast is placed exclusively in the stern.

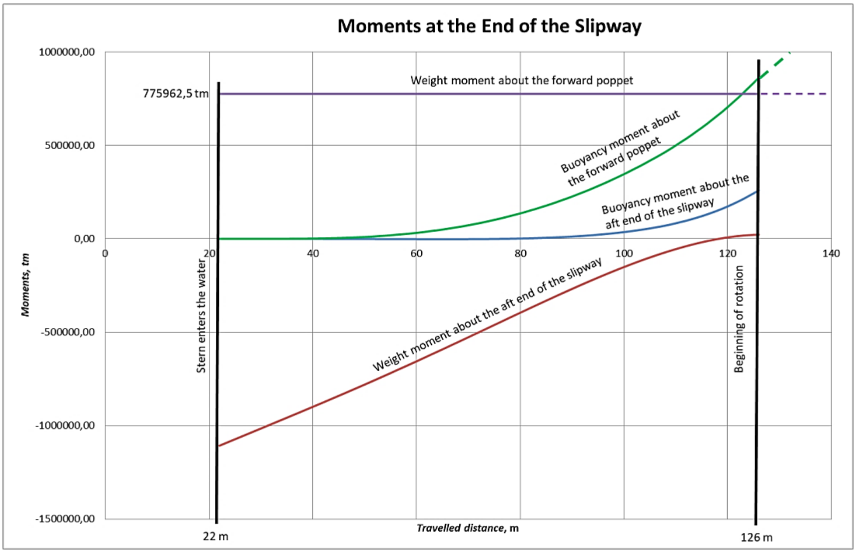

Figure 6. Moments at the end of the slipway [1]

A significant issue is also the overlapping of stopper teeth, specifically the reduction in stopper height by 42 mm compared to the design value. The target installation height was 1390 mm, however, due to construction delays and the added mass on the slipway, the height decreased to 1348 mm [2]. Although this value is still within the safe range for launch execution, it must be carefully monitored until completion of vessel construction. The minimum clearance at the beginning of ship construction between the ship's keel and the upper edge of the slipway stopper mechanism shall be 300 mm. The clearance between the lower edge of the pawl tooth and the housing line of the stopper mechanism at the beginning of construction is 120 mm. The engagement height of the pawl tooth prior to launching is approximately 110 mm, while the theoretical clearance between the lower edge of the pawl tooth and the stopper housing immediately before launching should be 40 mm [8]. This provides an additional safety margin in case of fabrication deviations. The current overlapping value is 62 mm.

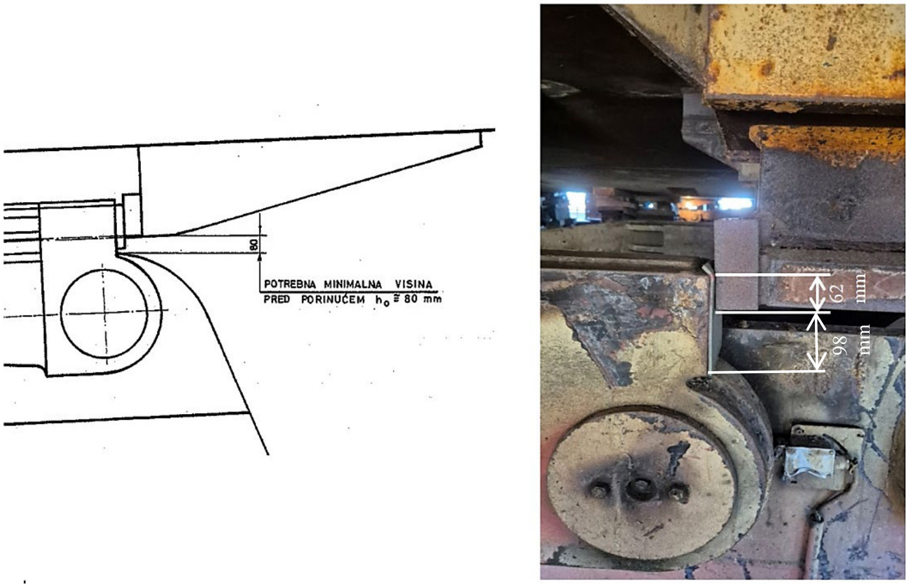

Figure 7. Allowed and current overlapping on hydraulic stopper [1]

5. Changes in launching methodology under specific conditions of construction downtime

The preparation of the slipway for launching involves a complex technical procedure carried out in several stages over a period of 30 to 45 days. For the launching of a vessel, a total of 14 m³ of base grease is used, which is heated to 120 °C and applied in a layer of 8 mm on the sledges and 12 mm on the sliding ways. The application may take place no earlier than 21 days prior to launching in order to prevent loss of performance properties [8].

