



## ARTICLE

# Study on Mooring Design and Calculation Method of Ocean Farm Based on Time-Domain Potential Flow Theory

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### ABSTRACT

In order to calculate the mooring force of a new semi-submerged Ocean Farm quickly and accurately, based on the unsteady time-domain potential flow theory and combined the catenary model, the control equation of mooring cable is established, and the mooring force of the platform under the wave spectrum is calculated. First of all, based on the actual situation of the ocean environment and platform, the mooring design of the platform is carried out, and the failure analysis and sensitivity analysis of the single anchor chain by the time domain coupling method are adopted: including different water depth, cycle, pretension size, anchor chain layout direction and wind speed, etc. The analysis results confirm the reliability of anchoring method. Based on this, the mooring point location of the platform is determined, the force of each anchor chain in the anchoring process is calculated, and the mooring force and the number of mooring cables are obtained for each cable that satisfies the specification, the results of this paper can provide theoretical calculation methods for mooring setting and mooring force calculation of similar offshore platforms.

## 1. Introduction

Ocean Farm is a multifunctional new semi-submersible platform which integrates leisure, entertainment, scientific research and marine aquaculture, and its safety is especially important. The stability of the platform is the precondition and foundation of realizing all functions, so this paper focuses on the mooring mode and mooring force of the platform under wave action. Offshore platforms are often in extreme marine environments, while wave loads are often the main control loads. Scholars at home and abroad have devoted a great deal of effort to this: Nakajima<sup>[1]</sup> considering the non-linear effect of mooring cable, and

focus these considerations on a representative location, using a point or part of the quality problem instead of the entire structure, and call it a centralized quality model. Huang<sup>[2]</sup> set up a centralized quality model by the computational force obtained by finite element method, and a method for calculating the force of three-dimensional mooring cable is proposed. Groshenbaug<sup>[3]</sup> proposed a calculation model of the dynamic and tension of the upper part of the catenary mooring cable is caused by the wave to its vertical motion. It is found that the model is applicable to the ocean wave frequency force, and the corresponding stress value is obtained by calculating the standard deviation of mooring cable tension in the

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platform. Loukogeorgaki<sup>[4]</sup> by studying the interaction between three-dimensional floating body and mooring cable, the relationship between mooring force and the force of floating body is proposed. Chaudhury<sup>[5]</sup> integrated analysis of the coupling dynamics of the platform cylinder, inlet riser and mooring system, research shows that: the results of this fully coupled model are less than the error of analysis and calculation of the opposing pipe and mooring cable respectively, the effect of this coupling is more sensitive in the process of platform motion. Bernitsas<sup>[6]</sup> based on the three-order maneuverability equation, the dynamic analysis of the radiation mooring is carried out on the semi-submersible platform, and the catenary model is used for mooring calculation. Wichers<sup>[7]</sup> introduced the influence of a new type of offshore structure on different mooring systems, and calculated its mooring force in polar, deep water and harsh environments, and a lot of mooring experiments are carried out on mooring of the floating body under the condition of polar summer shallow water environment.

At home, the research on mooring calculation of offshore platform has made some progress. Qi-Qi Shi<sup>[8]</sup> based on the time-domain coupling analysis method of mooring and wave load, the hydrodynamic performance of catenary mooring system is calculated, and the design law of mooring system is studied by changing the parameters required in mooring calculation. Jian Huang<sup>[9]</sup> the static analysis of mooring system is carried out on the offshore platform structure with the complex mooring system, and the recovery force formula of the mooring force calculation is deduced, and the recovery effort spectrum of the offshore platform is calculated. Su-Lian Zhou<sup>[10]</sup> compared the mooring force size of semi-submersible platform by using anchor schemes with different root numbers, and analyzed the influence of mooring line number on mooring tension and platform motion response. Bo Tong<sup>[11]</sup> compared analyzed the dynamic response characteristics of the semi-submersible platform using the two schemes of tension mooring and catenary mooring, and analyzed the influence of the change of drag force coefficient on different mooring modes. Li-Ya Fan<sup>[12]</sup> designed the mooring system of the deep-water semi-submersible platform by using the tensioned mooring, and proved that the motion response and the tension of the mooring can meet the requirement of the specification by numerical calculation. On the basis of summarizing the previous research results, based on the unsteady time-domain potential flow theory and combined the catenary model, this paper establishes the control equation of mooring cable, and calculates the mooring force of the platform

under irregular wave conditions. At first, the mooring design was carried out, and the tension and displacement analysis was carried out under the condition of self-storage and complete working conditions, and the sensitivity analysis of different water depth, period, pretension size, anchor cable arrangement direction and wind speed were conducted, finally, a reliable anchoring method is obtained, based on which the mooring point position is determined, and the force of the platform is calculated during the anchoring process. Finally, the mooring force and the number of mooring cables are required for each cable to meet the specification requirements; the results of this paper can provide theoretical calculation methods for mooring setting and mooring force calculation of similar offshore platforms.

