Gmail **JAMIATUL AKMAL <jamiatul.akmal@eng.unila.ac.id>**

[Kapal] Submission Acknowledgement

1 message

Editor-in-Chief <jurnal.kapal@live.undip.ac.id> Tue, Mar 9, 2021 at 8:06 PM
Reply-To: "Dr. Jamiatul Akmal" <jamiatul.akmal@eng.unila.ac.id>
To: "Dr. Jamiatul Akmal" <jamiatul.akmal@eng.unila.ac.id>

Dr. Jamiatul Akmal:

Thank you for submitting the manuscript, "New model of tension leg platform for extreme wave applications" to Kapal: Jurnal Ilmu Pengetahuan dan Teknologi Kelautan. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL: https://ejournal.undip.ac.id/index.php/kapal/author/submission/37187
Username: jamiatulakmal

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Editor-in-Chief
Kapal: Jurnal Ilmu Pengetahuan dan Teknologi Kelautan
Department Of Naval Architecture,
Faculty of Engineering,
Diponegoro University,
Tembalang Campus - Semarang
Phone. +62-24-7680784, Fax. +62-24-7460055

Gmail

JAMIATUL AKMAL <jamiatul.akmal@eng.unila.ac.id>

[Kapal] Editor Decision (Revision Required)

1 message

Dr. Andi Trimulyono <anditrimulyono@lecturer.undip.ac.id> Wed, Apr 7, 2021 at 7:21 AM
Reply-To: "Dr. Andi Trimulyono" <anditrimulyono@lecturer.undip.ac.id>
To: "Dr. Jamiatul Akmal" <jamiatul.akmal@eng.unila.ac.id>
Cc: Asnawi Lubis <asnawi.lubis@eng.unila.ac.id>, Novri Tanti <novri.tanti@eng.unila.ac.id>, Nuryanto Nuryanto <nuryanto.1546@gmail.com>, Adam Wisnu Murti <adam.wisnumurti1517@students.unila.ac.id>

Dr. Jamiatul Akmal:

We have reached a decision regarding your submission to Kapal: Jurnal Ilmu Pengetahuan dan Teknologi Kelautan, "New model of tension leg platform for extreme wave applications".

Our decision is to:

Please revise the manuscript as recommended by the reviewer.
Please also write the revision results on the revision form available on the link below.
https://drive.google.com/file/d/1AA5LjIMVbDjRBzFLNq4rvobnT6j5ohIv/view?usp=sharing
Please submit the revised manuscript along with the revision form to our OJS System (not to email).

Thank you,
Dr. Andi Trimulyono
Department of Naval Architecture,
Faculty of Engineering,
Diponegoro University
Department Of Naval Architecture,
Faculty of Engineering,
Diponegoro University,
Tembalang Campus - Semarang
Phone. +62-24-7680784, Fax. +62-24-7460055

Gmail

JAMIATUL AKMAL <jamiatul.akmal@eng.unila.ac.id>

[Kapal] [ID-37187] Revised Version Acknowledgement

1 message

Editor-in-Chief <jurnal.kapal@live.undip.ac.id> Thu, Apr 29, 2021 at 3:34 PM
Reply-To: "Dr. Jamiatul Akmal" <jamiatul.akmal@eng.unila.ac.id>
To: "Dr. Jamiatul Akmal" <jamiatul.akmal@eng.unila.ac.id>

Dr. Jamiatul Akmal:

Thank you for submitting the revision of manuscript, "New model of tension leg platform for extreme wave applications" to Kapal: Jurnal Ilmu Pengetahuan dan Teknologi Kelautan. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL: https://ejournal.undip.ac.id/index.php/kapal/author/submission/37187
Username: jamiatulakmal
Editor: Andi Trimulyono

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Editor-in-Chief
Kapal: Jurnal Ilmu Pengetahuan dan Teknologi Kelautan
Department Of Naval Architecture,
Faculty of Engineering,
Diponegoro University,
Tembalang Campus - Semarang
Phone. +62-24-7680784, Fax. +62-24-7460055

Gmail **JAMIATUL AKMAL <jamiatul.akmal@eng.unila.ac.id>**

[Kapal] Editor Decision (Accept Submission)

1 message

Dr. Andi Trimulyono <anditrimulyono@lecturer.undip.ac.id> Thu, May 6, 2021 at 3:57 PM
Reply-To: "Dr. Andi Trimulyono" <anditrimulyono@lecturer.undip.ac.id>
To: "Dr. Jamiatul Akmal" <jamiatul.akmal@eng.unila.ac.id>
Cc: Asnawi Lubis <asnawi.lubis@eng.unila.ac.id>, Novri Tanti <novri.tanti@eng.unila.ac.id>, Nuryanto Nuryanto <nuryanto.1546@gmail.com>, Adam Wisnu Murti <adam.wisnumurti1517@students.unila.ac.id>

Dr. Jamiatul Akmal:

We have reached a decision regarding your submission to Kapal: Jurnal Ilmu Pengetahuan dan Teknologi Kelautan, "New model of tension leg platform for extreme wave applications".

Our decision is to:
Accept Submission.
Please fill the COPYRIGHT TRANSFER AGREEMENT available on the link below and resend it to our email.

https://drive.google.com/file/d/1-PD1W4sd6J969CgHvgoMXRK-ejDOtTsB/view?usp=sharing

Thank you for your contribution to our Journal.

Dr. Andi Trimulyono
Department Of Naval Architecture,
Faculty of Engineering,
Diponegoro University,
Tembalang Campus - Semarang
Phone. +62-24-7680784, Fax. +62-24-7460055

Kapal: Jurnal Ilmu Pengetahuan dan Teknologi Kelautan
(Kapal: Journal of Marine Science and Technology)

sinta S2 Science and Technology Index
Open Access Journal
e-ISSN: 2301-9069

#37187 Review

Submission

Authors	Jamiatul Akmal, Asnawi Lubis, Novri Tanti, Nuryanto Nuryanto, Adam Wisnu Murti
Title	The TLP 2-DOF as an alternative model for extreme wave application
Section	Research Articles
Editor	Andi Trimulyono

Peer Review

Round 1

Review Version	37187-112288-1-RV.docx 09-03-2021
Initiated	01-04-2021
Last modified	07-04-2021
Uploaded file	Reviewer B 37187-114434-1-RV.pdf 07-04-2021 Reviewer A 37187-114132-1-RV.docx 02-04-2021

2301-9069 (e)
1829-8370 (p)

KAPAL

Jurnal Ilmu Pengetahuan dan Teknologi Kelautan

journal homepage : http://ejournal.undip.ac.id/index.php/kapal

New model of tension leg platform for extreme wave applications

Abstract

Tension Leg Platform (TLP) is an offshore platform structure that is usually used for deep sea oil and gas exploration. The main structure of the TLP consists of a deck, pontoon, mooring system and foundation. The working principle balances the buoyancy force, the weight of the structure and the tension of the mooring rope. The problem is the use of TLP in the deep sea where sometimes extreme waves appear with various strange behaviors, which can damage the TLP structure. This paper proposes a new model of TLP that is more stable to wave forces. The working principle is to separate the mass of the deck and the mass of the pontoon into two flexible parts, which are connected by cantilever spring system. Thus the TLP displacement becomes two degrees of freedom (TLP 2-DOF). Furthermore, the TLP 2-DOF model was developed into a dynamic damping system (Dynamic Vibration Absorber / DVA). The design parameters were optimized to minimize the operator amplitude response (RAO) on the deck, with the pontoon mass being considered as damping mass.

Keywords : TLP; 2-DOF system; Dynamic Vibration Absorber; Optimization; RAO.

Comment [HE1]: First of all, the title should be relevant with the investigation study.

Comment [HE2]: The subject should mentioned

Comment [HE3]: Perhap "use" is replace with "construction".

Comment [HE4]: It should be mentioned, what are kind strange behaviors?

Comment [HE5]: Perhaps after this sentence, the design process of a new model should be explained shortly.

Comment [HE6]: Author(s) should state shortly the present results after th sentences.

1. Introduction

Tension Leg Platform (TLP) is an offshore platform that is "compliant structure", floating above sea level because the buoyancy force is greater than the weight of the structure. The main components of the TLP are the pontoon, deck, mooring system and foundation. In the installed condition, deck position is above sea level while the pontoon is submerged in sea water. The overall structure is tethered to the seabed by mooring ropes. TLP is usually used for deep sea oil / gas exploration activities. In the past, the TLP was installed at a depth of only 147 m [1] and now TLP has been installed at a depth of more than 1500 m [2].

In the operation of TLP in the deep sea, sometimes there are extreme waves that look strange and are "out of nowhere" [3]. For example, in the South China Sea there are frequent extreme waves known as internal waves. Internal waves are floating waves caused by variations in water density, propagating in the boundary layer of warm water and cold water below. It can propagate in many ways, including: short regular waves, cnoidal and solitary waves and internal tidal waves [4]. Recently, the phenomenon of extreme waves has become a concern because it has a potential to damage structures. For example, in the period 2004-2005, hurricanes Ivan, Katrina and Rita in the Gulf of Mexico destroyed 126 offshore structures and damaged 83 others [5].

