RAO of Round Shape FLNG due to Interaction with Shuttle Tanker

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ABSTRACT
This paper aims to present the effect of dynamic motion interaction between Round Shape FLNG and KVLCC2 to the RAO of the Round Shape FLNG. The research focuses on the effect of radiation wave generated from the motion of floating structures and the propagated radiation wave outward to nearby influenced structures. To conduct this study, the Round Shape FLNG and KVLCC2 were arranged in parallel head-sea arrangement to capture the strong radiation wave effect on the RAO of Round Shape FLNG. The proposed method was developed to estimate the RAO of Round Shape FLNG from to the radiation wave generated by the motion of nearby structures. Using this method, the wave force and hydrodynamic coefficient were calculated based on the diffraction potential theory and modified drag term of Morison. In addition, the dynamic motion interaction effect was estimated based on the Motion Dissipate Energy concept and Huygens Principle. To verify the proposed method, motion experiments in regular wave were conducted in selected conditions. Then, the results predicted by the proposed method agrees with the results from the experimental test. Hence, this study concludes that the effect of the radiation wave generated by the motion of floating structure is an important factor in the study of motion interaction among the floating structures.

KEY WORDS: Response Amplitude Operator; FLNG; Shuttle Tanker.

NOMENCLATURE
FLNG Floating Liquefied Natural Gas
RAO Response Amplitude Operator
DOF Degree Of Freedom
NRIFE National Research Institute of Fisheries Engineering

1.0 INTRODUCTION
Study on floating structure system is an important research topic in offshore industry. The floating structures are allowed to move freely within the design limit when the motion of structures is induced by external force such as wave force, drift force, wind force and current force. Besides, these motion characteristics would be affected when the floating structures interact with each other on sea surface. Interaction between floating structures becomes an important research topic especially on the study of the FLNG offloading system design.

In this research, only the influence of first order wave forces to the motion of floating structure was studied because it is a significant factor in inducing the motion of floating structures. In single floating structure condition, the external force acting on the single floating structure is only caused by incident wave. However, the study of the wave load on the multiple floating structures becomes more complicated as the total wave force acted to the floating structures is the summation of the force from incident wave, the scattering wave from nearby structures and radiation wave due to the motion from nearby structures (Ali et al., 2010).

To simulate the motion of a floating structure by diffraction potential theory, a programming code was developed and written in visual basic programming language. The diffraction potential
theory estimates wave exciting forces on the floating structure based on the frequency domain and this method can be considered as an efficient method to study the motion of large size floating structures with acceptable accuracy. The good accuracy of this diffraction theory applied to large structures is due to the significant diffraction effect that exists in the large size structures in wave (Kvittem et al. 2012). But, in the potential theory, it is assumed that the viscous effect can be ignored in the calculation. This assumption causes the potential theory to estimate a lower damping coefficient for the motion of floating structures so that the RAO of floating structures prediction to become higher than the actual value in damping dominant region. This weakness of the potential theory was reported by Loken (1981) and Lu et al. (2011). Also, by comparing the numerical results predicted by using diffraction potential theory to experimental results, it is concluded that the motion prediction by diffraction potential theory has an acceptable accuracy in most cases, except for heave motion when the wave frequency is near to the structure natural frequency (Siow et al. 2013b & 2014a).

To obtain better simulation results, this work is targeted to propose correction methods which can be applied to the diffraction potential theory in order to evaluate the motion response of selected offshore floating structure when the structure alone and when it is interacting with nearby structure. In order to improve the heave motion prediction by the diffraction potential theory, this research tried to integrate the linearized Morison drag equation with diffraction potential theory. This linear Morison drag equation will modify both the damping term and exciting term in the motion equation. After that, the research further develop the method on estimation of RAO of the floating structure due to interaction with another structure using diffraction potential theory, Huygens principle, motions dissipate energy method and drag term of Morison.

The accuracy of these modification solutions are also checked with the experiment result which was conducted out at the wave dynamic tank owned by National Research Institute of Fisheries Engineering (NRIFE), Japan. (Siow et al. 2015a & 2015b). A Round Shape FLNG model was selected to study its RAO. The experiment was conducted in heak sea condition and slack mooring condition. Only the heak sea condition is considered in this paper because the effect of radiating wave generated by motion of shuttle tanker to the FLNG is focused in this study. This is because the radiating wave effect contributes in interacting between floating structures is more dominant in head sea condition. In the comparison, it is shown that the proposed method can be an alternative to predict the RAO of floating structure when the structure is alone and when the floating structure is interactive with nearby structure which arrange in parallel arrangement.

