Vibration Study in the Passenger Cabin of the Polbeng II Ship

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Abstract. The Polbeng II ship has the following main dimensions: Lpp = 9.8 m, B = 1.8 m, H = 1 m, T = 0.6 m, and Vs = 21 knots. Based on the calculation, the ship's resistance is 5.7 kN, and the engine power is 98 HP. In the ship's transmission system, the gearbox ratio is 1:3, the shaft has a diameter of 13/4", and the propeller size is 19 cm x 17 cm. The bearing size is also 13/4" for greater efficiency in preventing shaft wear during rotation and reducing the level of ship vibrations.
The passenger space in fast ships has seen significant development to accommodate various passenger needs, including densely packed economy class to comfortable business class. The passenger space on the Polbeng II ship has a length of 3 m and a width of 1.6 m.
According to ISO 6954-2000 standards, allowable vibrations in the fast ship's passenger space should fall within the frequency range of 1-80 Hz to ensure the safety and comfort of passengers during travel. Testing and assessment of vibrations inside the passenger space are conducted by measuring and evaluating the level of vibration speed that occurs. The average vibration speed in the Polbeng II ship's passenger space, measured from frames 5 to 9, is 1.2 mm/s.

Keywords: *component; The Polbeng II ship, passenger cabin, vibrations.*

1. INTRODUCTION

Ship vibrations are an important factor in ship dynamics [1,2]. There are two categories of vibrations: overall ship vibrations caused by sea waves and ship propellers, as well as local vibrations that occur in ship construction components and machinery. Ship dynamics refer to a ship's response to various influences such as sea waves, wind, ocean currents, and interactions with ship propellers or propulsion systems [2]. This is crucial in ship design, operation, and maintenance to ensure efficient and safe functionality, including aspects such as stability, maneuverability, vibrations, ship structural dynamics, and behavior in sea waves. Furthermore, ship vibrations can occur in three main directions: torsional, lateral, and axial [3-4]. Factors such as the main engine, propellers, sea waves, and wind can induce these vibrations. Managing vibrations is essential to maintain stability, passenger and crew comfort, as well as ship structural and propulsion performance.

In fast ships, vibrations can be caused by engine rotation, hydrodynamic effects during motion, and environmental factors such as sea waves and wind. Passenger cabin

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comfort is an important aspect of sea travel [5]. Efforts are made to create a good travel experience for passengers. This includes elements like comfortable interior design, adequate facilities, vibration and noise control, as well as cleanliness and safety aspects [6,7].

The aim of this research is to measure the vibrations that occur in the passenger cabin of the Polbeng II ship and determine whether the vibration levels comply with ISO standards [8,9]. This research aims to ensure passenger comfort and safety by identifying and comparing the vibration levels with the applicable standards.

2. THEORETICAL FOUNDATION

Ship vibrations are the phenomenon of oscillations or shocks that occur on a ship during its voyage. Ship vibrations can be caused by various factors, including sea waves, ship engines, or interactions with the surrounding environment. Ship vibrations can have negative impacts on passenger comfort and safety and can also affect the performance of equipment on board. Ship vibrations can be controlled and managed through proper ship design, the use of vibration damping systems, and regular maintenance. In some cases, ship vibrations can also be harnessed for specific purposes, such as generating electricity through the utilization of ship motion.

To calculate the effective acceleration of vibrations on the ship, it is necessary to measure at various points in the passenger cabin over a specific period of time and then use this formula to calculate the square root of the average of these accelerations. The result will provide the level of vibration experienced by passengers during that time period. Additionally, when using measurement equipment, it should adhere to the applicable vibration measurement standards to ensure accurate results. Vibration analysis is important for understanding and managing the impact of vibrations on the ship concerning passenger comfort, safety, and onboard equipment.

The standard used for measuring vibrations on ships is ISO 6954-2000. This regulation governs the allowable levels of vibration on ships concerning the human body and typically assesses within the frequency range of 1 to 80 Hz. This means that the regulation limits the intensity and characteristics of vibrations that can be deemed acceptable to humans within that frequency range. In this context, frequency refers to how often vibrations repeat in one second. The frequency range of 1-80 Hz encompasses most of the frequencies that can be generated by ship engines, sea waves, or other factors that can influence vibrations on the ship.

3. METHODOLOGY

The Polbeng II ship is a fast vessel with specific primary dimensions and characteristics:

- Length between perpendiculars (Lpp): It measures 9.8 meters from the bow to the stern.
- Ship's width (B): It has a width of 1.8 meters.

- Ship's height (H): The ship's height, from the keel to the highest point, is 1 meter.
- Draft of the ship (T): The draft, which represents how deep the ship sits in the water, is 0.6 meters.
- Ship's speed (Vs): The ship can reach a speed of 21 knots.
- Engine power of the ship: The ship is equipped with an engine that provides 98 Horsepower (HP).

Additionally, calculations have determined that the ship's resistance while sailing is approximately 5.7 kilonewtons (kN).