Researchers have also attempted to study the relationship between extreme waves and dynamic TLP responses. For example Rudman and Cleary (2013) have conducted simulations and analyzes on rogue wafes impact and its effect on angle and rope tension [3]. The interaction between extreme waves and TLP results in complex dynamics, affecting buoyancy, rope tension and rotational motion. Chandrasekaran (2013) also analyzes TLP dynamics under wave extremes [6]. It is known that the dynamic response of the TLP is sensitive to extreme waves at high degrees of freedom and an operating frequency nearly the same as the natural wave frequency.

Many efforts to improve the design concept have been carried out by making design innovations. Among them, modifying the TLP geometry to be triangular [7], adding and adjusting the mass of dampers [8] and proposing a new model of mooring system configuration [9]. In addition, there are also those who propose a design for tension-leg twin platform structural systems [10]. However, besides having advantages, those design concepts also have several weaknesses. For example, the design of the Tension-leg twin platform structural systems proposed by Choi, Y. M. et al (2018) depends on the ratio of the distance of the two pontoon and wavelength, which at a certain number actually increases the resulting dynamic response [11]. For these reasons, this study will discuss a new design that is different from the previous designs, called the Tension Leg Platform Two Degree Of Freedom (TLP 2-DOF), which is relatively more stable to wave force.

????

Comment [HE7]: Author(s) should make the last paragraph that explains th purpose of the study and short method how to obtain the present results.

2. Methods

2.1. Models and assumptions

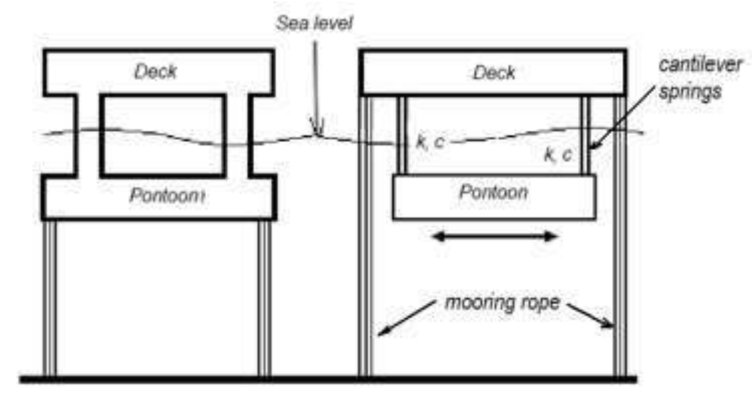
In the existing model, the deck and pontoon form a single unit into a rigid body. In the proposed TLP 2-DOF model, the deck and pontoon are made into two separate masses which are connected by a cantilever spring system. This separation allows a flexible structure and movement in the direction of the waves (*surge*) to be modeled as a two degree of freedom (2-DOF) system. Optimization of the design can be done with the principle of Dynamic Vibration Absorber / DVA where the pontoon is considered as a damper to stabilize the deck motion. Figure 1 (a) and Figure 1 (b) show the TLP exixting model and the TLP 2-DOF model, respectively. To see the performance improvement, a comparison study was carried out between the two models. The test set-up is shown in Figure 2 and the test specifications are given in Table-1.

??????

Comment [HE8]: Author(s) should explained clearly this sentences. Author shoud state an additional or supporting sentence. Furthermore, what is the meaning of su of wave direction? Could Author(s) mak coordinate system?

Comment [HE9]: Author(s) should make more explanation regarding the measurment method and divices.

Comment [HE10]: Author(s) should provide the main dimensions of TLP, existing and new model.



(a) (b)

Figure 1. TLP (a) The Existing Model and (b) The 2-DOF Model

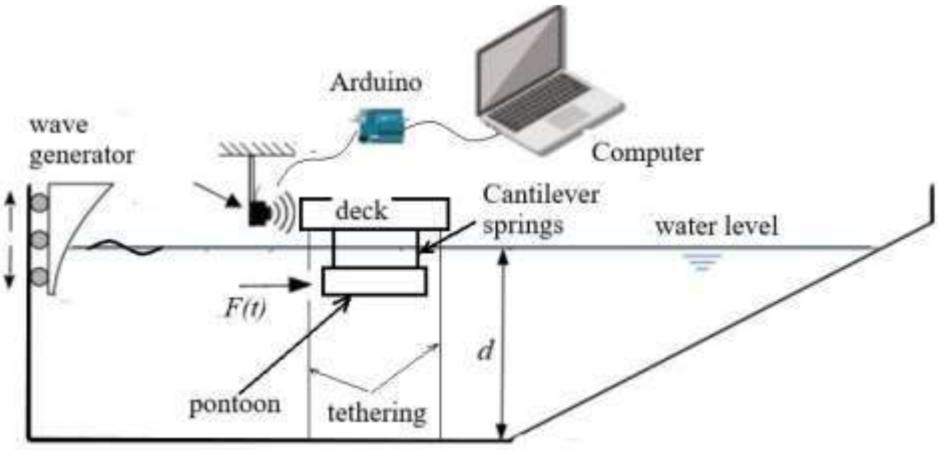


Figure 2. Test set-up

Tabel 1. The test specifications

Magnitude	**value**
Deck mass (m_d)	0,3 kg
Ponton mass (m_p)	0.9 kg
Cantilever spring stiffness (k_{tot})	9,537 N/m
Excitation frequency (ω)	9,77 rad/s
Excitation force ($F_{p)}$	0,242 N

2.2. Mathematical model for determining natural frequencies

Determining the natural frequency is necessary to anticipate the resonance phenomenon during operation. The analysis is carried out referring to the free body diagram (FDB) shown in Figure 3. If the damping factor of the structure is neglected, the equations of translational and rotational motion are as written in Equation (1) and Equation (2), respectively. With the stiffness matrix method, equations (1) and (2) can be solved to obtain equation (3). The next solution is carried out by calculating Equation (4) and Equation (5) and the equations of motion are obtained as written in Equation (6) and Equation (7).

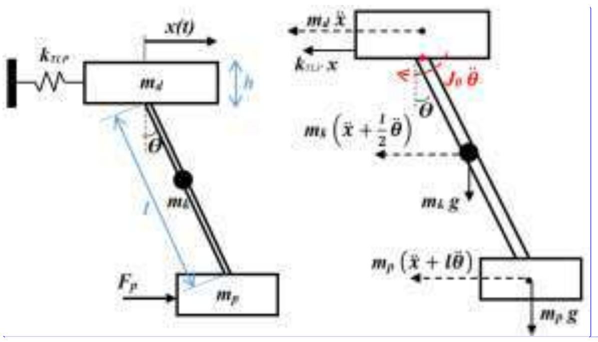


Figure 3. Free Body Diagram of TLP 2-DOF model

Comment [HE11]: Perhaps it is replaced to be "Description".

Comment [HE12]: Author(s) should state the decription of elemnts of the diagram.

$$m_d\ddot{x} + m_k\left(\ddot{x}+\frac{l}{2}\ddot{\theta}\right) + m_p(\ddot{x}+l\ddot{\theta}) + k_{TLP}x = 0$$
$$(m_d+m_k+m_p)\ddot{x} + \left(m_k\frac{l}{2}+m_pl\right)\ddot{\theta} + k_{TLP}x = 0 \qquad (1)$$

Comment [HE13]: Author(s) should provide the meaning of each equation component, equation 1 to 7.

$$\Sigma M = 0$$
$$J_0\ddot{\theta} - m_d\frac{h}{2}\ddot{x} + m_k\left(\ddot{x}+\frac{l}{2}\ddot{\theta}\right)\frac{l}{2} + m_p(\ddot{x}+l\ddot{\theta})l + m_kg\frac{l}{2}sin\theta$$
$$+m_pgl\,sin\theta = 0$$
$$m_k\frac{l^2}{12}\ddot{\theta} + \left(-m_d\frac{h}{2}+m_k\frac{l}{2}+m_pl\right)\ddot{x} + \left(m_k\frac{l^2}{4}+m_pl^2\right)\ddot{\theta}$$
$$+m_kg\frac{l}{2}sin\theta + m_pgl\,sin\theta = 0 \qquad (2)$$

$$\left(-m_d\frac{h}{2}+m_k\frac{l}{2}+m_pl\right)\ddot{x} + \left(m_k\frac{l^2}{3}+m_pl^2\right)\ddot{\theta}$$
$$+\left(m_kg\frac{l}{2}+m_pgl\right)\theta = 0$$

Comment [HE14]:

$$\begin{bmatrix} m_d+m_k+m_p & m_k\frac{l}{2}+m_pl \\ -m_d\frac{h}{2}+m_k\frac{l}{2}+m_pl & m_k\frac{l^2}{3}+m_pl^2 \end{bmatrix}\begin{Bmatrix}\ddot{x}\\ \ddot{\theta}\end{Bmatrix} + \begin{bmatrix} k_{TLP} & 0 \\ 0 & m_kg\frac{l}{2}+m_pgl \end{bmatrix}\begin{Bmatrix}x\\ \theta\end{Bmatrix} = 0 \qquad (3)$$