2.0 LITERATURE REVIEW

2.1 Diffraction Potential Theory

Hess & Smith (1964), Oortmerssen (1979) & Loken (1981) studied on non-lifting potential flow calculation about arbitrary 3D objects. They utilized a source density distribution on the surface of the structure and solved for the distribution necessary to make the normal component of fluid velocity zero on the boundary. Plane quadrilateral source elements are used to approximate the structure surface, and the integral equation for the source density is replaced by a set of linear algebraic equations for the values of the source density on the quadrilateral elements. By solving this set of equations, the flow velocity both on and off the surface was calculated.

Besides, Siow et al. (2014b) also proposed an in-tegrating model where the linearized Morison drag term is employed in their diffraction potential nu-merical solution to improve the accuracy of heave motion prediction in the damping dominate region. The method is able to increase the heave damping in order to improve the numerical result. By this modification, it was obtained that the significant over-prediction of heave motion when the wave frequency is near to the floating structure natural frequency is corrected and the result is more similar to the experimental one.

2.2 Motion Interaction between floating structure

From the available literatures, the existing method to predict the interaction between floating structures were mostly developed based on diffraction potential theory. A practical theory to analyse hydrodynamic forces on multiple cylinders in waves has been introduced by Ohkusu in 1974. The concept proposed was considered as the hydrodynamic interaction effect in multiple cylinders system. Ohkusu found that the magnitude of the interaction effect between vertical cylinders is roughly inversely proportional to the square root of the spacing between the cylinders (Ohkusu, 1974). Besides, an exact interaction theory based on linear potential theory to study the hydrodynamic interaction among multiple 3-D floating bodies has been introduced by Kagemoto and Yue (1987). This concept became the essential concept for further development in the method for hydrodynamic interaction study by many researchers.

A research on hydrodynamic interaction between two vertical cylinders in waves by using linearized potential theory has been conducted by Zhou et al. (1996). The method proposed by them calculates the velocity potential by using Graf’s addition theo-rem. The research found that the magnitude of wave exciting forces acting on cylinders depended on the incident wave angle and the separation distance be-tween the cylinders.

Besides, Chakrabarti (2000) conducted a research to investigate hydrodynamic forces acting on multi-module structures. The wave force on the structures was estimated by using an analytical approach. The study found that the wave force is mostly depending on the progressive wave coefficients.

Kashiwagi et al. (2005) were conducted a re-search to investigate the wave drift force and mo-ment on two side by side arranged ships by using Higher-Order Boundary Element method (HOBEM). His research showed that the hydrodynamic interaction forces are more dominant in the motion equation in the shorter wavelength region due to resonant phenomena.

A numerical method has been employed by Zhu et al. (2006) to study the effect of gap in multiple box shape structures system. In that study, the potential of incident wave and scattering wave is ignored and the motion of the structures is assumed only affected by radiated wave. The simulation result obtained showed the hydrodynamic interaction between floating structures can influence the surge, sway and heave motion. However, only sway motion showed a strong interaction effect on certain resonance wave number.

The hydrodynamic response of an offshore spar structure...
which is linked to semi-submersible under regular waves has been investigated by Nallayarasu & Prasad (2012) using experimental and numerical method (ANSYS AQWA). In their simulation, they included the viscous damping coefficient to predict the motion response using the AQWA software. The viscous damping coefficient they applied was estimated from the model decay experiment.

3.0 MATHEMATICAL MODELS

3.1 Diffraction Potential Theory

In this study, the diffraction potential method is used to obtain the wave force acting on the floating structures and the added mass and damping for all six directions of motions. The regular wave act on floating structures can be described by a velocity potential.

\[ \Phi(x, y, z) = Re\{\phi(x, y, z)e^{i\omega t}\} \]  
(1)

\[ \phi(x, y, z) = \frac{1}{2\pi}\int \left(\phi_0(x', y, z) + \phi_\gamma(x', y, z)\right) + \sum_{j=1}^{N} i\omega X_j \phi_j(x, y, z) \]  
(2)

where, \( g \) is acceleration of gravity, \( \gamma \) is incident wave amplitude, \( X_j \) is motions amplitude, \( \phi_0 \) incident wave potential, \( \phi_\gamma \) is scattering wave potential, \( \phi_j \) is radiation wave potential due to motions and \( j \) is motion of direction.