## 2. The Basic Theory

### 2.1 Static Calculation Method of Anchor Chain

The static calculation of the anchor chain is based on the catenary equation, namely<sup>[13]</sup>:

$$H = AE \sqrt{\left(\frac{T}{AE} + 1\right)^2 - \frac{2wZ}{AE}} - AE \quad (1)$$

$$X = \frac{H}{w} \sinh^{-1}\left(\frac{wL}{H}\right) + \frac{HL}{AE} \quad (2)$$

$$V = wL \quad (3)$$

$$T = \sqrt{H^2 + V^2} \quad (4)$$

In Eq. (1), Eq. (2), Eq. (3) and Eq.(4),  $L$  is the length of the catenary strand in the water part,  $w$  is the wet weight of mooring line material,  $AE$  is the stiffness of unit length,  $X$  is the horizontal distance between platform mooring point and seabed mooring point,  $Z$  is the vertical distance from platform mooring point to seabed mooring point,  $H$  is the horizontal tension,  $V$  is the vertical component of tension in platform mooring point,  $T$  is the tension at the platform mooring point.

The time domain platform motion can be obtained by solving the following equations:

$$M \frac{d^2x}{dt^2} = F(t)$$

$$\begin{aligned}
 F(t) &= F_{wave}(t) + F_{wind}(t) + F_{curr}(t) + F_{moor}(t) + F_{static}(t) + \dots \\
 F_{wave}(t) &= F_{inc}(t) + F_{diff}(t) + F_{rad}(t) + F_{drift}(t) + \dots
 \end{aligned}
 \tag{5}$$

$$\begin{cases}
 \vec{T}_1 = (t + \frac{dT}{ds} \frac{ds}{2})(\tau + \frac{d\tau}{ds} \frac{ds}{2}) \\
 \vec{T}_2 = (t - \frac{dT}{ds} \frac{ds}{2})(\tau - \frac{d\tau}{ds} \frac{ds}{2})
 \end{cases}
 \tag{7}$$

In Eq.(5),  $F_{wave}$  is the wave force,  $F_{wind}$  is the wind force,  $F_{curr}$  is the flow force,  $F_{moor}$  is the anchor chain force,  $F_{static}$  is the hydrostatic pressure.

In the wave force, it also includes the incident waves force ( $F_{inc}$ ), the diffraction waves force ( $F_{diff}$ ), the radiation waves force ( $F_{rad}$ ), and the second-order drift force ( $F_{drift}$ ).

### 2.2 Catenary Model

The catenary mooring cable has a standard quasi-static model equation, which is based on the vertical gravity action of the mooring cable to resist the resilience of the environmental load of the platform, whose equation is [14]:

$$l_w - \sqrt{h(h + 2\frac{T_H}{P})} - l' + \frac{T_H}{P} \sinh^{-1}(\frac{P}{T_H} \sqrt{h(h + 2\frac{T_H}{P})}) = 0
 \tag{6}$$

In Eq.(6),  $l_w$  is the working length of cable when not stretched,  $l'$  is the length of cable after stretching,  $h$  is the water depth,  $T_H$  is the cable tension,  $P$  is the gravity of the unit catenary line in the water.

Catenary model is very effective in shallow water mooring calculation, so it has been widely used. This paper studies the mooring calculation of shallow water in a water depth of 30m, so the catenary model is used.

### 2.3 Control Equation of Mooring Cable

The main forces of the floating body mooring cables are gravity  $W$ , buoyancy  $F$ , cable tension  $T$ , normal fluid resistance  $f_N$  ( $f_n, f_b$ ) and tangential fluid resistance  $f_\tau$ . Assuming that  $\vec{v}_w$  and  $\vec{a}_w$  are the velocity vectors and acceleration vectors of the water points, respectively, and  $\vec{v}_m$  and  $\vec{a}_m$  are the speed vectors and acceleration vectors of mooring chain, respectively [15], the relative velocity is  $\vec{v}_r = \vec{v}_w - \vec{v}_m$  and the relative acceleration is  $\vec{a}_r = \vec{a}_w - \vec{a}_m$ .

Set  $\vec{T}$  is the tension at the midpoint of the cable micro section, the tension  $\vec{T}_1$  and  $\vec{T}_2$  on both ends of the cable micro section can be expressed as follows:

So that we can get:  $d\vec{T} = \vec{T}_1 + \vec{T}_2 = (\frac{dT}{ds} \vec{\tau} + \frac{T}{\rho} \vec{n}) ds$

$$\begin{cases}
 \vec{f}_N ds = 0.5 \rho_w C_{Dn} |\vec{v}_N| \vec{v}_N ds \\
 \vec{f}_\tau ds = 0.5 \rho_w C_{D\tau} |\vec{v}_\tau| \vec{v}_\tau ds \\
 (\vec{W} - \vec{B}) ds = (\rho_m - \rho_w) \vec{g} A ds \\
 \vec{l} ds = -\rho_m A ds \vec{a}_m + C_m \rho_w A ds (\vec{a}_w - \vec{a}_m)
 \end{cases}
 \tag{8}$$

In Eq. (8),  $\rho_w$  and  $\rho_m$  are the fluid density and mooring cable density,  $A$  is the cable cross-sectional area,  $ds$  is the Cable Micro-segment,  $C_{Dn}$  is the normal resistance coefficient,  $C_{D\tau}$  is the tangential resistance coefficient,  $C_m$  is the additional mass coefficients for mooring cables.