Comment [HE15]:

$$x = A_1\sin\omega t \text{ ---->} \quad \ddot{x} = -A_1\,\omega^2\sin\omega t \qquad (4)$$

$$\theta = A_2\,sin\,\omega \text{ ---->} \quad \ddot{\theta} = -A_2\,\omega^2\sin\omega t \qquad (5)$$

Comment [HE17]:

$$\begin{bmatrix} m_d+m_k+m_p & m_k\frac{l}{2}+m_pl \\ -m_d\frac{h}{2}+m_k\frac{l}{2}+m_pl & m_k\frac{l^2}{3}+m_pl^2 \end{bmatrix}\begin{Bmatrix}-A_1\omega^2\\ -A_2\omega^2\end{Bmatrix}\sin\omega t$$
$$+\begin{bmatrix} k_{TLP} & 0 \\ 0 & m_kg\frac{l}{2}+m_pgl \end{bmatrix}\begin{Bmatrix}A_1\\ A_2\end{Bmatrix}sin\,\omega t = 0 \qquad (6)$$

Comment [HE18]:

$$\begin{bmatrix} -m_d\omega^2 - m_k\omega^2 - m_p\omega^2 + k_{TLP} & -m_k\frac{l}{2}\omega^2 - m_pl\omega^2 \\ m_d\frac{h}{2}\omega^2 - m_k\frac{l}{2}\omega^2 - m_pl\omega^2 & -m_k\frac{l^2}{3}\omega^2 - m_pl^2\omega^2 + m_kg\frac{l}{2} + m_pgl \end{bmatrix} = 0 \qquad (7)$$

Comment [HE19]:

2.3 Numerical Solution

Equation (7) which is known as the characteristic equation can be expressed in the matrix as Equation (8) and Equation (9). This equation is a second order differential equation so that it can be converted into first order (state-space form). If the form of the equation is taken to be Equation (10), the next solution can be seen in Eq. (11, 12 and 13). If solved by numerical method by direct integration using finite difference method, the solution is obtained as Equations (14 and 15).

$$\begin{bmatrix} m_d+m_k+m_p & m_k\frac{l}{2}+m_p l \\ -m_d\frac{h}{2}+m_k\frac{l}{2}+m_p l & m_k\frac{l^2}{3}+m_p l^2 \end{bmatrix}\begin{Bmatrix}\ddot{x}\\ \ddot{\theta}\end{Bmatrix}+\begin{bmatrix} k_{tlp} & 0 \\ 0 & m_k g\frac{l}{2}+m_p g l \end{bmatrix}\begin{Bmatrix}x\\ \theta\end{Bmatrix}=\begin{Bmatrix}0\\ F_d\cos\omega t\end{Bmatrix} \tag{8}$$

Comment [HE20]: Author(s) should provide the description of each equatio elemnt, eqaution 8 to 15.

$$[M]\,\ddot{\vec{x}} + [K]\,\vec{x} = \vec{F}_{(t)} \tag{9}$$

Comment [HE21]:

$$\dot{\vec{Y}} = \begin{Bmatrix}\ddot{x}\\ \dot{x}\end{Bmatrix}, \quad \vec{Y} = \begin{Bmatrix}\dot{x}\\ x\end{Bmatrix} \tag{10}$$

Comment [HE22]:

$$\begin{bmatrix}[M] & [0]\\ [0] & [I]\end{bmatrix}\begin{Bmatrix}\ddot{x}\\ \dot{x}\end{Bmatrix} + \begin{bmatrix}[C] & [K]\\ [-I] & [0]\end{bmatrix}\begin{Bmatrix}\dot{x}\\ x\end{Bmatrix} = \vec{F}_{(t)} \tag{11}$$

Comment [HE23]:

$$[A]\,\dot{\vec{Y}} + [B]\,\vec{Y} = \vec{F}_{(t)} \tag{12}$$

Comment [HE24]:

$$\dot{\vec{Y}} = [A]^{-1}\left(\vec{F}_{(t)} - [B]\,\vec{Y}\right) \tag{13}$$

Comment [HE25]:

$$\frac{\vec{Y}_{(t+1)}-\vec{Y}_{(t)}}{\Delta t} = [A]^{-1}\left(\vec{F}_{(t)} - [B]\,\vec{Y}_{(t)}\right) \tag{14}$$

$$\vec{Y}_{(t+1)} = \vec{Y}_{(t)} + \Delta t$$

Comment [HE26]:

$$\left([A]^{-1}\left(\vec{F}_{(t)} - [B]\,\vec{Y}_{(t)}\right)\right) \tag{15}$$

Comment [HE27]:

2. 4. Experimental studies

The experimental equipment is a pool of water as a medium for waves. The wave generator engine consists of an exciter driven by a connecting rod connected to an eccentric rotor. The waves oscillate at a frequency of 1.55 Hz. In this test, the displacement of the existing TLP and TLP 2-DOF models were measured respectively and a comparative study was carried out. Displacement is measured using an ultrasonic sensor device. Figure 4(a) shows water waves as a medium, and Figure 4(b) shows the new model (TLP 2-DOF) and the existing model. Test equipment specifications and wave specifications are shown in Table 2.

Comment [HE28]: What are the kin of displacment. Perhaps, they should be mentioned obviously.

(a) (b)

Figure 4. (a) Water waves as a medium, and (b) The new model (TLP 2-DOF) and the existing model.

Tabel 2. Test equipment and wave specifications

Magnitude	**value**
Pool length (p)	200 cm
Pool width (l)	60 cm
Pool height (t)	80 cm
Water level/height (h)	60 cm
Wave direction	Horizontal (*surge*)
Wave amplitude (A)	5 cm
Wavelength (λ)	35 cm
Wave frequency (f_w)	9,77 rad/s (1,55 Hz)

Comment [HE29]: Please change it with "Description"

3. Results And Discussion

Comment [HE30]: Please check the instruction for author

Before discussing further, it needs to be reminded first that the dynamic response in question is that which is measured on the deck component. The dynamic response is expressed in the response amplitude operator (RAO). In this case, RAO is defined as the ratio of TLP displacement (deck) to wave amplitude. The design is carried out to minimize the amplitude response of the deck components, because this component is used for operational activities.

Comment [HE31]: What is "it" refer to?

Comment [HE32]: Please check this grammar

Comment [HE33]: I think there are kinds of displacement, are the RAO definition used for both of them?

3.1.Natural Frequency

The natural frequency of the TLP 2-DOF model is obtained by solving the characteristic equation and the two lowest frequencies can be seen in Table 4. When compared to TLP on a real scale, of course this natural frequency is classified as large, this is due to the small mass of the model. This is not a problem because actually the TLP scale has a large mass so that the natural frequency is small. Natural frequency is affected by the ratio of the mass of the deck to the mass of the pontoon (m_d/m_p). If mass of the deck become smaller, then the natural frequency will be larger. This is true according to the well known formula of natural frequency wich is inversly proportional to the root square of mass, as shown in Equation (16).

$$f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}. \quad (1)\ (16)$$

Comment [HE34]: Author(s) should provide the description of each equatio elemnt.

Tabel 4. Frequency of the TLP 2-DOF model

Ratio (m_d/m_p)	**Natural frequency**	
	f1	**f2**
1:3	0,587 hz	2,831 hz
1:2	0,562 hz	2,431 hz
2:3	0,539 hz	2,202 hz
1:1	0,501 hz	1,946 hz

Comment [HE35]: Author(s) should state in text these elements.

3.2 Comparison of the new model vs the existing model

Figure 5 shows a graph of the amplitude response of the new model and the existing model. Resonance occurs at the first natural frequency and the second natural frequency, around 0.587 and 2.831, respectively. The graph was plotted for mass ratio (m_d:m_p) of 1:3. At resonance conditions, the dynamic response of the new model is only 0.4 times the existing model, the RAO new model is about 1. It should be noted that the real TLP does not operate in the resonant state. Outside the resonance region, it can be seen that the RAO response is much smaller. From this discussion it is concluded that this model (TLP-2-DOF) can be considered for application in extreme ocean waves.

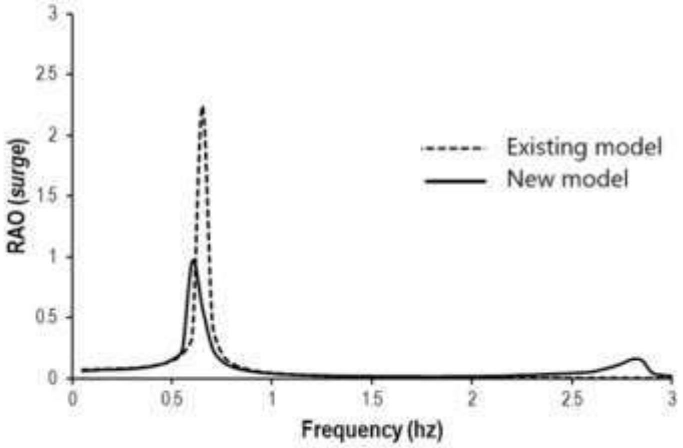


Figure 5. The dynamic response comparison between the new model and the existing model

Comment [HE36]: What is RAO (surge)??? RAO is a nondimensional patrameter.

