## ABSTRACT

## MODELLING OF A 2-DOF (TWO DEGREE OF FREEDOM) TENSION LEG PLATFORM THAT IS MORE STABLE AGAINST WAVE DISTURBANCES

**By**

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Tension Leg Platform (TLP) is an offshore platform structure that floats due to buoyancy that is greater than the overall weight of the structure. TLP is generally used for oil and gas drilling (exploration) activities. The TLP structure consists of a deck, a pontoon, tendon ropes and a foundation. In the existing TLP model, the deck and pontoon is a rigid body with structures characteristics that do not stand waves (flows with the direction of the waves) so that the structure vibrates which damages the structure and drilling equipments.

In this research, a new TLP model (laboratory scale) was designed with a separation between the deck and the pontoon that connected by springs so that the structure is more flexible. This separation method is known as the two-degree of freedom system (2-DOF) which is developed into the dynamic damping system (Dynamic Vibration absorber / DVA). With the DVA method, design parameters can be optimized so that the disturbance of the water wave is completely muted by the mass of the immersed ponton.

The results of research showed that the best solution for the new TLP model (TLP 2-DOF) that was able to reduce the dynamic response was the deck: pontoon mass ratio of 1: 3 (0.3 kg: 0.9 kg) and spring constant 34,3808 N/m. At water frequency disturbance of 1.55 hz and 1.74 hz, the TLP 2-DOF model is able to reduce vibrations on the deck up to 57% in the horizontal direction (surge) as evidenced by numerical simulations using ANSYS. On the experimental results the TLP 2-DOF model were able to reduce deck vibrations up to 18.59% at 1.55 hz water frequency and 21.96% at 1.74 hz water frequency. The difference of numerical simulation and experimental values was caused by different conditions

where the interference force numerical simulation is assumed to be stable while in the experimental tests the interference force originating from the waves is relatively unstable.

**Keywords :** 2-DOF system, Deck, Dynamic Vibration Absorber, Foundation, Ponton, Surge, Tendon, Tension Leg Platform.

# ABSTRAK

## MODEL *TENSION LEG PLATFORM 2-DOF* (*TWO DEGREE OF FREEDOM*) YANG LEBIH STABIL TERHADAP GANGGUAN OMBAK

**Oleh**

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*Tension Leg Platform* (TLP) merupakan struktur anjungan lepas pantai yang mengapung akibat gaya apung yang lebih besar daripada berat keseluruhan struktur. TLP umumnya digunakan untuk kegiatan pengeboran (eksplorasi) minyak dan gas. Struktur TLP terdiri dari *deck*, *ponton*, tali *tendon* dan fondasi. Pada model TLP yang sekarang (*existing*) antara *deck* dan *ponton* menjadi satu kesatuan (*rigid body*) dengan karakteristik struktur yang tidak menahan gelombang (mengikuti arah gelombang) sehingga keadaan struktur bergetar yang berpotensi merusak struktur dan peralatan pengeboran.

Pada penelitian ini dirancang model TLP baru (skala laboratorium) dengan pemisahan antara *deck* dan *ponton* yang dihubungkan dengan pegas sehingga strukturnya lebih fleksibel. Metode pemisahan ini dikenal dengan sistem dua derajat kebebasan (2-DOF) yang dikembangkan menjadi sistem peredam dinamik (*Dynamic Vibration Absorber*/DVA). Dengan metode DVA parameter-parameter rancangan bisa dioptimalisasi sehingga gangguan gelombang air sepenuhnya diredam oleh massa *ponton* yang terbenam.

Hasil penelitian menunjukkan bahwa solusi terbaik untuk model TLP baru (TLP 2-DOF) yang mampu meredam respon dinamik adalah rasio massa *deck* : massa *ponton* sebesar 1:3 (0,3 kg : 0,9 kg) dan konstanta pegas 34,3808 N/m. Pada frekuensi gangguan air 1,55 hz dan 1,74 hz model TLP 2-DOF ini mampu mereduksi getaran pada *deck* hingga 57% pada arah horizontal (*surge*) yang dibuktikan melalui simulasi numerik menggunakan ANSYS. Sedangkan pada hasil pengujian eksperimen model TLP 2-DOF mampu meredam getaran *deck* hingga 18,59 % pada frekuensi air 1,55 hz dan 21,96 % pada frekuensi air 1,74 hz.

Perbedaan nilai simulasi numerik dan eksperimen ini dikarenakan kondisi yang berbeda dimana pada simulasi numerik gaya gangguan diasumsikan stabil sedangkan pada pengujian eksperimen gaya gangguan yang berasal dari ombak relatif tidak stabil.

**Kata kunci :** 2-DOF *system, Deck, Dynamic Vibration Absorber,* Fondasi, *Ponton, Surge*, *Tendon, Tension Leg Platform.*