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Seakeeping Test of Ship Perambuan Model at Maneuovering and Ocean Engineering Basin (MOB) Laboratory for Hydrodynamics Technology

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ABSTRACT

Pure experiments done at Laboratory for Hydrodynamics Technology, in the form of seakeeping test of ship perambuan model at full load condition to obtain motion data of ship model recorded by using wireless optical tracking system. With wireless optical tracking system is expected to be more able to describe the phenomenon of motions the ship while sailing. Seakeeping test ship perambuan model is done at Maneuovering and Ocean Engineering Basin (MOB), in irregular wave conditions with significant wave heights Hs = 2.0 m and peak wave period Tp = 8.0 sec at the direction of wave relative to the direction of the ship 180 deg and 135 deg. Measurement of motion of the ship includes 6 DoF (Degree of Freedom) motions that is surge, sway, heave, roll pitch and yaw. Statistical analysis of measurement results is presented in order to know the quality of the ship motion. To support the analysis, the measurement results are also displayed in the Response Amplitude Operator, RAO.

KEY WORDS: *Ship Perambuan Model, Seakeeping Test, MOB, RAO*

NOMENCLATURE

DoF	Degree of Freedom
RAO	Reponse Amplitude Operator
RMS	Root Mean Square
ITTC	International Towing Tank Conference
MOB	Maneuovering and Ocean Engineering Basin
Hs	Wave Height
Tp	Peak Wave Period

1.0 PRELIMINARY

The construction of ship perambuan model is to realize the safety of cruise in Indonesian waters. However, these ships are planned to support the task Directorate General of Sea Transportation (Ministry of Transportation) in the navigation field such as the installation and maintenance of the Sailing Navigation Support Facility, delivering the tasks and supplies of the tower guard, and can assist Search And Rescue (SAR) tasks in searching

The ship in its operations is always faced with the problem of how the ship motions in the water, such as in sea water or also in fresh water. At the time the ship is in the waters then the ship will experience motions caused either from the ship itself (maneuoveribility) or from outside factor (seakeeping). Therefore, in order for the ship to have a high level of safety in sailing, prior to its construction or during the design process, the ship needs to be calculated and tested by a variety of wave motion [1].

Any floating structure that motions above sea level like a ship always experiences an oscillatory motion, ie among others heaving, rolling and pitching, because this motion works under force or moment of return when the structure is disturbed from its equilibrium position [2].

Therefore, a ship model is tested first and taken data for the original ship comparison data to be made, then ship model tested , and also to know if the motion of the ship whether the ship upside down when exposed to large

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waves or stay in a balanced position [3-4].

2.0 LITERATURE REVIEW

2.1 Activity Objectives

The purpose of seakeeping test of this ship perambuan model is:

2.1.1 Knowing the motions of ships in the sea especially heaving and pitching

2.1.2 Can calculate when the heaving of the largest and smallest and largest and smallest pitching.

2.1.3 Understand the RAO and the ship's response by making graphs on motions pitching, rolling and heaving ships while on the surface of the water, both seawater and freshwater.

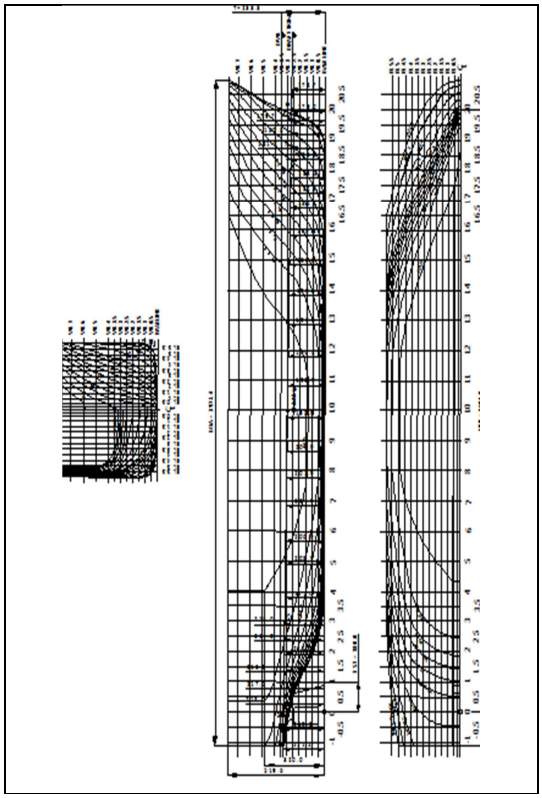

Figure 1: Lines plan model

Seakeeping test is performed on irregular wave condition with significant wave height Hs = 2.0 m and peak wave period Tp = 5,5 sec in the direction of the wave relative to the direction of the ship 180 deg (head seas) and 135 deg (quarter head seas). Measurement of motions of the ship includes 6 DoF (Degree of Freedom), motions that is surge, sway, heave, roll pitch and yaw. Statistical analysis of measurement results is presented in order to know the quality of the ship motion. To support the analysis, the measurement results are also displayed in the Response Amplitude Operator, RAO.