3.3. Experimental validation

Experimental validation is required to check the accuracy of the analytical method. Figure 6 shows the dynamic response comparison between theoretical and experimental. Both charts display good agreement and a corresponding resonance phenomenon occurs at a wave frequency of around 0.587 Hz.

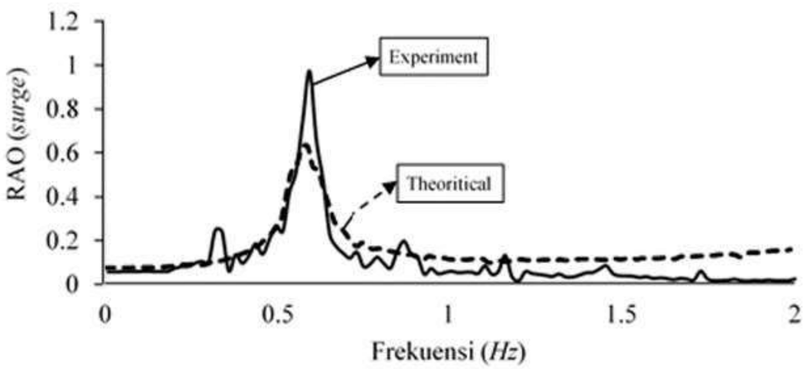


Figure 6. The dynamic response comparison between theoretical and experimental

Comment [HE37]: RAO (surge)? Why does theoritical result appear suddenly in this figure? In sub section 2 Author(s) have expalined regarding the numerical solution.

3.4 Effect of mass ratio ratio

The smaller the mass ratio (m_d/m_p), the greater the natural frequency. This is indicated by the position of the peak moving to the right as the ratio m_d/m_p become smaller. In addition, the relatively small deck mass resulted in a smaller RAO (except at $m_d/m_p = 1$).

Comment [HE38]: Please check its grammar.
The discussion is very short, and there a some data that clearly put in Figure 7, it would be worthwhile to discuss this deta

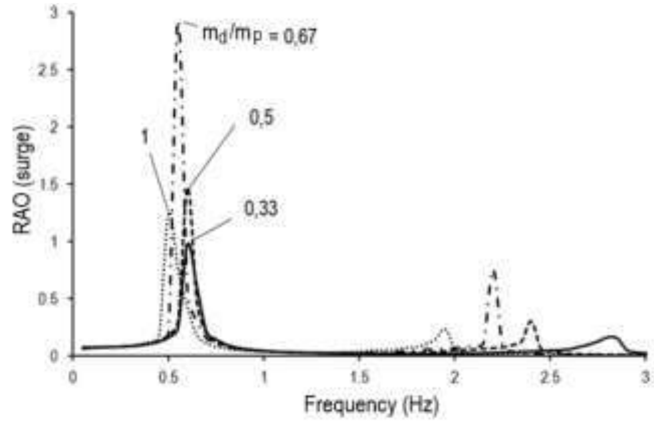
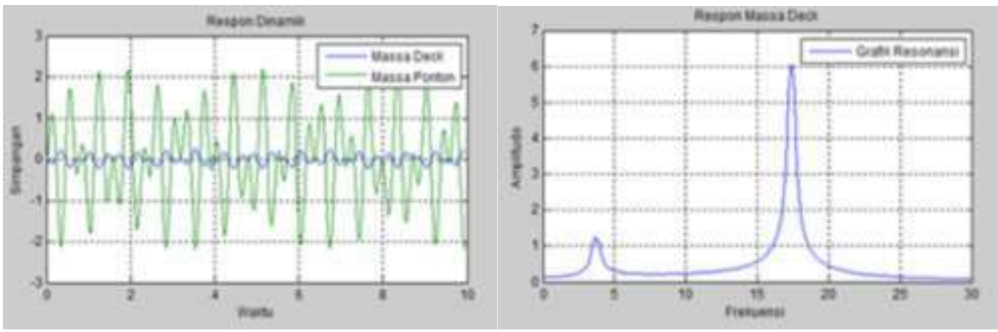


Figure 7. The effect of mass ratio (m_d/m_p) on dynamic response

3.5. Optimization

To get the optimal design, optimization of the mass ratio (m_d/m_p) is carried out to minimize the RAO value on the deck. The optimization process is carried out using the numerical method. Figure 8(a) shows recorded realtime displacement data and Figure 8(b) shows amplitudo response in domain frequency. Amplitude response (RAO) to the mass ratio variation (m_d/m_p) is shown in Figure 9. In this case, the best ratio of the mass of the deck to the mass of the pontoon (m_d/m_p) is about 0.2 where RAO becomes about 0.15. The excitation frequency given is 1.55 Hz, according to the frequency of the waves on the test equipment.

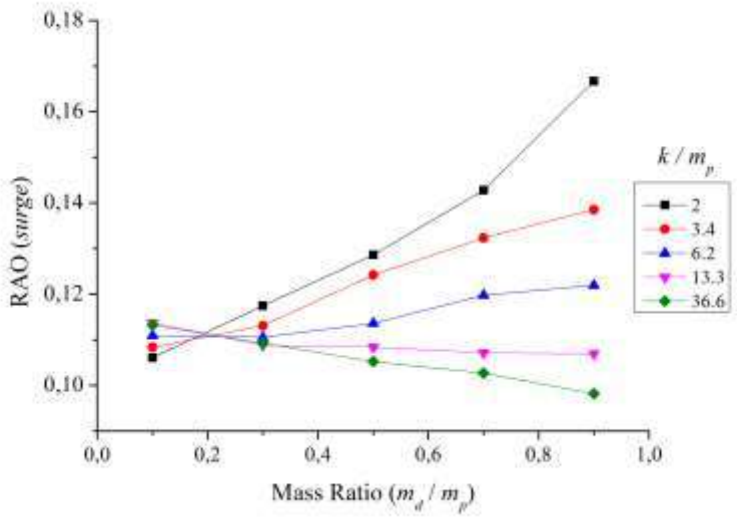


(a) (b)

Figure 8(a). The recorded realtime displacement data, (b) The amplitudo response in domain frequency

Comment [HE39]: 1. RAO (surge
2. Author(s) should make clearly each line description. Are these all experimental results?
3. In this figure, there are some data clearly put, it would be worthwhile to discuss this detail.

Comment [HE40]: The figure is not clear. Also, Author should make in Engli term.



. Figure 9. Amplitude response (RAO) to the mass ratio variation (m_d/m_p)

Comment [HE41]: RAO (surge)? Is this numerical result or experimental results? Please state in text.

4. Conclusion

The proposed new model, called TLP 2-DOF, has a relatively stable dynamic response when compared to the existing model. Thus this model can be an alternative solution to field conditions with extreme waves. For a more optimal design, it is necessary to optimize the ratio of mass of the deck to the mass of the pontoon. As example, in this study the optimum ratio is 0,2.

Comment [HE42]: In this part, Author(s) should state firstly the objecti of the present study.
Also, Author(s) should clearly make conculison the new model, and then the characteristics of the new model.

Acknowledgment

The authors would like to acknowledge the Research Institute ("LPPM Universitas Lampung"), for funding this research under the scheme of "Penelitian Unggulan BLU 2019".

References

[1] I. Senjanović, M. Tomić, and S. Rudan, "Investigation of nonlinear restoring stiffness in dynamic analysis of tension leg platforms," *Eng. Struct.*, vol. 56, pp. 117–125, 2013.

[2] X. Song, S. Wang, H. Li, and T. Li, "Investigation of the Hydrodynamic Performance of a Novel Semi-Submersible Platform with Multiple Small Columns," *J. Ocean Univ. China*, vol. 18, no. 1, pp. 108–122, 2019.

[3] M. Rudman and P. W. Cleary, "Rogue wave impact on a tension leg platform: The effect of wave incidence angle and mooring line tension," *Ocean Eng.*, vol. 61, pp. 123–138, Mar. 2013, doi: 10.1016/j.oceaneng.2013.01.006.

[4] M. Lou, C. Yu, and P. Chen, "Dynamic response of a riser under excitation of internal waves," *J. Ocean Univ. China*, vol. 14, no. 6, pp. 982–988, Dec. 2015, doi: 10.1007/s11802-015-2701-2.

[5] N. Abdussamie, Y. Drobyshevski, R. Ojeda, G. Thomas, and W. Amin, "Experimental investigation of wave-in-deck impact events on a TLP model," *Ocean Eng.*, vol. 142, pp. 541–562, 2017.

[6] S. Chandrasekaran and K. Yuvraj, "Dynamic analysis of a tension leg platform under extreme waves," *J. Nav. Archit. Mar. Eng.*, vol. 10, no. 1, pp. 59–68, Jun. 2013, doi: 10.3329/jname.v10i1.14518.