Traditionally, after the sledges have been positioned and the blocks installed, the next stage is the driving of wedges, which ensures stability and an even distribution of the ship's weight. At this point, a firm physical connection between the sliding ways and the vessel's hull is established. Wedges are driven in manually with hammers until the characteristic metallic sound is produced, indicating that the joint has achieved sufficient stiffness and contact pressure. Furthermore, the shores and supports in the aft area, i.e., within the engine room, must be removed one day prior to launching, following the completion of wedge driving over sledges X. and XI. Once this step is completed, the ballasting operation immediately follows. In the cargo hold area, outside the region of the flat keel, the removal of shores and supports is performed in parallel with the wedge-driving process over the sledges. Additionally, shores between the sliding ways from frame 166 to frame 193, as well as supports along the centerline from frame 198 to frame 210, are to be removed only after wedges over sledges and cradles have been fully driven. However, under the newly arisen circumstances, it is proposed to modify the methodology so that, during the positioning of sledges, a detailed inspection of all supports is simultaneously conducted. Supports identified as inadequate, whether due to damage, deformation, or nonconformity with technical requirements are to be immediately replaced or completely removed. While this approach enables timely detection and remediation of potential weak points, it carries significant risks, most notably the possibility of undesired hull settlement. Considering that the permissible settlement allowance is limited to only 50 millimeters, there exists a real danger that this limit could be exceeded, potentially compromising both the safety and the success of the launch itself. As an alternative solution, consideration is being given to the removal of all supports during the wedge-driving phase, with the entire weight of the vessel temporarily transferred to two hydraulic stoppers. Nevertheless, this method is also not without risk, as there is a possibility of grease extrusion and excessive loading on the stopper teeth, which could result in their damage and further jeopardize the entire launching process. Premature removal of supports also faces a time constraint, since the grease bearing the vessel's weight remains suitable for launching for only 48 hours after the physical connection between hull and sledges has been established. In coordination with the designers and the shipyard's technology department, the most appropriate method for the removal of defective supports will be selected, at a sufficiently early stage to prevent potential delays in the launching process and to ensure the availability of all necessary resources.

6. Conclusion

A visual and technical inspection of the ship position was carried out, followed by the definition of settlement curves and measurement phases. Subsequently, all results were compared in order to obtain accurate data. Based on all available measurements for the construction of the aforementioned vessel, settlement values were approximated. This was followed by a description of the preparatory launch operations, covering all technological aspects and methodological changes necessitated by non-functional sliding blocks. Accordingly, all inadequate elements with potential influence on vessel settlement were replaced. A computational and technical launch analysis was conducted to compare with all limit values, and the sailing-off was calculated along with the corresponding braking plan. The investigation established that the vessel settlement is noticeable and must not be disregarded. The vessel does not settle below 1200 mm from the slipway line. Greater attention must be paid to slipway equipment, particularly sliding blocks on quartz sand. The entire ship structure rests on these blocks, and their timely collapse ensures proper seating of the vessel on the cradle and prevents uneven lubricant extrusion. It was observed that regulatory changes occur very rapidly, and the vessel must therefore be brought into full compliance with current requirements without exception. Such modifications present a considerable challenge when resuming construction after an extended halt. It was determined that, during the launch, special attention is focused on three critical moments in the process [1]:

1. the possibility of the bow detaching from the slipway,
2. the occurrence of potential uneven bearing of the ship on launch way,
3. the final phase prior to sailing-off, with the aim of preventing the bow from striking the slipway end.

Future considerations and actions related to this thesis should be based on comparing data obtained through calculations and analysis with actual values recorded during the launch. The primary task is to verify whether the implemented measures were sufficient. In addition, it is necessary to identify critical points of the vessel and possible deformations after launch, with the potential application of new solutions such as buoyancy aids and active ballasting.

7. Acknowledgements

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