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Analysis of Floating Mooring Buoy as Platforms at Sea

Abstract: Analysis of the buoyancy of this platform for use in mid-ocean land survey operations where this platform is loaded with the weight of the tools and workers on the platform. The purpose of this research is to describe the buoyancy of the mooring buoys. The research was conducted by calculating the capacity and weight of each material used and the buoyancy of the buoy to be used as a platform for land surveys in mid-ocean, the ability of seawater to shift the size of the pontoon to be used as a platform and calculate the load on the pontoon itself to obtain the buoyancy value of the pontoon. The ability of the strapping between the pontoon and the anchor was calculated to anticipate unstable pontoon motion and must have a stress capability that exceeds the stress experienced when the pontoon is hit by a wave. The tension in the chain is greatest force is assumed, namely the force of the ballast. When the earthworks pontoon capacity is used as mooring buoy by estimating the total weight of the earthworks pontoon capacity, it is still in a semi-floating condition, although under certain conditions it will drop to as much as 95% of the estimated buoyancy pressure capacity of the mourning buoy.

Keywords: bouy, floating, platform

INTRODUCTION

Buoy is a marker that is placed in the sea to prevent the ship from docking due to the shallow sea. Buoys are generally light in color to make them easy to spot from a distance. The mooring buoy, is a type of buoy used to moor ships in the sea area to allow large ships that cannot dock at the dock to still carry out loading and unloading activities. Mooring buoys have the heaviest weight among other types of buoys. An open water research platform requires safe surroundings to protect instruments from other lake activities, suchas fishing, transportation, and recreation. Close proximity of the sensors to the platform simplifies instrument opera-tion, maintenance, and data transfer. The platform itself should provide safe and spacious working conditions includinga shelter, personal facilities, and a motion-dampened workspace. Operating in direct contact with the lake environ-ment, the platform laboratory is especially useful for using instrument components that are not sealed in watertightapparatus. The platform size should accommodate a team of researchers (or even multiple teams) and thus supportsinterdisciplinary research. A large pontoon mass reduces buffeting and movements to levels suitable for stable atmo-spheric measurements and optical remote sensing, which require fixed or at least controlled positioning for preciseobservations. (Boo et al., 2018; Figueroa-Lara et al., 2019; Nair et al., 2018; Wüest et al., 2021). The obtained result shows that increasing stretch of mooring line could reduce motions of the platform, while increase the mooring line tension. Also increase in buoy size increases the amplitude

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of semi-submersible motion and decreases mooring line tension. (Ghafari & Dardel, 2018; Song et al., 2016).

The platform design is based on industry standards and rules. The wind turbines are installed on four columns located at each corner of the platform while the WECs are placed at the peripheral locations between semi pontoon and deck. The WECs are vertically supported by frames and the vertical linear WEC generators are integrated inside the deck (Barrera et al., 2019). Design of the unconventional size of platform faces many design challenges in configuration of the system, structural design, wind turbine wake effects, constructability, loadout, WEC structures, multi-turbine and platform coupled response, mooring system design and power cable and such design challenges are discussed. Brief results of the motion responses, mooring analysis, structural analysis and power cable analysis are also described. (Boo et al., 2016; Boo et al., 2021). Mooring buoys are often placed in the middle of the sea to allow ships to dock temporarily. When the sea conditions are unsafe due to waves and strong winds, it is not excluded that the anchor buoy will be flung far away, sometimes even the chains tying the buoy cannot hold the buoy, resulting in the buoy floating away from the predetermined Location. Therefore each buoy is equipped with a GPS to locate and track the location of the buoy (Barbanti et al., 2019; Neisi, et al., 2022).

The key to the success of any mooring buoy system is regular maintenance. Each area requires different attention depending on the natural conditions. Therefore, the treatment plan should be flexible and based on local conditions. The mooring buoy is equipped with a manhole to carry out regular checks to ensure there are no leaks and the buoy is in good working order. It is important to analyze of the buoyancy of this platform for use in mid-ocean land survey operations where this platform is loaded with the weight of the tools and workers on the platform. Therefore, this research is aimed to describe the buoyancy of several mooring buoys.