[7] S. Chandrasekaran and A. K. Jain, "Triangular configuration tension leg platform behaviour under random sea wave loads," *Ocean Eng.*, vol. 29, no. 15, pp. 1895–1928, 2002.

[8] S. Chandrasekaran, D. Kumar, and R. Ramanathan, "Dynamic response of tension leg platform with tuned mass dampers," *J. Nav. Archit. Mar. Eng.*, vol. 10, no. 2, pp. 149–156, 2013.
[9] D. Qiao, B. Li, and J. Ou, "Use of different mooring models on global response analysis of an innovative deep draft platform," *J. Ocean Univ. China*, vol. 13, no. 2, pp. 215–222, 2014.
[10] H. H. Lee and P.-W. Wang, "Analytical solution on the surge motion of tension-leg twin platform structural systems," *Ocean Eng.*, vol. 27, no. 4, pp. 393–415, 2000.
[11] Y.-M. Choi, B. W. Nam, S. Y. Hong, D. W. Jung, and H. J. Kim, "Coupled motion analysis of a tension leg platform with a tender semi-submersible system," *Ocean Eng.*, vol. 156, pp. 224–239, 2018.

Comment [HE43]: Author(s) should add some references to be 15 updated references.

KAPAL
Jurnal Ilmu Pengetahuan dan Teknologi Kelautan
2301-9069 (e)
1829-8370 (p)
journal homepage : http://ejournal.undip.ac.id/index.php/kapal

New model of tension leg platform for extreme wave applications

Commented [AT1]: New model is too strong, please consider it

Abstract

Commented [AT2]: Abstract is in between 200-250 words

Tension Leg Platform (TLP) is an offshore platform structure that is usually used for deep sea oil and gas exploration. The main structure of the TLP consists of a deck, pontoon, mooring system and foundation. The working principle balances the buoyancy force, the weight of the structure and the tension of the mooring rope. The problem is the use of TLP in the deep sea where sometimes extreme waves appear with various strange behaviors, which can damage the TLP structure. This paper proposes a new model of TLP that is more stable to wave forces. The working principle is to separate the mass of the deck and the mass of the pontoon into two flexible parts, which are connected by cantilever spring system. Thus the TLP displacement becomes two degrees of freedom (TLP 2-DOF). Furthermore, the TLP 2-DOF model was developed into a dynamic damping system (Dynamic Vibration Absorber / DVA). The design parameters were optimized to minimize the operator amplitude response (RAO) on the deck, with the pontoon mass being considered as damping mass.

Commented [AT3]: Response amplitude operator

Commented [AT4]: General conclusion/ result have to added to abstract

Keywords : TLP; 2-DOF system; Dynamic Vibration Absorber; Optimization; RAO.

1. Introduction

Tension Leg Platform (TLP) is an offshore platform that is "compliant structure", floating above sea level because the buoyancy force is greater than the weight of the structure. The main components of the TLP are the pontoon, deck, mooring system and foundation. In the installed condition, deck position is above sea level while the pontoon is submerged in sea water. The overall structure is tethered to the seabed by mooring ropes. TLP is usually used for deep sea oil / gas exploration activities. In the past, the TLP was installed at a depth of only 147 m [1] and now TLP has been installed at a depth of more than 1500 m [2].

In the operation of TLP in the deep sea, sometimes there are extreme waves that look strange and are "out of nowhere" [3]. For example, in the South China Sea there are frequent extreme waves known as internal waves. Internal waves are floating waves caused by variations in water density, propagating in the boundary layer of warm water and cold water below. It can propagate in many ways, including: short regular waves, cnoidal and solitary waves and internal tidal waves [4]. Recently, the phenomenon of extreme waves has become a concern because it has a potential to damage structures. For example, in the period 2004-2005, hurricanes Ivan, Katrina and Rita in the Gulf of Mexico destroyed 126 offshore structures and damaged 83 others [5].

Researchers have also attempted to study the relationship between extreme waves and dynamic TLP responses. For example Rudman and Cleary (2013) have conducted simulations and analyzes on rogue wafes inpact and its effect on angle and rope tension [3]. The interaction between extreme waves and TLP results in complex dynamics, affecting buoyancy, rope tension and rotational motion. Chandrasekaran (2013) also analyzes TLP dynamics under wave extremes [6]. It is known that the dynamic response of

Commented [AT5]: Uses journal template for citation

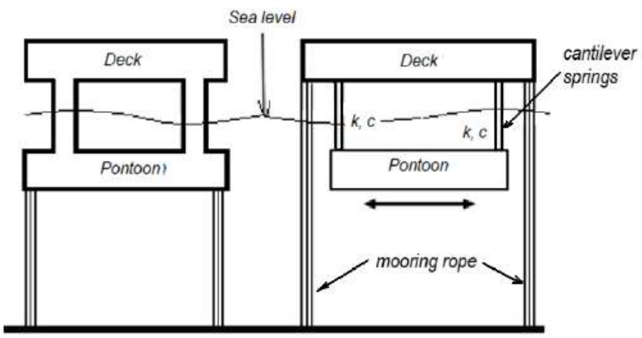
Commented [AT6]: Uses journal template for citation the TLP is sensitive to extreme waves at high degrees of freedom and an operating frequency nearly the same as the natural wave frequency.

Many efforts to improve the design concept have been carried out by making design innovations. Among them, modifying the TLP geometry to be triangular [7], adding and adjusting the mass of dampers [8] and proposing a new model of mooring system configuration [9]. In addition, there are also those who propose a design for tension-leg twin platform structural systems [10]. However, besides having advantages, those design concepts also have several weaknesses. For example, the design of the Tension-leg twin platform structural systems proposed by Choi, Y. M. et al (2018) depends on the ratio of the distance of the two pontoon and wavelength, which at a certain number actually increases the resulting dynamic response [11]. For these reasons, this study will discuss a new design that is different from the previous designs, called the Tension Leg Platform Two Degree Of Freedom (TLP 2-DOF), which is relatively more stable to wave force.

2. Methods

2.1. Models and assumptions

In the existing model, the deck and pontoon form a single unit into a rigid body. In the proposed TLP 2-DOF model, the deck and pontoon are made into two separate masses which are connected by a cantilever spring system. This separation allows a flexible structure and movement in the direction of the waves (*surge*) to be modeled as a two degree of freedom (2-DOF) system. Optimization of the design can be done with the principle of Dynamic Vibration Absorber / DVA where the pontoon is considered as a damper to stabilize the deck motion. Figure 1 (a) and Figure 1 (b) show the TLP exixting model and the TLP 2-DOF model, respectively. To see the performance improvement, a comparison study was carried out between the two models. The test set-up is shown in Figure 2 and the test specifications are given in Table-1.



(a) (b)

Figure 1. TLP (a) The Existing Model and (b) The 2-DOF Model

Commented [AT7]: Please give more reason why TLP is sensitive to extreme wave

Commented [AT8]: same issue as mentioned before

Commented [AT9]: why this more stable? Please give more explaination and comparison with other why this more stable

Commented [AT10]: this is strange, how the deck is float without buoyancy? The pontoon itself as buoyancy support for the deck, please expain it. Spring is known as damper, but in the sea wave is random and almost happened all the time? Can you elaborate about it

Formatted: English (United Kingdom)

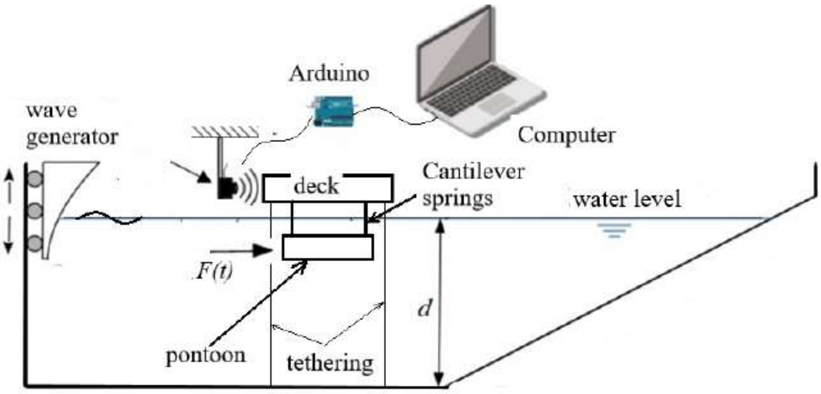


Figure 2. Test set-up

Tabel 1. The test specifications

Magnitude	value
Deck mass (m_d)	0,3 kg
Ponton mass (m_p)	0.9 kg
Cantilever spring stiffness (k_{tot})	9,537 N/m
Excitation frequency (ω)	9,77 rad/s
Excitation force (F_p)	0,242 N

2.2. Mathematical model for determining natural frequencies

Determining the natural frequency is necessary to anticipate the resonance phenomenon during operation. The analysis is carried out referring to the free body diagram (FDB) shown in Figure 3. If the damping factor of the structure is neglected, the equations of translational and rotational motion are as written in Equation (1) and Equation (2), respectively. With the stiffness matrix method, equations (1) and (2) can be solved to obtain equation (3). The next solution is carried out by calculating Equation (4) and Equation (5) and the equations of motion are obtained as written in Equation (6) and Equation (7).