Discussion of test results covering aspects of seakeeping criteria is given to provide an overview of this ship's motion ability, especially in supporting the safety aspects of the ship.

Photographs and videotapes are performed in ship model testing, to provide a visualization of the presentation of the ship's motion during seakeeping testing.

Seakeeping test is done in Maneuovering and Ocean Engineering Basin (MOB) - Laboratory for Hydrodynamics Technology - BPPT with variation of wave direction as follows:

1.Quarter head sea condition

2. Head sea condition

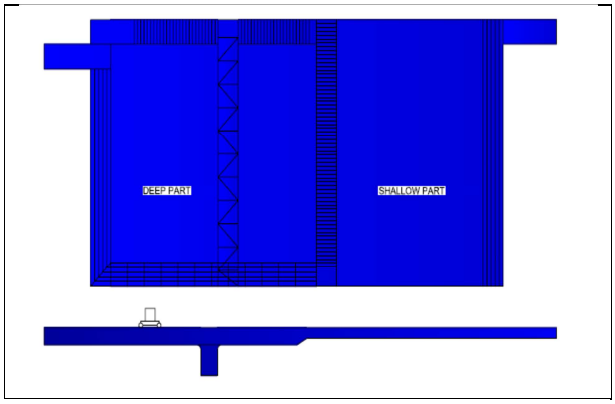

Figure 2: Test pool Maneuovering and Ocean Engineering Basin (MOB)

The Dimensions of Maneuovring and Ocean Engineering Basin (MOB) is 60.0 x 35.0 x 2.50 meters for each length, width and depth. The basin is equipped with wave generating equipment to generate regular or irregular wave and wave absorber to reduce the reflected wave.

In simulating the waves, the wave generator in the test pool is arranged in such a way, by moving the flap wave maker in various frequency variations and the length of the stroke so as to obtain a desired wave spectrum.

The wave elevation generated in Maneuovring and Ocean Engineering Basin (MOB) to describe the condition of sea state 4 in accordance with the World Meteorological Organization, ie with a significant wave height range of 1.25 - 2.50 m or sea state 5 with a significant wave height range of 2.50 - 4.0 m.

3.0 IMPLEMENTATION OF TESTING ACTIVITIES

Before seakeeping testing is done then it is done preparation in Maneuovring and Ocean Engineering Basin (MOB) test pool, ie performing wave calibration, with the aim of ensuring the resulting waveform is as intended. These waves are calibrated as follows: [3].

3.1 Before performing wave calibration, some wave modeling is calculated based on the time function, based on the spectrum

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of the necessary theoretical waves. Each wave type is based on the same spectrum shape, but with different generating rates for phase distribution. Then command to motioning every wave flap in the test pool in Maneuovring and Ocean Engineering Basin (MOB) and the waves are calculated based on the selected waves (combinations of spectral shapes and wave numbers).

3.2 Then the waves are generated and measured in the test pool for a full 30-minute test. The ship model is not placed in the test pool when waves making to prevent unwanted reflections

3.3 The measured wave signal is analyzed and the shape of the measurable wave spectrum, then compared to the desired wave spectrum form.

3.4 Requirements for broad spectrum of waves, $m_{\zeta 0}$ is set to < 3% of the theoretical value

If the measured wave spectrum does not meet this criterion, commands for the wave generator are corrected for the difference between the requirements and the measured wave spectrum. And steps (b) to (d) must be repeated.

Next, before the test is done all the measurement signal at zero readings, by means of signals for a zero position wave height with the condition of the ship model in equilibrium position of calm water.

Seakeeping test is done in Maneuovring and Ocean Engineering Basin (MOB) with irregular wave, the wave is generated by the wave maker, by performing various translational motions back and forth based on the desired frequency. The magnitude of translational motion back and forth and its frequency is related to the distribution of energy in the condition of irregular ocean waves generated. Thus the random sea wave conditions present at the actual location can be made in Maneuovring and Ocean Engineering Basin (MOB) test pool [6].