METHODS

This study uses a qualitative method. In this study, research coverage only on the Single Point Mooring (SPM) model, or what we often hear, SBM (Single Buoy Mooring) is a floating buoy anchored offshore and a platform for laying hen inspection work represents and seabed conditions in the surrounding area. Single Point Mooring (SPM) later serves as a link between the facility on land and the earthmoving platform. Several SPM types based on API RP 2 SK, 2006 are Turret, Catenary Anchor Leg Mooring (CALM), Single Anchor Leg Mooring (SALAM), Vertical Anchor Leg Mooring (VALM) and Single Point Mooring Tower (SPMT). However, the most common SPM type in Indonesia is the Catenary Anchor Leg Mooring (CALM) type. (Ghafari & Dardel, 2018; Lat et al., 2022) The CALM buoy system consists of a large buoy supported by multiple strands of chain anchored to the seabed. The configuration of the CALM buoy has a howser connecting the tanker and the buoy. Additionally there is a riser configuration under the buoy. In its working system, the CALM buoy, with its lifting device, distributes oil from or to tankers moored by floating hoses.

RESULT AND DISCUSSION

The mooring function is basically to secure the position of the ship to keep it in place. Generally, the mooring systems used for FSO/FPSO (Floating Production Storage and Offloading) are spread mooring, turret mooring, tower mooring and buoy mooring. It could be said that spread mooring is the easiest way to moor FSO/FPSO as with this system it is not possible for the vessel to move/turn to reach a position where environmental influences such as wind, current and waves are relatively are low. However, this leads to a greater environmental impact on the ship, resulting in an increase in the number of mooring lines and/or line tension.

The devices used are usually devices that are generally already present on the ship. This system uses a series of anchor legs and mooring lines, usually located in the ship's bow and stern positions. Because the equipment used is relatively simple, no dry docking is required to modify the mooring system. Spread mooring can be applied to any type of vessel, but with due regard for the production facilities on board. At the Belanak Natuna FPSO which has Crude Oil and LPG production facilities above it, the fixed heading position is a very important requirement and hence a spread mooring system is used as the movement/rotation of the vessel will greatly affect the LPG production process. With this system, the offloading equipment is usually located at the bow or stern of the vessel, or using a buoy dedicated specifically for cargo transhipment.

Figure 1. Laying spreaders

In mooring tower, the ship is connected to a tower that uses bearings to allow the ship to turn. Compared to spread mooring, this system offers space for more risers and umbilicals. The anchor tower can be either an external tower or an internal tower. The external tower can be placed outside the hull in the ship's bow or stern position, allowing the ship to rotate 360 degrees and operate in normal and extreme weather conditions. Chain strand "planted" with anchors or stakes on the seabed. The crafting cost is cheaper than the internal turret and the modifications made to the ship are not too many. In addition to the turret position, another difference to the inner turret is the position of the chain table. The outer tower has the chain table above the waterline, while the inner tower has the chain table submerged below the waterline. In general, this system is used in not too deep waters and in relatively small fields Application example in Indonesia: FPSO Anoa Natuna.

The advantages of internal tower are that it can be permanently installed or not installed (disconnectable), can be used in moderate to extreme environmental conditions in the field and is suitable for deep water. This system can accommodate risers up to 100 units and sea depths to 10,000 feet. It seems that there are no examples of use in Indonesia. In Tower berth, the FSO/FPSO is connected to the tower with a permanent control arm or a permanent/temporary cable. Suitable for shallow to medium sea with fairly strong currents. The advantages are: (1) Easy liquid transfer with bridging hoses from tower to ship; (2) Direct access from ship to tower; (3) Not too many modifications to the ship; (4) All mechanical devices are above sea level. Application example in Indonesia: FSO Ladinda.

Figure 2. Mooring tower

In mooring buoy, a buoy is used as a mooring for ships and for offloading liquids. Its main purpose is to carry liquids from shore or other offshore facilities to the vessel at anchor. Its components include: (1) Booy Body, as a provider of stability and buoyancy; Mooring and anchor components that connect the buoy to the seabed and the cable that connects the buoy to the ship. According to observations, most of the damage to the mooring buoy was caused by the collision of the docked vessel. Therefore, buoys are usually equipped with rubber fenders that are installed around the buoy to protect the buoy body. All types of buoys are generally painted a light color to make them easy to find. Although the body of the buoy is bright at night, there is still a chance that the buoy will not be seen. Therefore, the mooring buoy is also equipped with a lamp that has solar panels as a backup energy source to keep it lit at night. (Ghafari & Dardel, 2018; Lat et al., 2022; Wüest et al., 2021).