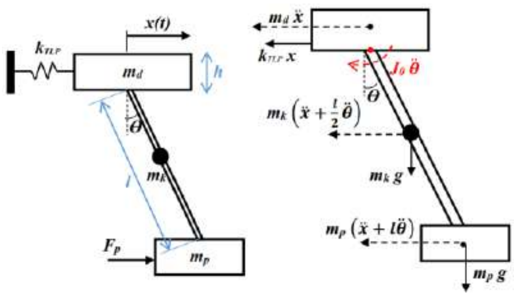


Figure 3. Free Body Diagram of TLP 2-DOF model

$$m_d\ddot{x} + m_k\left(\ddot{x} + \frac{l}{2}\ddot{\theta}\right) + m_p(\ddot{x} + l\ddot{\theta}) + k_{TLP}x = 0$$
$$(m_d + m_k + m_p)\ddot{x} + \left(m_k\frac{l}{2} + m_p l\right)\ddot{\theta} + k_{TLP}x = 0 \quad (1)$$

$$\Sigma M = 0$$

$$J_0\ddot{\theta} - m_d\frac{h}{2}\ddot{x} + m_k\left(\ddot{x} + \frac{l}{2}\ddot{\theta}\right)\frac{l}{2} + m_p(\ddot{x} + l\ddot{\theta})l + m_k g\frac{l}{2}sin\theta$$
$$+m_p gl\ sin\theta = 0$$

$$m_k\frac{l^2}{12}\ddot{\theta} + \left(-m_d\frac{h}{2} + m_k\frac{l}{2} + m_p l\right)\ddot{x} + \left(m_k\frac{l^2}{4} + m_p l^2\right)\ddot{\theta}$$
$$+m_k g\frac{l}{2}sin\theta + m_p gl\ sin\theta = 0 \quad (2)$$

$$\left(-m_d\frac{h}{2} + m_k\frac{l}{2} + m_p l\right)\ddot{x} + \left(m_k\frac{l^2}{3} + m_p l^2\right)\ddot{\theta}$$
$$+\left(m_k g\frac{l}{2} + m_p gl\right)\theta = 0$$

$$\begin{bmatrix} m_d + m_k + m_p & m_k\frac{l}{2} + m_p l \\ -m_d\frac{h}{2} + m_k\frac{l}{2} + m_p l & m_k\frac{l^2}{3} + m_p l^2 \end{bmatrix}\begin{Bmatrix}\ddot{x}\\ \ddot{\theta}\end{Bmatrix} + \begin{bmatrix} k_{TLP} & 0 \\ 0 & m_k g\frac{l}{2} + m_p gl \end{bmatrix}\begin{Bmatrix}x\\ \theta\end{Bmatrix} = 0 \quad (3)$$

$$x = A_1 \sin\omega t \text{ ---->} \quad \ddot{x} = -A_1\,\omega^2 \sin\omega t \quad (4)$$

$$\theta = A_2\ sin\ \omega \text{ ---->} \quad \ddot{\theta} = -A_2\,\omega^2 \sin\omega t \quad (5)$$

$$\begin{bmatrix} m_d + m_k + m_p & m_k\frac{l}{2} + m_p l \\ -m_d\frac{h}{2} + m_k\frac{l}{2} + m_p l & m_k\frac{l^2}{3} + m_p l^2 \end{bmatrix}\begin{Bmatrix}-A_1\omega^2\\ -A_2\omega^2\end{Bmatrix}\sin\omega t$$
$$+\begin{bmatrix} k_{TLP} & 0 \\ 0 & m_k g\frac{l}{2} + m_p gl \end{bmatrix}\begin{Bmatrix}A_1\\ A_2\end{Bmatrix} sin\ \omega t = 0 \quad (6)$$

$$\begin{bmatrix} -m_d\omega^2 - m_k\omega^2 - m_p\omega^2 + k_{TLP} & -m_k\frac{l}{2}\omega^2 - m_p l\omega^2 \\ m_d\frac{h}{2}\omega^2 - m_k\frac{l}{2}\omega^2 - m_p l\omega^2 & -m_k\frac{l^2}{3}\omega^2 - m_p l^2\omega^2 + m_k g\frac{l}{2} + m_p gl \end{bmatrix} = 0 \quad (7)$$

2.3 Numerical Solution

Equation (7) which is known as the characteristic equation can be expressed in the matrix as Equation (8) and Equation (9). This equation is a second order differential equation so that it can be converted into first order (state-space form). If the form of the equation is taken to be Equation (10), the next solution can be seen in Eq. (11, 12 and 13). If solved by numerical method by direct integration using finite difference method, the solution is obtained as Equations (14 and 15).

$$\begin{bmatrix} m_d+m_k+m_p & m_k\frac{l}{2}+m_p l \\ -m_d\frac{h}{2}+m_k\frac{l}{2}+m_p l & m_k\frac{l^2}{3}+m_p l^2 \end{bmatrix}\begin{Bmatrix} \ddot{x} \\ \ddot{\theta} \end{Bmatrix}+\begin{bmatrix} k_{tlp} & 0 \\ 0 & m_k g\frac{l}{2}+m_p g l \end{bmatrix}\begin{Bmatrix} x \\ \theta \end{Bmatrix}=\begin{Bmatrix} 0 \\ F_d \cos \omega t \end{Bmatrix} \quad (8)$$

$$[M]\,\ddot{\vec{x}} + [K]\,\vec{x} = \vec{F}_{(t)} \quad (9)$$

$$\dot{\vec{Y}} = \begin{Bmatrix} \ddot{\vec{x}} \\ \dot{\vec{x}} \end{Bmatrix}, \quad \vec{Y} = \begin{Bmatrix} \dot{\vec{x}} \\ \vec{x} \end{Bmatrix} \quad (10)$$

$$\begin{bmatrix} [M] & [0] \\ [0] & [I] \end{bmatrix}\begin{Bmatrix} \ddot{\vec{x}} \\ \dot{\vec{x}} \end{Bmatrix} + \begin{bmatrix} [C] & [K] \\ [-I] & [0] \end{bmatrix}\begin{Bmatrix} \dot{\vec{x}} \\ \vec{x} \end{Bmatrix} = \vec{F}_{(t)} \quad (11)$$

$$[A]\,\dot{\vec{Y}} + [B]\,\vec{Y} = \vec{F}_{(t)} \quad (12)$$

$$\dot{\vec{Y}} = [A]^{-1}\left(\vec{F}_{(t)} - [B]\,\vec{Y}\right) \quad (13)$$

$$\frac{\vec{Y}_{(t+1)}-\vec{Y}_{(t)}}{\Delta t} = [A]^{-1}\left(\vec{F}_{(t)} - [B]\,\vec{Y}_{(t)}\right) \quad (14)$$

$$\vec{Y}_{(t+1)} = \vec{Y}_{(t)} + \Delta t \left([A]^{-1}\left(\vec{F}_{(t)} - [B]\,\vec{Y}_{(t)}\right)\right) \quad (15)$$

2. 4. Experimental studies

The experimental equipment is a pool of water as a medium for waves. The wave generator engine consists of an exciter driven by a connecting rod connected to an eccentric rotor. The waves oscillate at a frequency of 1.55 Hz. In this test, the displacement of the existing TLP and TLP 2-DOF models were measured respectively and a comparative study was carried out. Displacement is measured using an ultrasonic sensor device. Figure 4(a) shows water waves as a medium, and Figure 4(b) shows the new model (TLP 2-DOF) and the existing model. Test equipment specifications and wave specifications are shown in Table 2.

(a) (b)

Figure 4. (a) Water waves as a medium, and (b) The new model (TLP 2-DOF) and the existing model.

Tabel 2. Test equipment and wave specifications

Magnitude	value
Pool length (p)	200 cm
Pool width (l)	60 cm
Pool height (t)	80 cm
Water level/height (h)	60 cm
Wave direction	Horizontal (*surge*)
Wave amplitude (A)	5 cm
Wavelength (λ)	35 cm
Wave frequency (f_w)	9,77 rad/s (1,55 Hz)

3. Results And Discussion

Before discussing further, it needs to be reminded first that the dynamic response in question is that which is measured on the deck component. The dynamic response is expressed in the response amplitude operator (RAO). In this case, RAO is defined as the ratio of TLP displacement (deck) to wave amplitude. The design is carried out to minimize the amplitude response of the deck components, because this component is used for operational activities.