Also, the wave potential \( \Phi \) must be satisfied together with the boundary conditions as below:

\[ \nabla^2 \Phi = 0 \quad \text{for } 0 \leq z \leq h \]  
(3)

\[ \frac{\partial \phi}{\partial z} + k \Phi \quad \text{at } z = 0 \quad \left( k = \frac{w^2}{2} \right) \]  
(4)

\[ \frac{\partial \phi}{\partial z} = 0 \quad \text{at } z = h \]  
(5)

\[ \Phi \sim \frac{1}{r} e^{-ik_0 r} \text{ should be } 0 \text{ if } r \to \infty \]  
(6)

\[ \frac{\partial \phi_j}{\partial n} = -\frac{\partial \phi}{\partial n} \text{ on the body boundary} \]  
(7)

3.2 Green Theorem

By considering the wave potential only affected by structure surface, \( S_m \), the wave potential at any point can be presented by the following equation:

\[ \Phi(P) = \iint_{S_m} \left(\frac{\partial \phi}{\partial n}\Phi(P, Q) - \Phi(Q)\frac{\partial \phi}{\partial n}\right) dS(Q) \]  
(8)

where \( P = (x, y, z) \) represents the fluid point at any coordinate and \( Q = (\xi, \eta, \zeta) \) represents any coordinate, \( (x, y, z) \) on the structure surface, \( S_m \). The Green function can be applied here to estimate the strength of the wave flow potential. The Green function in eq. (8) can be summarized as follows:

\[ G(P; Q) = -\frac{1}{4\pi\sqrt{(x-x')^2 + (y-y')^2 + (z-z')^2}} + H(x-x',y-y',z-z') \]  
(9)

where \( H(x-x',y-y',z-z') \) in eq. (9) represent the effect of free surface and can be solved by second kind of Bessel function.

3.3 Wave Force, Added Mass and Damping

The wave force acting on the structure to cause its motions can be obtained by the integral of the diffraction wave potential along the structure surface.

\[ F_i = -\iint_{S_m} \Phi_\phi(x, y, z)n_i dS \]  
(10)

where \( \Phi_\phi \) is diffraction potential, \( \Phi_\phi = \phi_0 + \phi_\gamma \).

Also, the added mass, \( A_i \) and damping, \( B_i \) for each motion can be obtained by the integral of the radiation wave due to each motion along the structure surface.

\[ A_{ij} = -\rho \iint_{S_m} Re\{\phi_i(x, y, z)\}n_i dS \]  
(11)

\[ B_{ij} = -\rho \iint_{S_m} Im\{\phi_i(x, y, z)\}n_i dS \]  
(12)

\( n_i \) in eq. (10) to eq. (12) is the normal vector for each direction of motion, \( i = 1~6 \) represent the direction of motion and \( j = 1~6 \) represent the six type of motions.

3.4 Drag Term of Morison Equation

The drag term due to the wave effect on the floating structure can be calculated using the drag force equation as given by Morison equation:

\[ F_D = \frac{1}{2} \rho A_{Proj} C_D \left| \dot{X}_d \right| \left( \dot{\phi}_x - \dot{\phi}_z \right) \]  
(13)

where \( \rho \) is fluid density, \( A_{Proj} \) is projected area in Z direction, \( C_D \) is drag coefficient in wave particular motion direction, \( \dot{X}_d \) is velocity of particle motion at Z-direction in complex form and \( \dot{\phi}_x \) is structure velocity at Z-direction.

The calculation in this research is carried out based on the absolute velocity approach. The structure velocity is ignored in the calculation because it is assumed that the fluid velocity is much higher compared to the structure velocity. Expansion of the eq. (13) is shown as follows:

\[ F_D = \frac{1}{2} \rho A_{Proj} C_D \left| \dot{\phi}_x \right| \dot{\phi}_z - \frac{1}{2} \rho A_{Proj} C_D \dot{\phi}_z \dot{\phi}_x - \frac{1}{2} \rho A_{Proj} C_D \dot{\phi}_x \dot{\phi}_z + \frac{1}{2} \rho A_{Proj} C_D \dot{\phi}_z \dot{\phi}_x \]  
(14)