Figure 3. Tower berth

Figure 4. Mooring buoy

The works to install buoys + ballast at sea for the lifting sinkers (concrete block weights) will be done using the floating method using a mini pontoon. The plan is in accordance to the Figure 5.

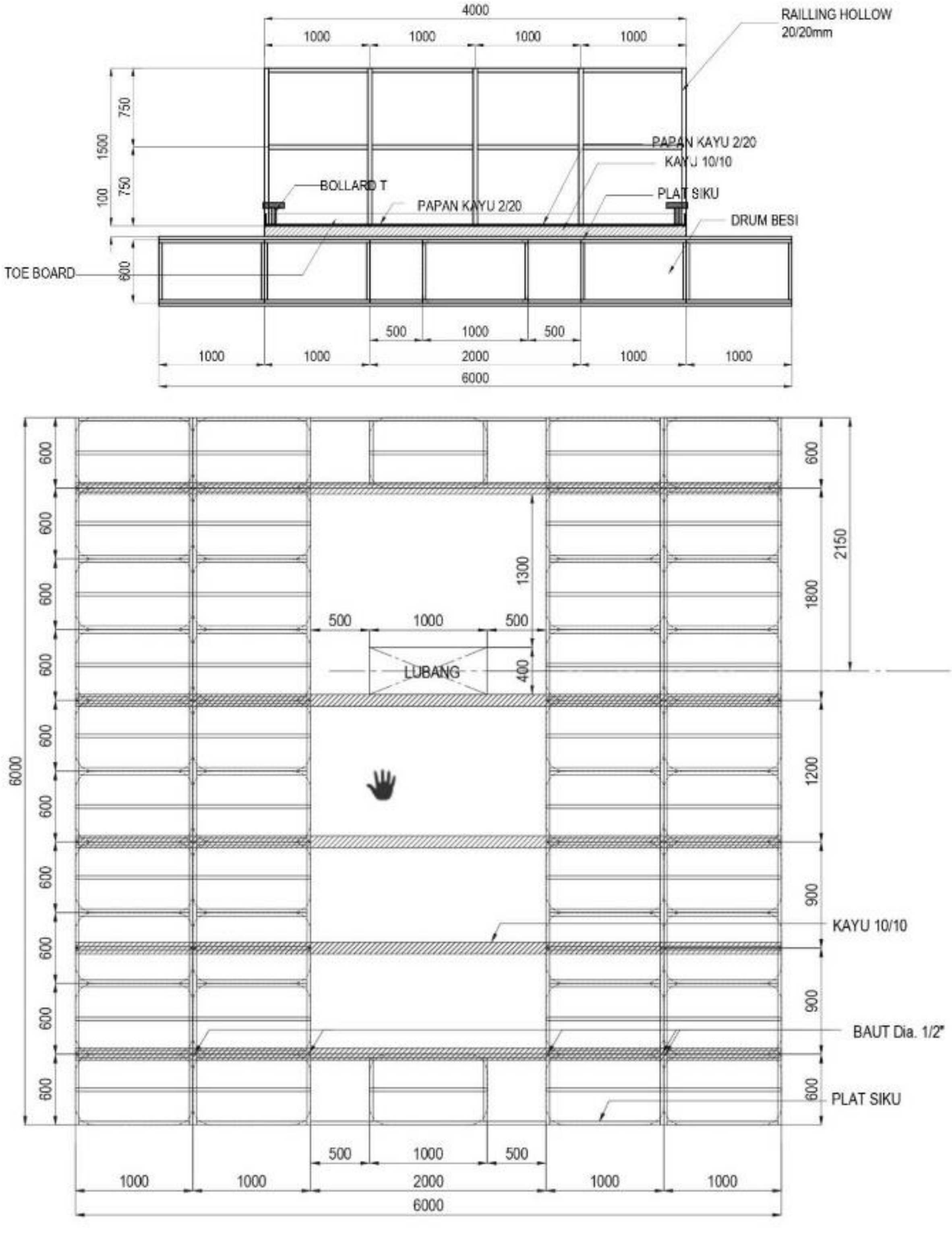

Figure 5 Ground plan of the buoy

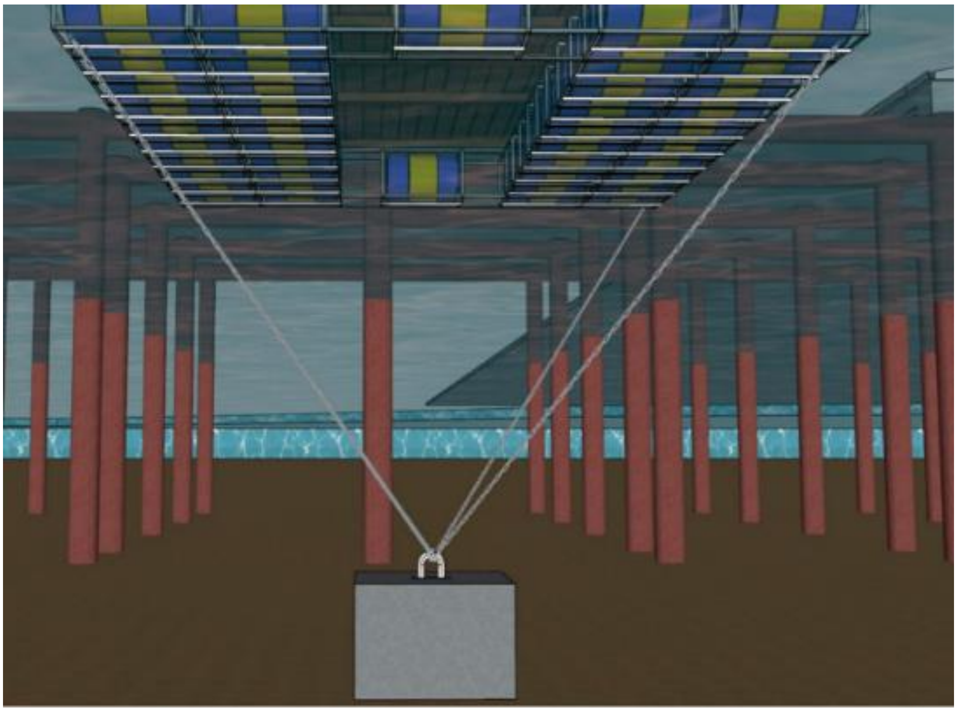

Figure 6. 3D plan of the buoy

The research was conducted by calculating the capacity and weight of each material used and the buoyancy of the buoy to be used as a platform for land surveys in mid-ocean.

Table 1. Weight of the material used

Material	Diameter (m)	Length (m)	Weight (Kg) [A]	Width (m)	Height (m)	Quantity (bh)	Weight of Field Material (kg)
Ralling Hollow 20x20		13.00	6.78				14.69
Elbow Plate 100 x 100 x 10 mm – 6 M 90.6 Kg		1,704.80	90.60				25,742.48
Drums 200 L	0.580	1.82		0.89	0.001	42.000	534.89
Concrete Weight		4.00		4.00	4.00		128,000.00
Chain	0.032	100.00	2,366.00		30.00	4.000	2,839.20
Bollard Capacity 35 Ton			25.00			4.000	100.00
10x10 . wood		300.00		0.10	0.10		2,700.00
2x20 . Wooden Board		60.00		60.00	0.02		64,728.00
							72.00
Total Weight							**224,659.26**

The first step is to consider the ability of seawater to shift the size of the pontoon to be used as a platform and calculate the load on the pontoon itself to obtain the buoyancy value of the pontoon. If the total weight of the mini pontoon is 96,659.26 kg, and we have parameter density of water is 997.00 kg/m^3 and also have density of sea water is1,026.00 kg/m^3 and than we have seawater pressure ratio is 1.03.

If the pontoon is assumed to float half the body or a half the height of the pontoon structure is 0.30 m, so volume of semi-floating pontoon (drum) is 9.88 m^3. Weight of pontoon semi-float is 48,329.63 kg and pressure of seawater against pontoon (buoyancy) - half body of pontoon (Fa) same as density of seawater multiplied gravity and volume will get results 99,443.48kg. The force on the pontoon push (Fb) is 96,659.26 kg. With Fa>Fb the pontoon is then in a floating state with almost 95% sink rate. Consider the formula $Fa = Vt \times \rho \times g$.

