

Research on energy self-sustaining tourism platform facing the deep sea

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Abstract: According to the needs of China's modernization development, China should develop the Marine economy, protect the Marine ecological environment, and accelerate the building of a maritime power. In order to respond to the national Marine power strategy and build a strong Marine perimeter, based on the green concept, this paper designs a self-sustaining comprehensive tourism platform integrating new energy development and utilization, tourism, scientific research and aquaculture. The platform is a semi-submersible platform with a length of 900 meters and a width of 600 meters ^[1], which can be used in waters with a water depth of 800 to 1200 meters. Catenary is provided at the bottom to stabilize the platform. The platform is divided into four major areas: energy area, living area, tourism area and business area. The platform designed in this paper has the following three innovative points: First, the platform uses temperature difference energy, wave energy, solar energy and other devices to achieve self-sufficiency of platform electricity, and deep seawater desalination through temperature difference energy power generation device; Second, relying on the special geographical advantages of far-reaching sea, the platform develops tourism projects with far-reaching sea characteristics according to local conditions, such as deep-sea restaurant, far-reaching sea fishing, deep sea bathing, etc., to provide a model for innovation in the development and utilization of far-reaching sea; Third, the platform is equipped with oscillating float-type power generation equipment, which combines wave energy generation and wave dissipation, and converts the abundant wave energy at sea level into electric energy, which provides power supply for the platform and reduces the load effect of waves on the platform.

1. Introduction

At present, countries around the world have designed and manufactured more usable offshore new energy development devices, and countries are also vigorously developing tourism platforms that can be used at sea. Through the design of multi-functional platforms with high economic added value, long-term stable use on the sea surface, and full use of Marine resources, the purpose is to serve the development of national defense, tourism, deep-sea water resources utilization, etc. To

provide a maritime base for human development and utilization of the ocean.

At present, the research direction of various countries is mainly how to build platforms for the development of Marine resources. Mobile platforms mainly composed of semi-submersible, tension-leg and jack-up, and fixed platforms mainly composed of concrete gravity and conduit have been widely used in oil exploration and production, mineral exploitation, aquaculture and other fields. A number of offshore platforms have been designed and developed for the exploitation of seabed resources and achieved certain results. The research and development of new offshore energy technologies, mainly based on temperature difference energy, offshore wind energy and wave energy, has been developing for a long time ^[2], but most conversion devices store the results of production operations or transfer them to the land in various modes of transportation, which greatly increases the cost of energy transportation and use, and also causes certain pollution to the Marine environment. Countries have made some achievements in the research and development of deep-sea water resources ^[3], but the difficulty and high cost of deep-sea water production and reprocessing make it difficult to be widely used, and still hinder the development of this industry.

How to directly combine the development of Marine new energy with Marine tourism, achieve self-sufficiency in long-term operation of the offshore platform through high-quality utilization of water resources, and finally achieve high-quality development and utilization of water resources, improve the processing capacity of Marine resources, innovate the tertiary industry to develop the Marine economy, and practice the green development concept in this process? Protecting the Marine ecological environment and improving the quality and efficiency for sustainable development, so as to realize the development of Marine economy and improve the quality of human life, are the commanding heights that countries strive to compete for in the field of Marine engineering.

2. Principles of Offshore Platform Design

2.1 Design approach

According to the characteristics of seawater providing buoyancy, a super-large floating tank with both high stability and high strength is designed to serve as the support structure of the entire platform ^[4], providing a stable environment for production and living above the deck of the platform.

According to the feature that the platform connected by the catenary can maintain stability due to the huge gravity, the catenary is adopted as the main device of the mooring system, and the platform can float firmly on the sea surface under the strong gravity brought by the eight chains ^[5].

According to the characteristics of huge energy contained in the temperature difference between the surface warm seawater and the deep cold seawater, the temperature difference energy conversion device is set on the platform to provide electric energy for the platform, and at the same time, it also carries out multi-comprehensive effect production such as fresh water production, cold source supply and aquaculture.

The main difficulty of the platform is to resist the effect of wind and wave load. In this paper, the direct influence of external load on the platform is reduced through the following three ways. ^[6]

First of all, according to the characteristics of the energy of the wave, the oscillating float wave energy generation device is placed around the platform to make full use of the energy of the wave while reducing the impact of the wave on the platform and docked ships, so as to achieve a "win-win situation" of safety and benefit.

Secondly, according to the characteristics of high strength and full utilization of volume of ellipsoid, this paper designs the underwater sightseeing restaurant connected to the platform as ellipsoid, which can increase the structural strength and reduce the force under a certain volume, and at the same time provide tourists in the restaurant with a more comprehensive viewing Angle.

Furthermore, according to the characteristics of the offshore wind load force related to the wind

area and building shape, this paper designs the building shape on the platform into a streamlined shape with as little windward area as possible to reduce the interference of offshore wind load on the platform and building.

2.2 Structural design

2.2.1 The area that makes the platform structure stable

The stable region of platform structure is mainly considered from three aspects: platform structure, mooring system and building adapted to wind and wave load.