The dynamic equation of the vector differential form of the mooring cable from Eq. (7) and Eq. (8) type:

$$\begin{aligned}
 (\rho_m + C_m \rho_w) A \vec{a}_m &= C_m \rho_w A \vec{a}_w + (\rho_m - \rho_w) A \vec{g} + \\
 0.5 \rho_m C_{D\tau} \pi D |\vec{v}_\tau| \vec{v}_\tau &+ 0.5 \rho_w C_{Dn} D |\vec{v}_N| \vec{v}_N + d\vec{T} / ds = 0
 \end{aligned}
 \tag{9}$$

When the cable is in a static equilibrium state, the cable acceleration  $\vec{a}_m = 0$ , inertia force  $\vec{T} = 0$ , can be simplified to the mooring cable differential form of the static equation, the following formula:

$$\vec{f}_N + \vec{f}_\tau + (\vec{W} - \vec{B}) + d\vec{T} = 0
 \tag{10}$$

$$\begin{aligned}
 (\rho_m - \rho_w) A \vec{g} + 0.5 \rho_w C_{D\tau} \pi D |\vec{v}_\tau| \vec{v}_\tau &+ \\
 0.5 \rho_m C_{Dn} D |\vec{v}_N| \vec{v}_N + d\vec{T} / ds &= 0
 \end{aligned}
 \tag{11}$$

## 3. Calculation Model of Platform

### 3.1 Platform Main Scale and Parameters

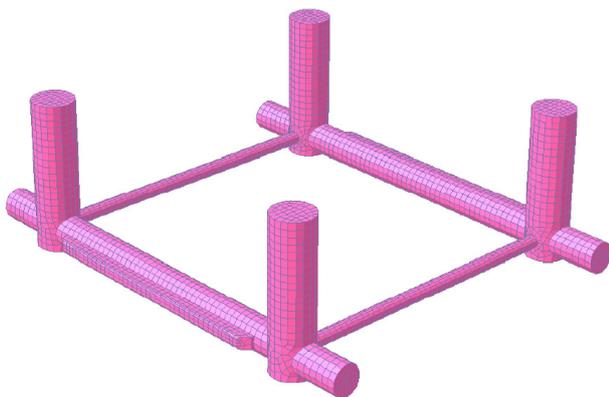
Semi-submersible Ocean Farm is a rectangular steel platform. The principal and parameters of the platform are shown in Table 1.

**Table 1.** Ocean Farm principal and parameters

General length	35.0 m
Breadth	29.0 m
Length and Breadth of main deck	25.0×25.0 m
Draft	3.0~4.0m
Buoy length	35.0m
Buoy diameter	2.3m
Center distance between buoys	25.0m
upright column high	11.0m
column diameter	3.2m
Center distance between columns(longitudinal)	25.0m
Center distance between columns(transverse)	25.0m

### 3.2 Ocean Farm Modelling

For the mooring force calculation of semi-submersible offshore platform, it is necessary to use finite element software to realize model modeling and grid division. The model of grid partitioning after modeling is shown in Figure 1: After the completion of the mesh model file writing, the platform quality file needs to be written. The compilation of quality documents is based on the platform information file, namely the tank capacity table of the operation manual file. Here, only two typical working conditions of self-storage and operation of the offshore platform are considered.



**Figure 1.** Meshing of the Ocean Farm

## 4. Ocean Farm Mooring Point Setting

### 4.1 Design Fundamentals and Environmental Conditions

The semi-submersible multifunctional Ocean Farm operating depth of about 30m. According to the design requirements of the platform and the actual working envi-

ronment of the platform, the wave spectra of the platform are selected as Jonswap type. In the design process, the self-storage environment condition of the mooring system is calculated according to the 12-stage typhoon, maximum wave height 8.4m and surface velocity 1.15m/s. The significant wave height according to the requirements in the specification, the maximum wave height is divided by 1.86, and the significant wave height is 4.52m. According to the recommended range in the specification, the upper limit of the spectral peak period is taken as the design value of the anchorage system, that is, the spectral peak period is 11.64s, since the anchorage system is subject to large response of long period wave action. Thus, the maximum sea condition parameters are obtained. At the same time, set its operating environment conditions according to the 6-stage wind calculation, as shown in Tab.2.