By ignoring all the term consisting of \( \dot{\phi}_d \) and linearized the eq. (14) by using the Fourier series linearization method, eq. (14) can be reduced into the following format.

\[ F_D = \frac{1}{2} \rho A_{Proj} C_D \frac{\pi}{3} \left| \dot{\phi}_x \right| - \frac{1}{2} \rho A_{Proj} C_D \frac{\pi}{3} \left| \dot{\phi}_z \right| \]  
(15)
where, \( V_{max} \) is the magnitude of complex fluid particle velocity in \( Z \) direction. From the eq. (15), it can be summarized that the first term is linearized drag force due to wave and the second term is the viscous damping force due to the drag effect.

The linearized drag equation as shown in eq. (15) can now be combined with the diffraction term which calculated by diffraction potential theory. The modified motion equation is shown as follows:

\[
(m + m_\text{d})\ddot{x}_x + \left(b_p + \frac{1}{2} \rho A_{\text{prop}} c_D \frac{8}{3\pi} V_{\text{max}}\right)\dot{x}_x + k = F_p + \frac{1}{2} \rho A_{\text{prop}} c_D \frac{8}{3\pi} V_{\text{max}} (\dot{\phi}_Z) \]  

(16)

where \( m \) is mass, \( k \) is restoring force, \( m_\text{d} \), \( b_p \) are heave added mass, heave diffraction damping coefficient and heave diffraction force calculated from diffraction potential method respectively. \( 1/2 \rho A_{\text{prop}} c_D 8/3\pi V_{\text{max}} \) is the viscous damping and \( 1/2 \rho A_{\text{prop}} c_D 8/3\pi V_{\text{max}} (\dot{\phi}_Z) \) is the drag force based on drag term of Morison equation.

3.5 Radiation wave propagation

In this research, the propagation of radiation wave was predicted by Huygen’s Principle. The Huygens Principle stated that all the points at the wave front can be considered as a center position of the secondary source given rise to spherical wave; the new wave front is considered as an envelope for all the wavelet from the secondary source given rise to spherical wavelet; the new points at the wave front can be considered as a center position of the wavelet given rise to spherical wavelet. By assumed the total energy dissipate by the motion of floating structure is absorbed by fluid to generate the radiation wave arrives at the location \( P \) from the source \( S \). \( t_{\text{rad}} \) can be calculated by the following equations.

\[
\theta_{\text{rad}} = \tan^{-1} \frac{-1}{2a_\text{p} x^2 + b_\text{p} x + c_\text{p}} = \pi 
\]

(22)

\[
l_{\text{rad}} = (x_p - x_s) \cos \theta_{\text{rad}} + (y_p - y_s) \sin \theta_{\text{rad}} 
\]

(23)

The energy can be dissipated from the motion to water and wave is generated through damping effect. Therefore, the energy dissipates, \( E_d \) from the structure motion can be calculated by integrating the damping force of structure \( b_\text{p} \dot{x}_p + \dot{\phi}_Z \) times the distance \( s \) the structure travel \( s = \dot{z} \cdot dt \) and then divided by motion period \( T \) (Journee and Massie, 2001). In eq. (24), the dissipate energy evaluated is in unit of work done per unit of time.

\[
E_d = \frac{1}{2} b w^2 z^2 
\]

(24)

Besides, total wave energy, \( E_W \) on the ocean surface can be obtained from the sum of the potential energy and kinetic energy (Journee and Massie, 2001). The total wave energy per length of crest is as shown in eq. (25).

\[
E_W = \frac{1}{2} p g \xi_0^2 \cdot \lambda 
\]

(25)

By assumed the total energy dissipate by the motion of floating structures is absorbed by fluid to generate the radiation wave, \( E_d = E_W \) and then the wave amplitude at any location can be evaluated by the following equation.
\[ \zeta_a = \sqrt{\frac{E_{iw}}{C_{iw} \cdot S_{cfrt}}} \]  

(26)

whereas in eq. (26), \( E_{iw} \) is the total wave energy over a wave crest, \( C_{iw} \) is a constant and \( C_{iw} = \frac{1}{2} g \cdot \zeta_a \) is wave amplitude at \( P \), \( \lambda \) is the wave length, \( S_{cfrt} \) is the total length of the wave crest.