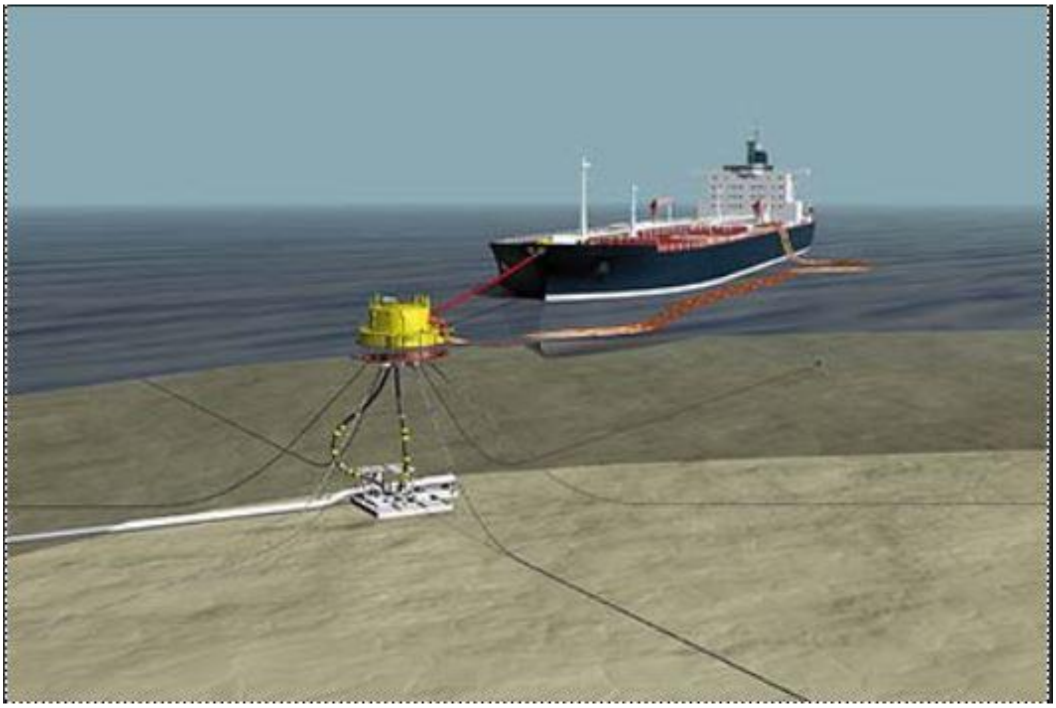

Figure 7. 3D plan of the buoy

Next we calculate the concrete anchor to anticipate the dynamic force of the waves that will disturb the movement of the pontoon, the weight of this anchor being in the form of a rectangular concrete with the size according to the data below, which will be greater than expected the weight of the pontoon platform. Concrete weights that can be used with dimensions.

P = 4.00 m
L = 4.00 m
D = 4.00 m
BJ = 2,0000.00 kg/m^3

The weight of the concrete anchor must be greater than the buoyancy 128,000.00 > 99,443.48kg. The calculation of the ability of the strapping between the pontoon and the anchor to anticipate unstable pontoon motion and must have a stress capability that exceeds the stress experienced when the pontoon is hit by a wave. The tension in the chain is greatest force is assumed, namely the force of the ballast.

F = 32000 Kg of 4 point anchor block
A = 0.000804571 m^2
= 8.05 cm^2

The occurring stress = 3,977.27 kg/cm^2

Galvanized allowable stress of chain ability specification is 32.20 tons or 32,200.00kg Chain material tension = 4,002.13 kg/cm2. Max Chain Tension> Tension applied in the anchor block.

CONCLUSION

When the earthworks pontoon is used as Mooring Buoy by estimating the total weight of the earthworks pontoon capacity, it is still in a semi-floating condition, although under certain conditions it will drop to as much as 95% of the estimated buoyancy pressure capacity of the mourning buoy. The carrying capacity of the mourning buoy chain tension is also calculated to withstand the movement of the pontoon to keep it stable during ground exploration work over the sea.

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