The wave height is measured by a measuring device resistance wire wave probes. The condition of irregular ocean waves are arranged so that the spectral density distribution corresponds to the desired theoretical energy distribution

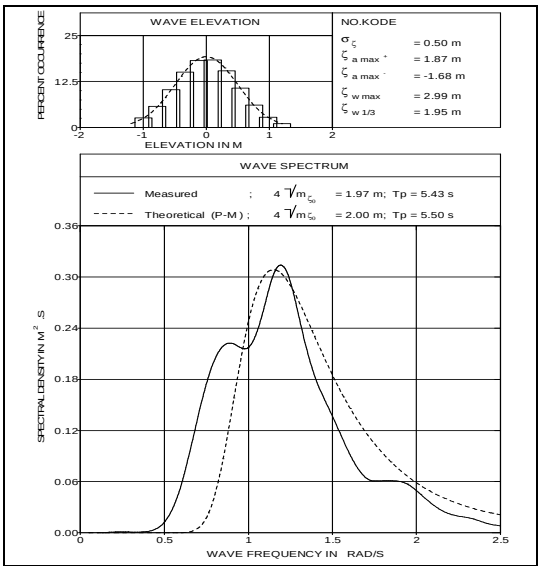

Figure 3: The wave spectrum of measurement results Hs = 2.00 m; Tp = 5.50 s

4.0 RESULT OF DISCUSSION AND DISCUSSION

The ship model is tested using free running method, namely by mounting the installation of the driver and remote control on the ship model so the ship model can motions in 6 DoF. To get motion data model ship recorded by using wireless optical tracking system. Target sensors mounted on the ship model will be detected by the motion tracking equipment for subsequent recording in the form of motion data ship model . With this system is expected to better describe the phenomenon of motions the ship while operating.

To know the natural roll period is done decay test, from the decay test results it is known that the ship model without mooring has a natural roll period Tn = 4.906 *sec*,. The Prior to be done is testing decay done zero readings for all channels. Then the wave making begins, after a while until the transient effect disappears then the measurement begins. The testing procedure is based on the ITTC standard No. 7.5-02-07-02.

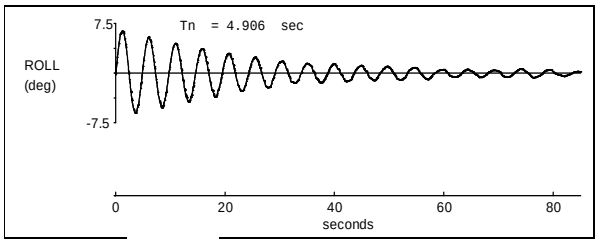

Figure 4: Time traces roll decay test

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In testing seakeeping this measuring instrument used are a wave probe and wireless optical tracking motion system, respectively to measure wave elevation and motion of ship models. Before seakeeping testing, all electronic equipment used is calibrated. Signal testing measurements are recorded in files stored on Personal Computer (PC).

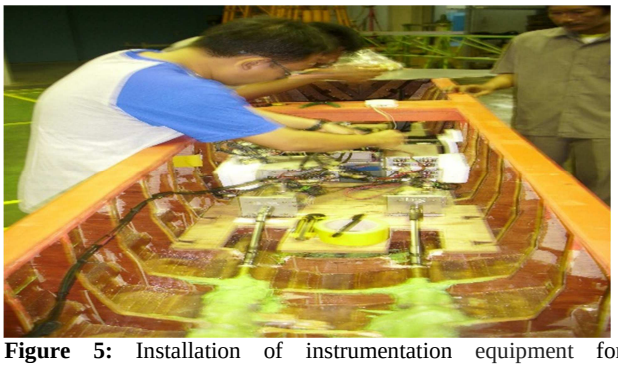

Figure 5: Installation of instrumentation equipment for seakeeping test

Figure 6: Test conditions seakeeping heading 180 degrees

Figure 7: Test conditions seakeeping heading 135 deg

All measurements are made by defining the right hand axis system. The positive direction of moving the model is as follows :
X: surge, forward direction
Y: sway, the portside direction
Z: heave, top direction

For rotational motion, the positive direction is indicated clockwise for each rotation axis
ϕ: roll against x-axis
θ: pitch against the y-axis
ψ: yaw against the z-axis

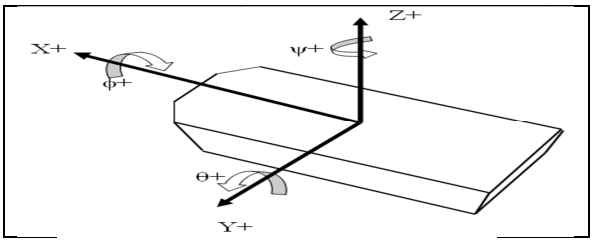

Figure 8: The axes on the fixed system model.