Once the amplitude of radiation wave arrived at location \( P \), the distance propagate by the radiation wave before arrive location \( P \) and the direction of radiation wave arrive location \( P \) are known, then the effect of the radiation wave generate by nearby structure to the influence structure is able to predict using diffraction potential theory and drag term of Morison which presented in Section 3.1 and 3.2. The radiation wave generate by nearby structure is considered as the new incident wave act on the influence structure to increase the motion of the structure.

4.0 EXPERIMENTAL MODEL ARRANGEMENT

As mentioned, the Round Shape FLNG model was selected as the model to test in this study. To study the effect of interaction, KVLCC2 model was also selected to produce the interaction effect to the FLNG model. The models were constructed from wood following the scale of 1:110. Upon the model complete constructed, inclining test and decay test were conducted out to obtain the model particulars of the selected models. The dimension and measured data of the models were summarized as in Table 1 and Table 2.

### Table 1: Model Particular for Round Shape FLNG.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Model</th>
<th>Full scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (m)</td>
<td>1.018</td>
<td>111.98</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>0.4401</td>
<td>48.41</td>
</tr>
<tr>
<td>Draught (m)</td>
<td>0.2901</td>
<td>31.91</td>
</tr>
<tr>
<td>Free board (m)</td>
<td>0.150</td>
<td>16.5</td>
</tr>
<tr>
<td>Displacement (m²)</td>
<td>0.2361</td>
<td>314249</td>
</tr>
<tr>
<td>Water plane Area (m²)</td>
<td>0.814</td>
<td>9849</td>
</tr>
<tr>
<td>KG (m)</td>
<td>0.225</td>
<td>24.8</td>
</tr>
<tr>
<td>GM (m)</td>
<td>0.069</td>
<td>7.6</td>
</tr>
<tr>
<td>( K_{xx} ) and ( K_{yy} ) (m)</td>
<td>0.208</td>
<td>29.48</td>
</tr>
<tr>
<td>( K_{zz} ) (m)</td>
<td>0.360</td>
<td>39.60</td>
</tr>
<tr>
<td>CB</td>
<td>0.785</td>
<td></td>
</tr>
<tr>
<td>CW</td>
<td>0.785</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2: Model Particular for KVLCC2.

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Full scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lpp (m)</td>
<td>2.9091</td>
<td>320</td>
</tr>
<tr>
<td>Water line length (m)</td>
<td>2.9591</td>
<td>325.5</td>
</tr>
<tr>
<td>Breadth (m)</td>
<td>0.5273</td>
<td>58</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>0.2727</td>
<td>30</td>
</tr>
<tr>
<td>Draught (m)</td>
<td>0.1891</td>
<td>20.8</td>
</tr>
<tr>
<td>Displacement (m²)</td>
<td>0.2349</td>
<td>312677</td>
</tr>
<tr>
<td>Water Plane Area (m²)</td>
<td>1.3843</td>
<td>16750</td>
</tr>
<tr>
<td>CB</td>
<td>0.8098</td>
<td></td>
</tr>
<tr>
<td>CW</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>LCB (m), fwd+</td>
<td>0.1012</td>
<td>11.136</td>
</tr>
<tr>
<td>LCG (m), fwd+</td>
<td>0.1012</td>
<td>11.136</td>
</tr>
</tbody>
</table>

In interaction test, the FLNG model and KVLCC2 model were arranged in parallel head sea arrangement as shown in Figure 2. The gap distance between the structures is 0.5 to the diameter of FLNG. During the experiment test, the regular wave test was repeated for the wavelength between the ratios of wavelength to FLNG diameter from 0.5 to 10.

5.0 HYDRODYNAMIC SIMULATION

In this study, the numerical method has been applied to execute the RAO of Round Shape FLNG when the FLNG is alone developed by using the diffraction potential theory and drag term of Morison using Offshore Pro Hydrodynamic Simulation as shown in Figure 3. The radiation wave interaction method also included in the calculation when the FLNG is interacted with KVLCC2.
Figure 3: Offshore Pro Hydrodynamic Simulation Software.

The total number of panels has been used in the execution is 3370 for the FLNG model and 3672 panels for KVLCC2. The mesh and simulation set up of both floating structures used in the execution is shown in Figures 4 – 7.

Figure 4: Mesh of Round shape FLNG.

Figure 5: Mesh of KVLCC2 ship.

Figure 6: Arrangement of Round-Shaped FLNG and KVLCC2 ship.