**Table 2.** Environmental conditions

Conditions	Self-existent Conditions	Operating Conditions
Wave spectrum	JONSWAP Spectrum	JONSWAP Spectrum
Maximum wave height (m)	8.4	5.8
significant wave height (m)	4.52	3.12
spectral peak period (s)	11.64	9.67
Spectral peak rising factor	1	1
mean wind speed (m/s)	31.825	11.3
surface velocity (m/s)	1.15	1.15

The purpose of this paper is to consider the anchor positioning capability of the platform under extreme sea conditions, and to consider part of water depth, anchor chain layout direction, pretension and sensitivity to sea conditions. Through analysis to obtain a safe and reliable mooring arrangement scheme, and to provide data support for mooring system installation.

### 4.2 Semi-submersible Platform Overall Mooring Setting

#### 4.2.1 Coordinates

The coordinates origin O in the static water surface, Z axis vertical upward, the X axis points to the bow, the Y axis points to the port side. For the wind, wave and flow are set to be from the stern to the bow of 0°, the starboard side of the port is 90°, the bow-pointing tail is 180°. As for the number of the anchor chain from small to large starting from the ship stem port, counterclockwise rotation, the specific format as shown in Figure 2.

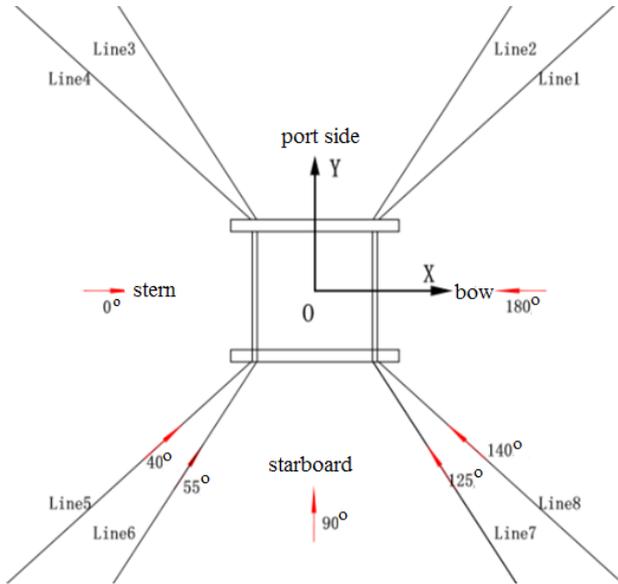


Figure 2. The plan of coordinate system and anchor chain layout

#### 4.2.2 Anchoring Mode and Anchoring System Setting

The mooring system uses 8-point decentralized catenary system, connecting 1 anchor chains per point, a total of 8, the anchoring method is used to arrange anchor and anchor chain in the target position, the platform is shifted to the target location to connect reserved anchor chain link, and the whole mooring system is installed.

As the working environment of this platform is water depth of 30m, which belongs to shallow waters, the environmental requirements to be met by the platform are not particularly serious, and the mooring level to be achieved under this environmental condition is relatively simple. Moreover, the working state of this special platform of Ocean Farm is mostly entertainment, surveying and breeding, compared with other deep water drilling platforms, its working intensity is small, the mooring strength to be achieved is relatively small, but also for the space comfort of the platform, the requirements are relatively high, combined with the above conditions and according to the current specification requirements, The platform mooring is set to all anchor chain. According to the data of mooring of the corresponding semi-submersible platform, the platform of mooring in shallow water is calculated according to the force equation of catenary mooring, and its equation is.

According to the En.(6), the length of anchor chain is about 448.9m, due to the high requirements of the platform for stability and human comfort, this platform is set as each anchor chain is composed of three grade ships

with a length of 550m and a diameter of 44mm. The main parameters of the anchor chain are shown in Tab. 3.

Table 3. Main parameters of anchor chain

Diameter (mm)	Axial stiffness(kN)	Dry weight (kg/m)	Wet weight (kg/m)	Minimum breaking force (kN)	Inertia coefficient	Resistance coefficient
44	174240	42.0	36.5	1540	1	2.6

According to the characteristics of the platform general layout and the semi-submersible platform mooring points, the anchor points are set in 40°, 55°, 125°, 140°, 220°, 235°, 305°and 320°. The position of the guide cable is set at the underwater buoy position of the platform, and according to the draught and the length of the anchor chain, the guide cable hole and the anchoring point position are initially set up.

#### 4.3 Setting and Sensitivity Analysis of Anchorage System

The specific calculation conditions of the mooring setting of the platform are divided into basic condition analysis and other sensitivity analysis conditions. The sensitivity condition analysis mainly considers the safety of the whole mooring system after small deviation producing in the installation process of the mooring system and theoretical analysis, and the security redundancy of the anchoring system is calculated. In the case of sensitivity analysis, the time-domain coupling analysis method of mooring system is used to check the failure condition of single anchor chain and select some dangerous waves to check the work.