The measurement results in seakeeping test are presented in the form of statistical analysis and RAO. In this measurement used RMS (Root Mean Square) value of each signal for the evaluation of ship motion. Motions ship model measurement result; roll, pitch, heave, surge, yaw and sway.

4.1. Rolling

Rolling motion is an important mode of motion associated with the stability of the ship. From the test results it is known that the RMS or standard deviation roll for 180 deg heading is 2.363 deg, while the 135 deg heading is 3.096 deg. In standard criteria NORDFORSK 1987 for the merchant ship class, RMS motion roll given limit 6 deg. Note that the maximum roll value is also important, although it occurs in one cycle but the high roll rate is very influential on the condition of the stability of the ship. The results of the maximum roll measurement at 180 deg obtained 13,054 deg and at 135 deg obtained 22,090 deg. The magnitude of this large roll is understandable because the ship is operated by sea state 4 and the wave period approaches the natural frequency value of the ship's period.

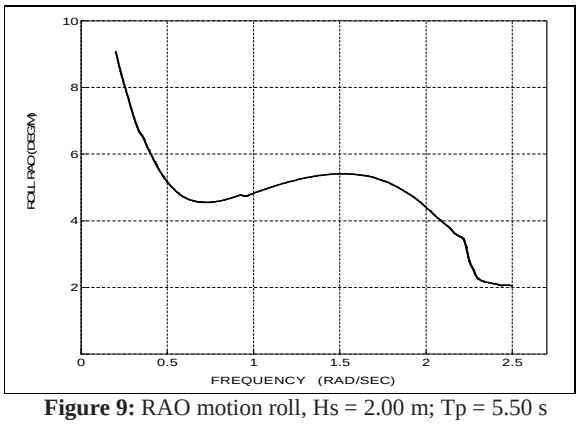

Figure 9: RAO motion roll, Hs = 2.00 m; Tp = 5.50 s

4.2. Pitching

Sea state greatly affects pitching motion. The effects of pitching motion is also accurate to slamming, deck wetness and vertical acceleration. The RMS pitch of the test is known to 1,091 deg for

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180 deg heading and 2,274 deg to 135 deg, but from the data the maximum pitch value looks beyond that value, although not significant but noteworthy, for 180 deg heading is 6,179 deg and at 135 deg is 18,432 deg ,. In the standard criteria NORDFORSK 1987 for merchant ship class, RMS pitch motion given limit 1.5 deg.

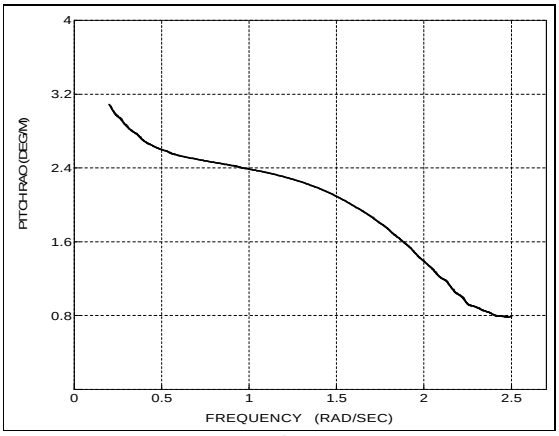

Figure 10: RAO motion pitch, Hs = 2.00 m; Tp = 5.50 s

4.3 Heaving

Heaving is the vertical motion up or down from the ship against its center of gravity and usually related with couple pitching. Large porpoising motions (couple heaving and pitching) are likely to result in parametric rolling ie excessive roll motion in the direction of the head seas. From the test obtained RMS heave value is 0.202 m for heading 180 deg and 0.293 m to 135 deg. Heaving maximum 1.083 m at 180 deg and 2,357 m heading at 135 deg.