Figure 7: Simulation set up using Offshore Pro software.

6.0 RESULT AND DISCUSSION

The RAOs of Round Shape FLNG when it is alone and interacting with KVLCC2 were predicted using experimental method and the proposed method. The estimated RAOs of Round Shape FLNG when it is alone and interacting with KVLCC2 with the gap distance 0.5 to the breadth of FLNG are shown in Figure 8 to Figure 13.

Figure 8: Surge RAO of Round Shape FLNG when it alone with when interacting with another floating structure.
In the Figure 8 to Figure 13, the RAO tendencies are plotted against the ratio of wavelength to length of the Round Shape FLNG, $\lambda/L$. In this research, the interaction studies are conducted to parallel head sea condition. From Figure 8 and Figure 13, it shows the proposed method and experimental result predicted almost similar tendency of the surge RAO and pitch RAO of Round Shape FLNG in the condition FLNG alone and FLNG interacting with second floating structure. Besides, it is observed that the interaction between Round Shape FLNG with KVLCC2 only gives very limited influence to the surge motion and pitch motion of the FLNG.

On the other hand, the sway RAO and roll RAO of the Round Shape FLNG are showing strong interaction effect in the interaction case. Especially in sway direction, the RAO of Round Shape FLNG achieved maximum response around 0.2 in interaction case. This observation is similar with the finding reported by Zhu et al. (2006) and the finding from research of Kagemoto & Yue (1987), where they also obtained that the interaction of floating structure in parallel head sea condition would lead to strong interaction effect in sway motion.

Besides, comparison of the sway RAO of Round Shape FLNG when it is alone to the interaction case, it is observed that the interaction of KVLCC2 to the FLNG is stronger in short wavelength condition compared to the long wavelength condition because the interaction wave force is stronger in short wavelength condition. The finding is similar with the outcome obtained from the research conducted by Kashiwagi et al. (2005).

In the roll RAO shown in Figure 11, the roll motion of Round Shape FLNG does not exist when the FLNG is alone. In interaction case, the roll motion is induced due to the influence of interaction wave generated by the motion of nearby structure. The peak motion response of roll motion of the FLNG is predicted to occur at the ratio $\lambda/L$, which is equal to 9.2. The large roll RAO exists at the long wavelength region in interaction case because the interaction wave force is stronger in long wavelength region. As information, the roll natural period is happened at $\lambda/L$ equal to 9.355. Due to small roll damping and resonance effect, small interaction wave force acting on the FLNG is able to induce large roll motion when the wave frequency is close to motion natural frequency.

The heave RAOs for the Round Shape FLNG are shown in Figure 10. From the figure, it is observed that the influence of interaction between Round Shape FLNG with KVLCC2, which is stronger in the damping dominant region of the heave motion for this FLNG structure. To estimate the heave RAO of the Round
Shape FLNG, the damping coefficient for heave motion is required to be predicted accurately. In this research, the heave RAO predicted by the proposed method was developed from the diffraction potential theory and drag term of Morison. The predicted peak heave RAO of Round Shape FLNG by proposed method is close to the experimental result, where the estimated heave RAO of Round Shape FLNG in interaction case is around 2.1, but the peak heave RAO of the FLNG when it alone estimated by proposed method is around 1.75.

The yaw RAO is shown in Figure 13. The similar tendency of yaw RAO is predicted by proposed method and experimental test. From the figure, it is observed that the yaw motion of Round Shape FLNG does not exist in the cases, where the FLNG is alone and interacting with another floating structure.

7.0 CONCLUSION

This research proposes a method to simulate the RAO of floating structure. The proposed method was developed based on diffraction potential theory and drag term of Morison. Radiation wave interaction method was also used to predict the influence of wave generated by the motion of nearby floating structure. The results obtained from experiment test were compared to the results from the proposed method to check the accuracy of the RAO tendency estimated by the proposed method. The comparison showed that the proposed method is a good alternative method to estimate the RAO of floating structure in the cases when it is alone and when the structure is interacting with another structure.

In general, the research study found that the existence of the KVLCC2 structure arranged parallel with the Round Shape FLNG would induce the sway motion and roll motion to the FLNG. In addition, the interaction effect gives more significant influence to the sway motion in shorter wavelength region. Besides, the heave RAO of the Round Shape FLNG at damping dominant region is also increased when it is interacting with KVLCC2 tanker.

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REFERENCE