##### 4.3.1 Analysis of Basic Working Conditions and Operating Conditions

The anchor system uses the arrangement method shown in Figure 2, carry out the full working condition analysis of 5 wave direction (0°,40°,47.5°,55°,90°) in the self-storage condition and operation condition. The analysis results are shown in Figure 3 and Figure 4, the figure shows that the anchor chain has a large margin of safety factor under the condition of self-storage and complete working condition, even if the safety factor under the most dangerous conditions is greater than the allowable safety factor of 1.67. In the two working conditions, the 6-DOF motion trend of the platform is basically the same, with the increase of wave Angle, the motion of surge, heave and pitch decreases, the motion of surge and roll increases with the increase of wave Angle, and the change trend of yawing motion with wave Angle is not obvious.

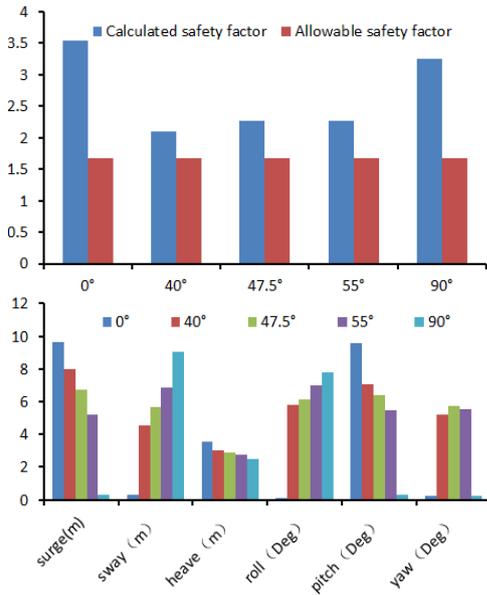


Figure 3. Calculation results of tension and displacement in working conditions

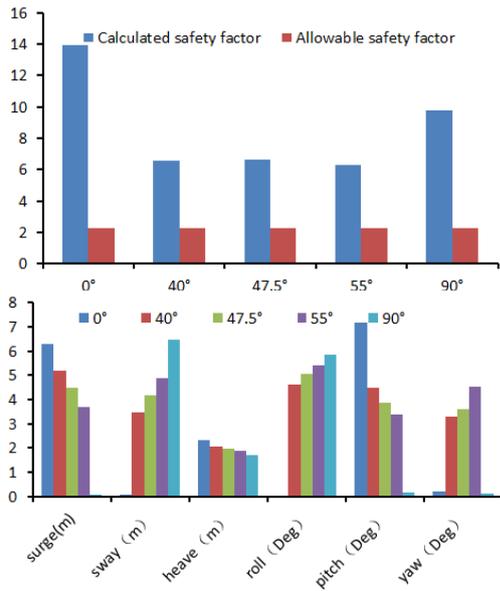


Figure 4. Calculation results of tension and displacement in operating conditions

### 4.3.2 Sensitivity Analysis

#### (1) Sensitivity analysis of water depth

On the basis of the analysis of the basic conditions, the anchor chain end is guaranteed to be unchanged, the mooring system is analyzed under the water depth condition of 28m and 32m (design water depth 30m), and the failure of the single anchor chain in the direction of 40° and 47.5° is checked, because these two directions are the most dangerous wave direction. Figure 5 and Figure 6 are the results of tension and displacement calculations for

32m and 28m water depth sensitivity analysis, the figure shows that the anchor chain has a high safety margin at 28 m and 32 m depth. The displacement and angle of 6-DOF motion of the platform under two conditions are small, which indicates that the mooring depth has little effect on the athletic performance of the platform.

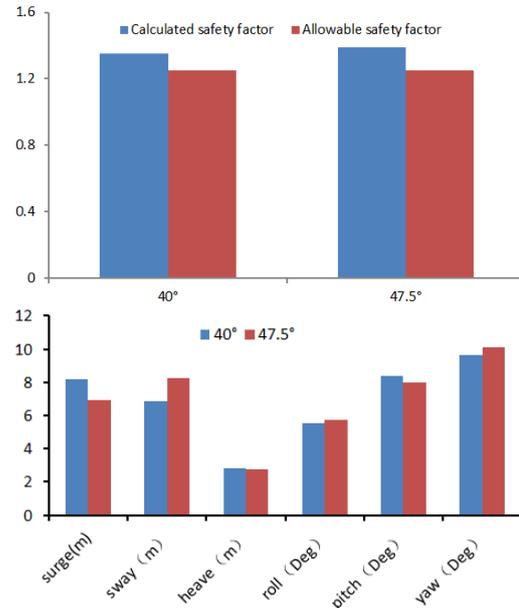


Figure 5. Calculation results of tension and displacement for 32m depth sensitivity analysis