These details are crucial parameters used to describe the Polbeng II ship and understand its capabilities. With these specific measurements, draft, speed, engine power, and resistance values provided, we can better analyze and plan the ship's operations while considering safety and efficiency factors.

4. RESULTS AND DISCUSSION

*A. **Polbeng II ship***

The Polbeng II ship is a fast vessel with key dimensions including length, width, height, draft, and speed. These specifications indicate that the ship is designed to operate efficiently and effectively in various applications, including passenger transportation, cargo delivery, and patrol duties. With a speed of up to 21 knots, it is well-suited for quickly covering sea journeys, while its relatively shallow draft allows it to operate in shallower waters. The Polbeng II ship is a prime example of a fast vessel that combines design and speed to meet the transportation and operational needs at sea. In Figure 1, the shape of the Polbeng II ship is depicted.

Image 1. Polbeng II Ship

B. Engine Installation on Bearings Connected to the Ship's Hull

The installation of engines on bearings connected to the ship's hull has a significant impact on the vibration speed experienced by the engine and the ship's structure. This impact relates to how the bearings and engine installation dampen or amplify vibrations. Here are some of the effects: Vibration Damping, Vibration Speed, Stability, Energy Efficiency, Maintenance. Therefore, the installation of engines on bearings connected to the ship's hull is crucial for managing vibration speed and minimizing its impact on the ship's performance and machinery. Proper design and regular vibration monitoring will help ensure that vibration speeds remain within safe and acceptable limits for efficient and comfortable ship operations. In Figure 2, the process of installing engine bearings on the Polbeng II ship is depicted.

Image 2. Engine Installation on Bearings

C. The Influence of Vibrations on Engine Installations

Vibrations can have a significant impact on engine installations. The influence of vibrations can be either positive or negative, depending on how well the engine installation is designed and managed. Here are some of the effects of vibrations on engine installations: Engine Damage, Operational Instability, Operator Comfort, Required Maintenance, Product Quality, Energy Efficiency, and Structural Safety. To reduce the negative impact of vibrations on engine installations, it is important to design robust installations, regularly monitor vibrations, and take necessary maintenance actions to prevent damage and other issues that may arise due to excessive vibrations.

In Figure 3, we show an example of the process of taking vibration speed test samples that we conducted inside the passenger cabin of the Polbeng II ship.

Image 3. Vibration Testing

Based on the vibration testing conducted inside the passenger cabin of the Polbeng II ship using vibration measurement equipment while the ship was sailing at a speed of 21 knots, we would like to inform you that the ship's vibration speed data for frames 5-9 can be found in Table 1.

TABLE I. VIBRATION SPEED MEASUREMENTS

No	Frame 5-9		
	Distance (cm)	Time (s)	Vibration Speed Values (mm/s)
1.	50	30	2.4
2.	50	30	1.6
3.	50	30	1.3
4.	50	30	0.9
5.	50	30	0.5
6.	50	30	0.3

In Figure 4, we visualize the changes in vibrations that occur inside the passenger cabin of the Polbeng II ship. The measurement starts at frame 5 and ends at frame 9. Each test point lasts for 30 seconds, and we measure the distance between measurement points as 50 cm. The result of this testing is data regarding the vibration speed that occurs inside the ship's passenger cabin.

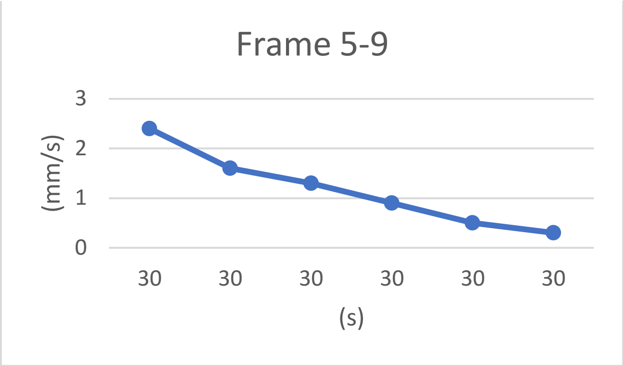

Image 4. Vibration Speed vs. Time Graph

D. Conclusion

Based on the generated data, it can be concluded that the average vibration values on the Polbeng II ship measured from frame 5 to 9 with a measurement distance of 50 cm in 30 seconds are as follows:

- Vibration at frame 5 is 2.4 mm/s.
- Vibration at frame 6 is 1.6 mm/s.
- Vibration at frame 7 is 1.3 mm/s.
- Vibration at frame 8 is 0.9 mm/s.
- Vibration at frame 9 is 0.5 mm/s.

To obtain the average value of these vibrations, we can sum up all the values and then divide by the number of frames measured, which is 5 frames:
(2.4 + 1.6 + 1.3 + 0.9 + 0.5) mm/s / 5 = 1.34 mm/s. So, the average vibration value on the Polbeng II ship over a period of 30 seconds is approximately 1.34 mm/s.

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