3.1.Natural Frequency

The natural frequency of the TLP 2-DOF model is obtained by solving the characteristic equation and the two lowest frequencies can be seen in Table 4. When compared to TLP on a real scale, of course this natural frequency is classified as large, this is due to the small mass of the model. This is not a problem because actually the TLP scale has a large mass so that the natural frequency is small. Natural frequency is affected by the ratio of the mass of the deck to the mass of the pontoon (m_d/m_p). If mass of the deck become smaller, then the natural frequency will be larger. This is true according to the well known formula of natural frequency wich is inversly proportional to the root square of mass, as shown in Equation (16).

$$f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}. \quad (1)\ (16)$$

Tabel 4. Frequency of the TLP 2-DOF model

Ratio (m_d/m_p)	Natural frequency f1	f2
1:3	0,587 hz	2,831 hz
1:2	0,562 hz	2,431 hz
2:3	0,539 hz	2,202 hz
1:1	0,501 hz	1,946 hz

3.2 Comparison of the new model vs the existing model

Figure 5 shows a graph of the amplitude response of the new model and the existing model. Resonance occurs at the first natural frequency and the second natural frequency, around 0.587 and 2.831, respectively. The graph was plotted for mass ratio (m_d:m_p) of 1:3. At resonance conditions, the dynamic response of the new model is only 0.4 times the existing model, the RAO new model is about 1. It should be noted that the real TLP does not operate in the resonant state. Outside the resonance region, it can be seen that the RAO response is much smaller. From this discussion it is concluded that this model (TLP-2-DOF) can be considered for application in extreme ocean waves.

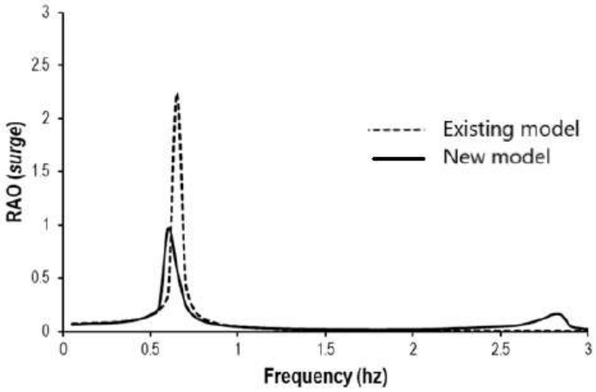


Figure 5. The dynamic response comparison between the new model and the existing model

3.3. Experimental validation

Experimental validation is required to check the accuracy of the analytical method. Figure 6 shows the dynamic response comparison between theoretical and experimental. Both charts display good agreement and a corresponding resonance phenomenon occurs at a wave frequency of around 0.587 Hz.

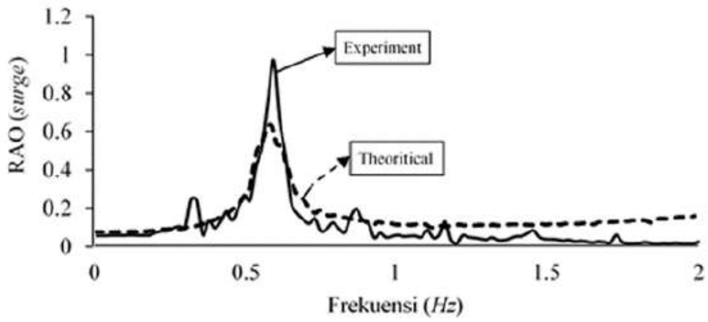


Figure 6. The dynamic response comparison between theoretical and experimental

3.4 Effect of mass ratio ratio

The smaller the mass ratio (m_d/m_p), the greater the natural frequency. This is indicated by the position of the peak moving to the right as the ratio m_d/m_p become smaller. In addition, the relatively small deck mass resulted in a smaller RAO (except at $m_d/m_p = 1$).

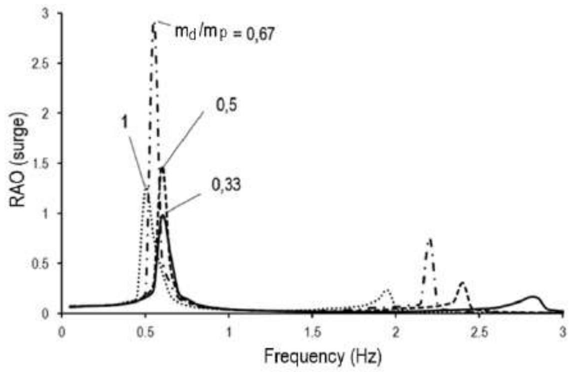
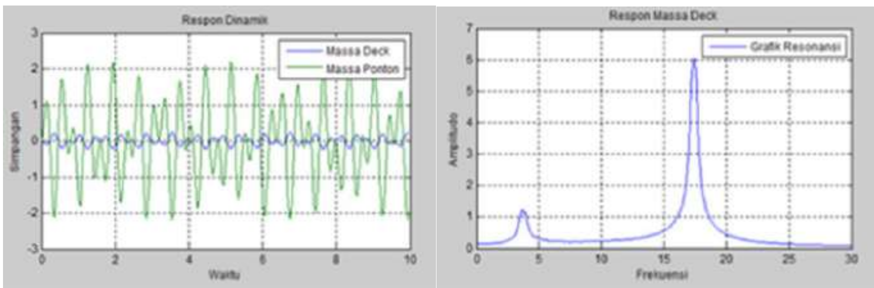


Figure 7. The effect of mass ratio (m_d/m_p) on dynamic response

3.5. Optimization

To get the optimal design, optimization of the mass ratio (m_d/m_p) is carried out to minimize the RAO value on the deck. The optimization process is carried out using the numerical method. Figure 8(a) shows recorded realtime displacement data and Figure 8(b) shows amplitudo response in domain frequency. Amplitude response (RAO) to the mass ratio variation (m_d/m_p) is shown in Figure 9. In this case, the best ratio of the mass of the deck to the mass of the pontoon (m_d/m_p) is about 0.2 where RAO becomes about 0.15. The excitation frequency given is 1.55 Hz, according to the frequency of the waves on the test equipment.

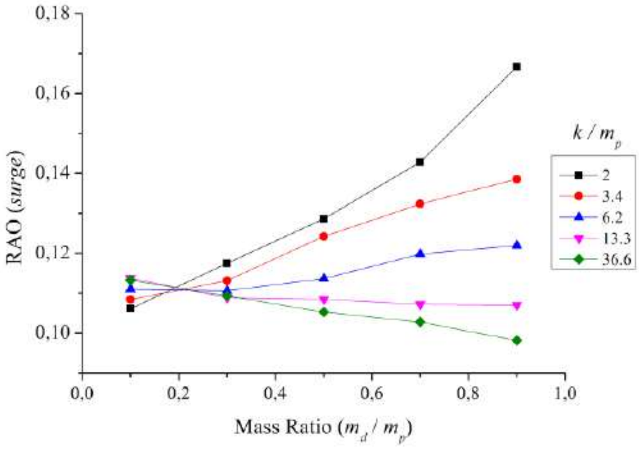
Commented [AT11]: please added the tool to record displacemen data



(a) (b)

Figure 8(a). The recorded realtime displacement data, (b) The amplitudo response in domain frequency

Commented [AT12]: please uses high resolution pictures



. Figure 9. Amplitude response (RAO) to the mass ratio variation (m_d/m_p)

4. Conclusion

The proposed new model, called TLP 2-DOF, has a relatively stable dynamic response when compared to the existing model. Thus this model can be an alternative solution to field conditions with extreme waves. For a more optimal design, it is necessary to optimize the ratio of mass of the deck to the mass of the pontoon. As example, in this study the optimum ratio is 0,2.

Commented [AT13]: Need more explaination, this conclusion too short. Optimization item is not yet mentioned

Acknowledgment

The authors would like to acknowledge the Research Institute ("LPPM Universitas Lampung"), for funding this research under the scheme of "Penelitian Unggulan BLU 2019".

References

Commented [AT14]: Add more references at least 17 or more, using the latest references (5 years)

[1] I. Senjanović, M. Tomić, and S. Rudan, "Investigation of nonlinear restoring stiffness in dynamic analysis of tension leg platforms," *Eng. Struct.*, vol. 56, pp. 117–125, 2013.
[2] X. Song, S. Wang, H. Li, and T. Li, "Investigation of the Hydrodynamic Performance of a Novel Semi-Submersible Platform with Multiple Small Columns," *J. Ocean Univ. China*, vol. 18, no. 1, pp. 108–122, 2019.
[3] M. Rudman and P. W. Cleary, "Rogue wave impact on a tension leg platform: The effect of wave incidence angle and mooring line tension," *Ocean Eng.*, vol. 61, pp. 123–138, Mar. 2013, doi: 10.1016/j.oceaneng.2013.01.006.
[4] M. Lou, C. Yu, and P. Chen, "Dynamic response of a riser under excitation of internal waves," *J. Ocean Univ. China*, vol. 14, no. 6, pp. 982–988, Dec. 2015, doi: 10.1007/s11802-015-2701-2.
[5] N. Abdussamie, Y. Drobyshevski, R. Ojeda, G. Thomas, and W. Amin, "Experimental investigation of wave-in-deck impact events on a TLP model," *Ocean Eng.*, vol. 142, pp. 541–562, 2017.
[6] S. Chandrasekaran and K. Yuvraj, "Dynamic analysis of a tension leg platform under extreme waves," *J. Nav. Archit. Mar. Eng.*, vol. 10, no. 1, pp. 59–68, Jun. 2013, doi: 10.3329/jname.v10i1.14518.
[7] S. Chandrasekaran and A. K. Jain, "Triangular configuration tension leg platform behaviour under random sea wave loads," *Ocean Eng.*, vol. 29, no. 15, pp. 1895–1928, 2002.