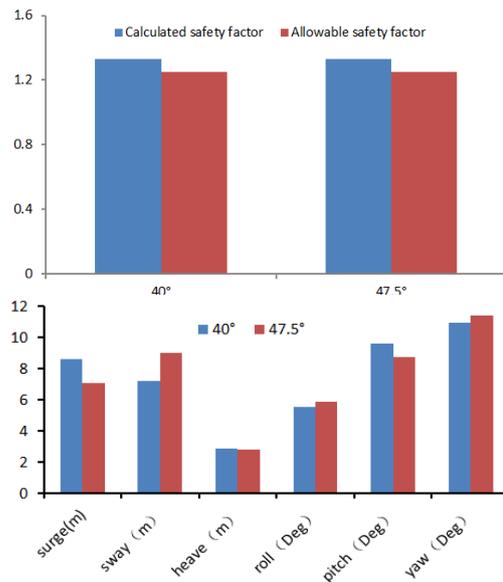


Figure 6. Calculation results of tension and displacement for 28m depth sensitivity analysis

#### (2) Periodic sensitivity analysis

Based on the wave parameters in Tab.2, the periodic sensitivity analysis is carried out, considering the 40° and 47.5° wave direction, Figure 7 is the periodic sensitivity analysis of tension and displacement calculation results,

it is shown by the figure that the platform can maintain stability under the action of the wave spectrum, which satisfies the safety requirement. The 6-DOF motion displacement and angle change of the platform under two working conditions is small, which indicates that the wind speed of different angles has little effect on the motion performance of the platform.

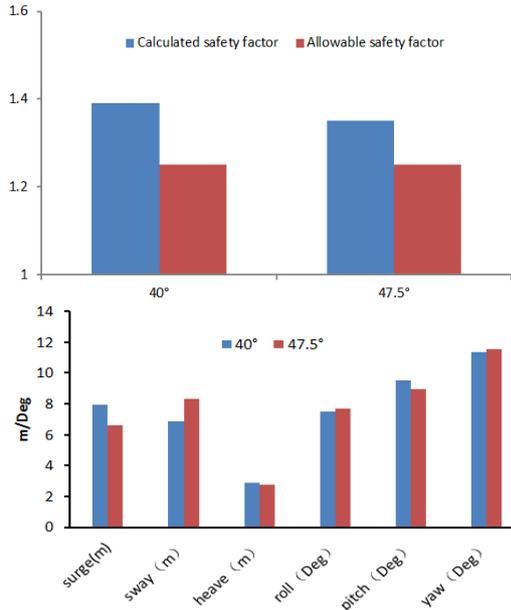


Figure 7. Periodic sensitivity analysis of displacement tension and displacement calculation results

(3) Wind speed sensitivity analysis

The mooring capacity of the platform under the 15-stage wind is mainly considered head seas within 15°, and the wave direction is 0° and 15°. The 1-hour average wind speed corresponding to the wind of grade 15 is 44.48m/s. Figure 8 is the calculation result of the tension and displacement of wind speed sensitivity analysis, from the figure, meet the security requirements, indicating that the platform can withstand the 15-stage wind; the 6-DOF motion displacement and angle change of the platform under two working conditions is small, which indicates that the wind speed of different angles has little effect on the performance of the platform.

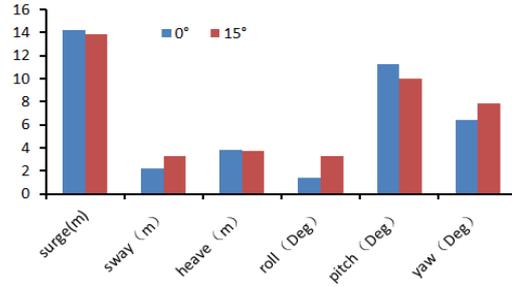
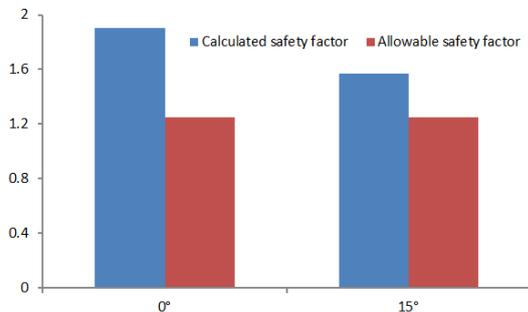


Figure 8. Wind speed sensitivity analysis of tension and displacement calculation results (15-stage wind)

## 5. Mooring Force Calculation of Marine Pasture Platform

### 5.1 Coordinate System Settings

During the calculation of the mooring force of floating system, its coordinate system usually sets its o point as the coordinate origin, which is located on the center line of the platform, intersects with the base plane, the x direction is positive in the direction of the bow, the y direction is the starboard, and the z direction is positive in the upward direction; as shown in Figure 9. N for the North, E for Orient, and Z to downward. From the diagram, we can see the direction of the wind, wave and flow that the platform is affected by.