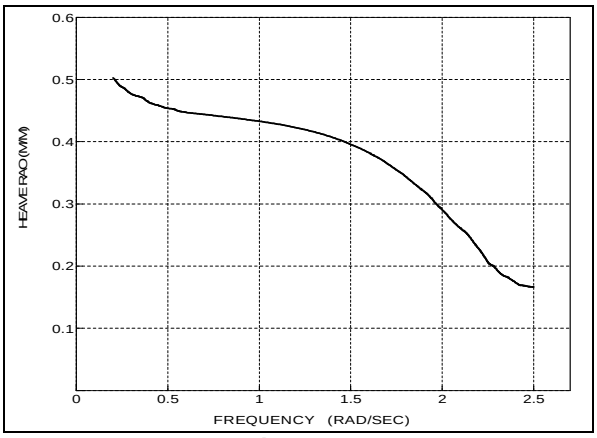

Figure 11: RAO motion heave, Hs = 2.00 m; Tp = 5.50 s

4.4. Yawing, Surging dan Swaying

Yaw, surge, and sway motions are common in the prediction of ship motion, usually not a consideration in the comfort and safety of the ship. From the test obtained value of RMS yaw 0.331 deg, surge 0.117 m and sway 0.112 m at 180 deg, and RMS yaw 0.427 deg, surge 0.169 m and sway 0.183 m at 135 deg. For yaw, surge, sway, and heave moves are not the limits specified in the NORDFORSK standard criteria of 1987.

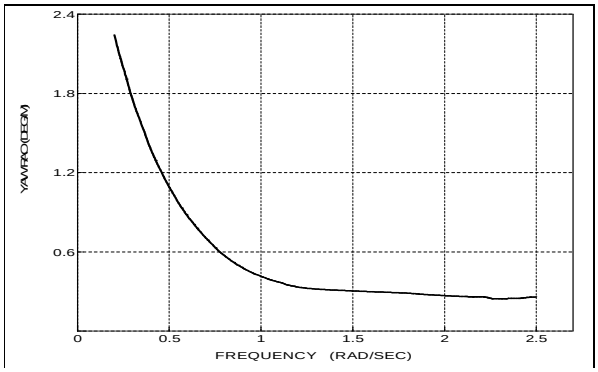

Figure 12: RAO motion yaw, Hs = 2.00 m; Tp = 5.50 s

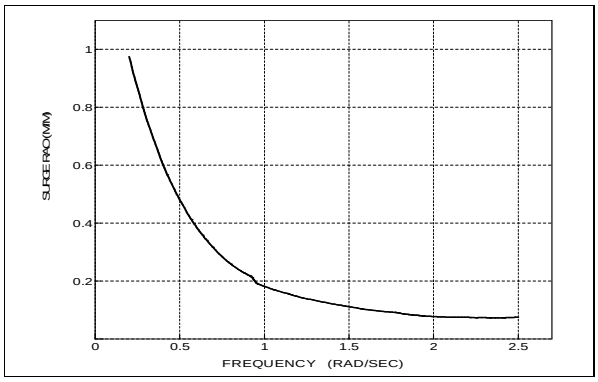

Figure 13: RAO motion surge, Hs = 2.00 m; Tp = 5.50 s

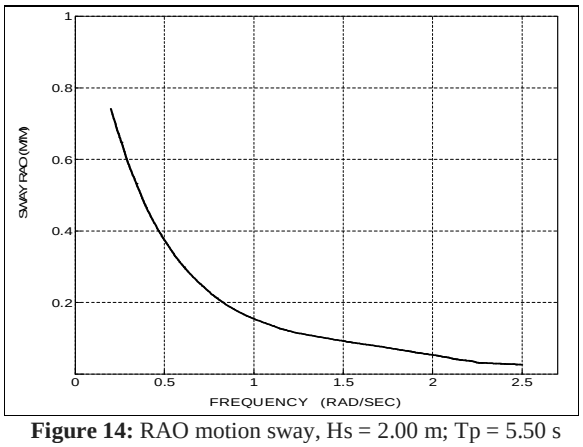

Figure 14: RAO motion sway, Hs = 2.00 m; Tp = 5.50 s

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5.0 CONCLUSION

Testing the ship perambuan model with a scale of 1:15 on irregular wave waves with significant wave height (Hs) = 2.00 m, peak wave period (Tp) = 5.50 sec with 180 deg and 135 deg heading using Pierson-Moskowitz spectrum type.

Ship motion behavior can be seen from the model test result where Root Mean Square (RMS) each heading (180 deg) roll = 2.363 deg, pitch = 1.091 deg and heading (135 deg) roll = 3.096 deg, pitch = 2.274 deg. Where the standard criteria NORDFORSK 1987 for RMS roll = 6 deg, RMS pitch = 1.5 deg.

From seakeeping testing it is known that the maximum amplitude of motion occurs, possibly because the sea state is too big in operation as well as ship heading very significant effect in this case.

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