[8] S. Chandrasekaran, D. Kumar, and R. Ramanathan, “Dynamic response of tension leg platform with tuned mass dampers,” *J. Nav. Archit. Mar. Eng.*, vol. 10, no. 2, pp. 149–156, 2013.
[9] D. Qiao, B. Li, and J. Ou, “Use of different mooring models on global response analysis of an innovative deep draft platform,” *J. Ocean Univ. China*, vol. 13, no. 2, pp. 215–222, 2014.
[10] H. H. Lee and P.-W. Wang, “Analytical solution on the surge motion of tension-leg twin platform structural systems,” *Ocean Eng.*, vol. 27, no. 4, pp. 393–415, 2000.
[11] Y.-M. Choi, B. W. Nam, S. Y. Hong, D. W. Jung, and H. J. Kim, “Coupled motion analysis of a tension leg platform with a tender semi-submersible system,” *Ocean Eng.*, vol. 156, pp. 224–239, 2018.

KAPAL
JURNAL ILMU PENGETAHUAN & TEKNOLOGI KELAUTAN
ISSN: 1829-8370 (Print); 2301-9069 (Online) Terindeks di Google scholar, DOAJ dan Portal Garuda
S-1 Teknik Perkapalan – Fakultas Teknik Undip Kampus Tembalang – Semarang
Telp. 024-7680784, Fax. 024 7460055e-mail : kapal.ft.undip.ac.id
http://ejournal.undip.ac.id/index.php/kapal

Revision Form

Title	**New model of tension leg platform for extreme wave applications**
Reviewer	*Please fill in the reviewers who are giving comments (#A / #B)*
	#A. Comment [HE1]:First of all, the title should be relevant with the investigation study. #B. Commented [AT1]: New model is too strong, please consider it Revision: **The TLP 2-DOF as an alternative model for extreme wave application**

Abstract

No	Reviewer comments	Revision
1	#A. Comment [HE2]: The subject should be mentioned	Revised Before:The working principle balances the buoyancy force After: TLP operates in a balance of buoyancy
2	#A. Comment [HE3]Perhap “use” is replace with “construction”.	Before:The problem is the use of TLP… After: The problem is the construction of TLP…
3	#A. Comment [HE4]It should be mentioned, what are kind strange behaviors?	the word "strange behaviors" was removed and revised editorial
4	#A. Comment [HE5]Perhaps after this sentence, the design process of a new model should be explained shortly.	revised and added explanatory sentences
5	#A. Comment [HE6]Author(s) should state shortly the present results after these sentences.	Done. this has added the current result
6	#B. Commented [AT2]: Abstract is in between 200-250 words	Done. the number of words became 203
7	#B. Commented [AT3]: Response amplitude operator	revised
8	#B. Commented [AT4]: General conclusion/ result have to added to abstract	Done. This has added the general conclusion/result

1. Introduction

No	Reviewer comments	Revision
1	#A. Comment [HE7]: Author(s) should make the last paragraph that explains the purpose of the study and short method on how to obtain the present results.	Done.
2	#B. Commented [AT5]: Uses journal template for citation	done
3	#B. Commented [AT6]: Uses journal template for citation	done
4	#B. Commented [AT7]: Please give more reason why TLP is sensitive to extreme wave before	revised and added explanatory sentences
5	#B. Commented [AT8]: same issue as	done

KAPAL
JURNAL ILMU PENGETAHUAN & TEKNOLOGI KELAUTAN
ISSN: 1829-8370 (Print); 2301-9069 (Online) Terindeks di Google scholar, DOAJ dan Portal Garuda
S-1 Teknik Perkapalan – Fakultas Teknik Undip Kampus Tembalang – Semarang
Telp. 024-7680784, Fax. 024 7460055e-mail : kapal.ft.undip.ac.id
http://ejournal.undip.ac.id/index.php/kapal

	mentioned	
6	#B. Commented [AT9]: why this more stable? Please give more explaination and comparison with other why this more stable	revised and corrected sentences

2. Method

No	Reviewer comments	Revision
1	#A. Comment [HE8]: Author(s) should explained clearly this sentences. Author(s) shoud state an additional or supporting sentence. Furthermore, what is the meaning of surge of wave direction? Could Author(s) make coordinate system?	Revised. The supporting sentence has been added
2	#A. Comment [HE9]: Author(s) should make more explanation regarding the measurment method and divices.	done
3	#A. Comment [HE10]: Author(s) should provide the main dimensions of TLP, existing and new model.	Done, added table 1
4	#A. Comment [HE11]: Perhaps it is replaced to be "Description".	done
5	#A. Comment [HE12]: Author(s) should state the decription of elemnts of the diagram.	done
6	#A. Comment [HE13-19]: Author(s) should provide the meaning of each equation component, equation 1 to 7.	done
7	#A. Comment [HE20-25]: Author(s) should provide the description of each equation elemnt, eqaution 8 to 15.	done
8	#A. Comment [HE26]: What are the kind of displacment. Perhaps, they should be mentioned obviously.	Before: In this test, the displacement of… After: In this test, the horizontal motion (x-direction) of…
9	#A. Comment [HE27]: Please change it with "Description"	Done
10	#B. Commented [AT10]: this is strange, how the deck is float without buoyancy? The pontoon itself as buoyancy support for the deck, please expain it. Spring is known as damper, but in the sea wave is random and almost happened all the time? Can you elaborate about it	Before: In the existing model, the deck and pontoon form a single unit into a rigid body. In the proposed TLP 2-DOF model, the deck and pontoon are made into two separate masses which are connected by a cantilever spring system. After: The buoyancy of the pontoon works to support the deck, as well as to act as a damping mass. (This sentence is moved to the last paragraph of the introduction)

3. Results and Discussion

No	Reviewer comments	Revision
1	#A. Comment [HE28]: Please check the	revised

KAPAL
JURNAL ILMU PENGETAHUAN & TEKNOLOGI KELAUTAN
ISSN: 1829-8370 (Print); 2301-9069 (Online) Terindeks di Google scholar, DOAJ dan Portal Garuda
S-1 Teknik Perkapalan – Fakultas Teknik Undip Kampus Tembalang – Semarang
Telp. 024-7680784, Fax. 024 7460055e-mail : kapal.ft.undip.ac.id
http://ejournal.undip.ac.id/index.php/kapal

	instruction for author	
2	#A. Comment [HE29]: What is "it" refer to?	Before: it needs to… After: revised sentence
3	#A. Comment [HE30]: Please check this grammar	Before: response in question is that which is measured on the deck component. After: revised sentence
4	#A. Comment [HE31]: I think there are two kinds of displacement, are the RAO definition used for both of them?	The definition of RAO is only used for deck movement as the primary mass, revised!
5	#A. Comment [HE32]: Author(s) should provide the description of each equation elemnt.	done
6	#A. Comment [HE33]: Author(s) should state in text these elements.	done
7	#A. Comment [HE34]: What is RAO (surge)??? RAO is a nondimensional patrameter.	revised
8	#A. Comment [HE35]: RAO (surge)? Why does theoritical result appear suddenly in this figure? In sub section 2.3, Author(s) have expalined regarding the numerical solution.	revised
9	#A. Comment [HE36]: Please check its grammar. The discussion is very short, and there are some data that clearly put in Figure 7, it would be worthwhile to discuss this detail.	Revised
10	#A. Comment [HE37]: RAO (surge)? Author(s) should make clearly each line description. Are these all experimental results? In this figure, there are some data that clearly put, it would be worthwhile to discuss this detail.	Before: RAO (surge) After: RAO horizontal motion Revised, more detailed explanation sentences
11	#A. Comment [HE38]: The figure is not clear. Also, Author should make in English term.	done
12	#A. Comment [HE39]: RAO (surge)? Is this numerical result or experimental results? Please state in text.	Before: RAO (surge) After: RAO horizontal motion
13	#B. Commented [AT11]: please added the tool to record displacemen data	done
14	#B Commented [AT12]: please uses high resolution pictures	done

4. Conclusion

No	Reviewer comments	Revision
1	#A. Comment [HE40]: In this part, Author(s) should state firstly the objectives of the present study. Also, Author(s) should clearly make	done

KAPAL
JURNAL ILMU PENGETAHUAN & TEKNOLOGI KELAUTAN
ISSN: 1829-8370 (Print); 2301-9069 (Online) Terindeks di Google scholar, DOAJ dan Portal Garuda
S-1 Teknik Perkapalan – Fakultas Teknik Undip Kampus Tembalang – Semarang
Telp. 024-7680784, Fax. 024 7460055e-mail : kapal.ft.undip.ac.id
http://ejournal.undip.ac.id/index.php/kapal

	conculison the new model, and then the characteristics of the new model.	
2	#A. Comment [HE41]: Author(s) should add some references to be 15 updated references.	Done

5. Overall Comments

No	Reviewer comments	Revision
	-	