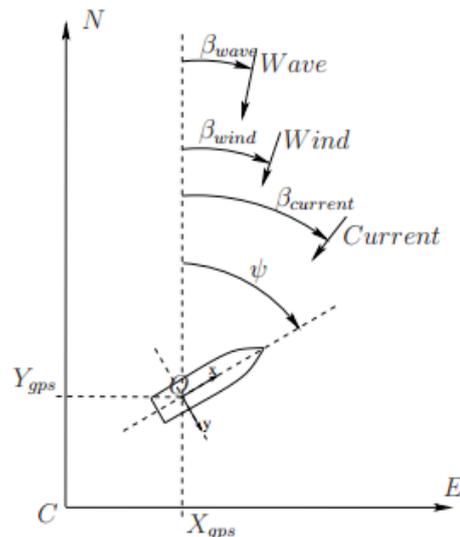


Figure 9. Mooring computing coordinate system

### 5.2 Mooring Parameters

The coordinate position of the guide port and the coordinate position of the anchor point are verified by the above section, and the position of the anchor point in the real operation is calculated as shown in Table4:

**Table 4.** Position correction of anchor point

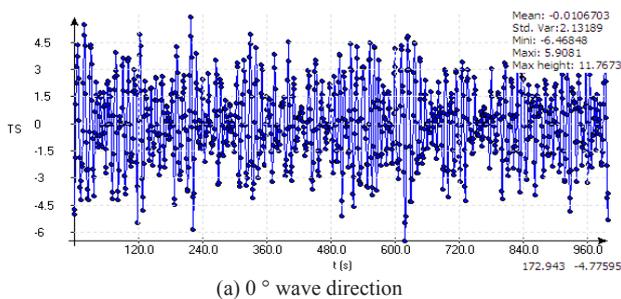
No	Coordinates			Degree(°)	Distance(m)
	X(m)	Y(m)	Z(m)		
1	434.831	367.274	-30	39.387	550
2	327.671	464.368	-30	54.984	550
3	-327.671	464.368	-30	124.984	550
4	-434.831	367.274	-30	139.987	550
5	-434.831	-367.274	-30	220.013	550
6	-327.671	-464.368	-30	235.016	550
7	327.671	-464.368	-30	305.016	550
8	434.831	-367.274	-30	320.013	550

**5.3 Environment Settings for the Platform**

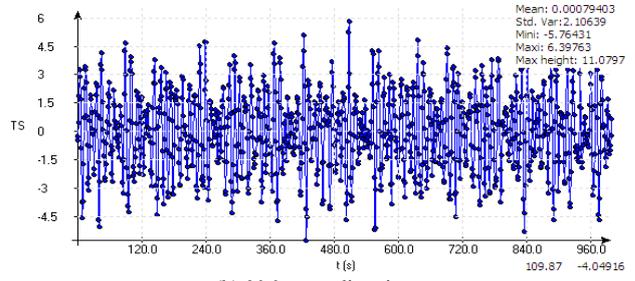
In this paper, the self-storage environmental conditions of the semi-submersible Ocean Farm mooring system were calculated according to the typhoon of category 12, the maximum wave height was 8.4m, the surface velocity was 1.15m/s, and the significant wave height was 4.52m. The axial force of wave direction and three wind direction of 0°, 90° and 150° is considered first in the wind wave of the platform, and the Jonswap wave spectrum is used, air density  $\rho_a=1.28\text{kg/m}^3$ , sea water density  $\rho_w=1025\text{kg/m}^3$ : All calculation in mooring condition trim angle of 0°. The specific environment settings are shown in table 5. Figure 10 is the wave shape in the environmental condition. of 0°, 90°, and 150°. And the wind and wave environment is set according to the working conditions of the owner in the design manual.

**Table 5.** Platform-specific environment Settings

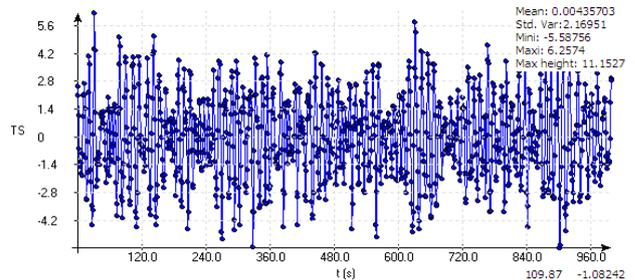
Wave			Wind		Current	
significant wave height	Cross zero cycle	Wave direction	Wind speed	Wind direction	Current speed	Current direction
4.52 m	7.5 s	0°	10.29 m/s	0°	1.15 m/s	0°
5.21 m	6.0 s	90°	12.72 m/s	90°	1.31 m/s	90°
4.92 m	6.5 s	150°	10.29 m/s	150°	1.03 m/s	150°



(a) 0° wave direction



(b) 90° wave direction



(c) 150° wave direction

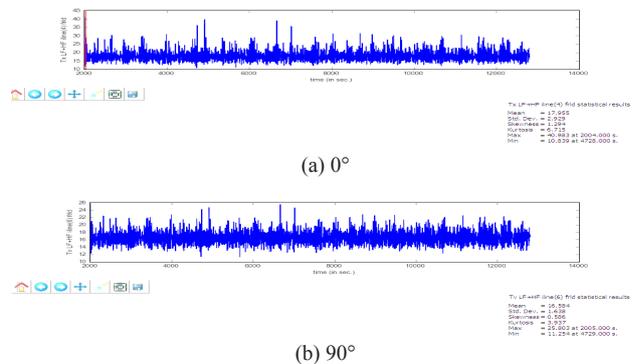
**Figure 10.** Different wave direction and the environmental state of the wave

**5.4 Calculation Results of Mooring Force for Semi-submersible Ocean Farm**

After calculation, the axial force of the platform in self-storage condition (draft at 3m) and different environments can be obtained, and the extreme value of the axial force on the cable is shown in table 6. The distribution of axial force is shown in Figure 11 ~ Figure 12.

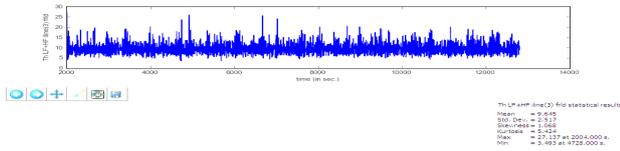
**Table 6.** Maximum axial force

Direction	Towing condition(kN)	Typical condition(kN)
0	40.983	47.537
90	25.803	27.066
150	27.137	37.340



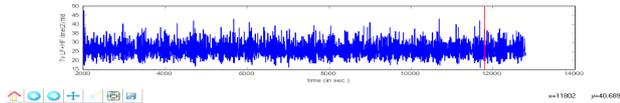
(a) 0°

(b) 90°

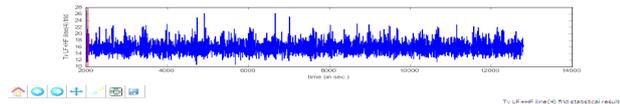


(c) 150°

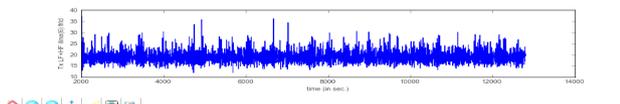
**Figure 11.** Maximum axial force for different wind and wave direction under towing conditions



(a) 0°



(b) 90°



(c) 150°

**Figure 12.** Maximum axial force for different wind direction and wave direction under typical operating conditions

### 5.5 Comparison of Calculated Results with Canonical Values

The canonical value calculation reference Mooring Equipment Guidelines OCIMF- MEG3- 2008 file, referred to as the OCIMF-MEG3-2008 file.

**Table 7.** Force and wind area of two working conditions

conditions	Longitudinal wind $A_L$ area (m <sup>2</sup> )	Lateral wind area $A_L$ (m <sup>2</sup> )	Maximum longitudinal force FXmax (kN)	Maximum transverse force FYmax (kN)
Ballast	110	105	98	399
full load	89	85	91	415

According to the minimum breaking force of mooring in the specification, according to the 8 mooring cables set on the platform, the transverse force is calculated:

$$F_y = 0.875A \times N + 0.158 \times 0$$

In the formula, N- is the number of cables.

The tension of each cable can be introduced:

$$A = F_y / (0.875 \times 8 + 0.158 \times 0) = 112 \text{KN}$$

Its longitudinal force is:

$$F_x = 0.893A \times 0 + 0.235A \times N$$

The tension of each cable can be introduced:

$$A = F_x / (0.893 \times 0 + 0.235 \times 8) = 91 \text{KN}$$

According to the specification requires that each root mooring cable can withstand a maximum of 55% of the tension, so the minimum breaking force per cable should be a theoretical value of 50kN. The maximum value of the axial force of the cable is 47.537kn, which is calculated from the upper section. Therefore, the calculated value meets the requirements of the specification. The mooring design of the platform meets the requirements of the specification for safety performance.

### 6. Conclusion

(1) Taking the semi-submersible marine pasture platform as an example, based on the time-domain potential flow theory and combine the catenary model, this paper establishes the control equation of mooring cable, and calculates the mooring condition of the platform under irregular wave spectrum.

(2) For the platform mooring design, the failure analysis and sensitivity analysis of single anchor chain were carried out by Time domain coupling method: Including different water depth, period, pretension size, anchor cable arrangement direction and wind speed, etc. The calculation and analysis results confirmed the reliability of mooring mode.

(3) Based on the actual mooring design, the mooring point location of the platform is determined, and the force of each anchor chain in the anchoring process is calculated, and the mooring force and the number of mooring cables are obtained for each cable that meets the specification requirements.

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