First of all, according to Academician Wu Sheng's ultra-large floating body theory, this paper designs an ultra-large floating platform with a semi-submersible platform as the main body, as shown in Fig 1. The floating tank provides a large amount of buoyancy for the platform, the column connects the platform deck with the floating tank support, and the transverse support ensures that the platform has sufficient transverse strength. Secondly, catenary is selected as the main device of the mooring system, as shown in Fig 2. The main advantage is that the dead weight of the chain can make the platform stable on the sea surface, and the reserve buoyancy of the platform does not change greatly with the rise and fall of the sea surface. Finally, in view of the wind and wave load conditions, the total windward area of the deck superstructure is reduced as much as possible, and the bending moment brought by the wind load is reduced by streamlining, as shown in Fig 3. Oscillating floats are placed in front of the platform along the wave facing direction to absorb the wave energy, as shown in Fig 4, to reduce the wave impact on the platform and ship.

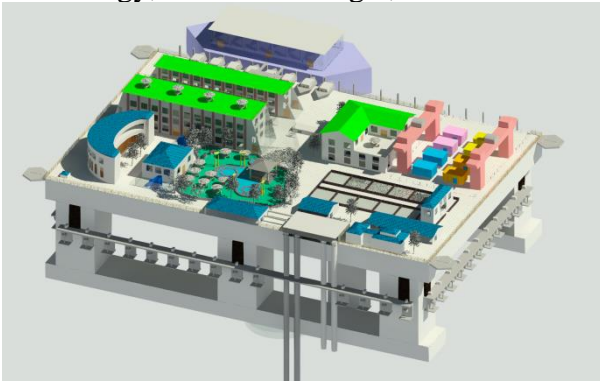


Figure 1: Very large floating platform



Figure 2: Catenary mooring device

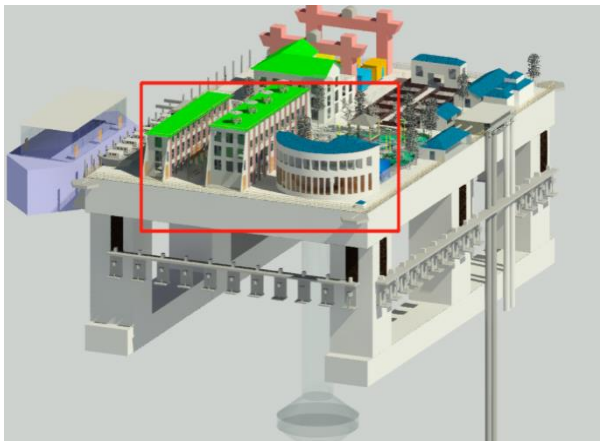


Figure 3: Streamlined building

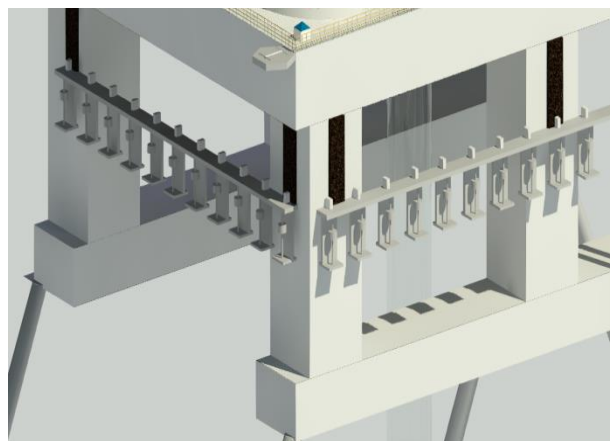


Figure 4: Wave facing oscillating float generator set

2.2.2 Functional areas of the platform structure

The functional aspect of the platform structure is mainly to consider the added value brought by high-quality water resources, including four major areas: energy area, living area, tourism area and business area [7].

The energy area, as shown in Fig 5, provides the power source for various activities of the platform. There are energy conversion and power generation devices such as temperature difference energy, wave energy and solar energy [8], which make full use of the energy and value contained in the water to achieve stable power supply for the platform. This area also uses the temperature difference power generation device to produce the deep sea water required by the platform, solving the water problem of the sea island, and realizing the water resources self-sustaining of the platform.

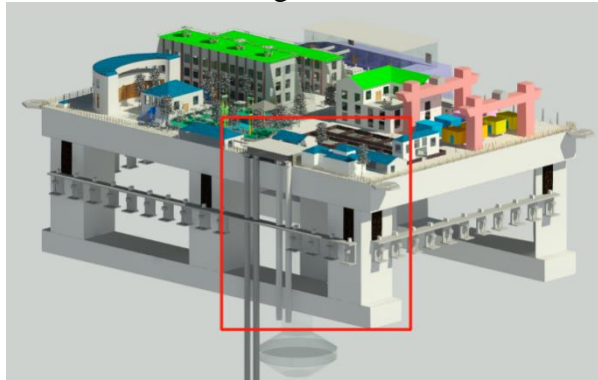


Figure 5: Energy zone layout

The living area, as shown in Fig 6, provides rest places and rescue equipment for the personnel on the platform, including the waterfront pier, evacuation boat, staff dormitory, glass corridor, tourist hotel and other buildings. The platform adopts a streamlined design for the staff dormitory and the tourist hotel, which helps to reduce the effect of wind load, and has a rest area for leisure, entertainment, overlooking and other functions on the top floor of the building.



Figure 6: Living area layout

The tourist area, as shown in Fig 7, is located adjacent to the hotel, which is convenient for tourists to reach after entering and leaving the hotel. Based on the desalination and processing of deep-sea water resources [9], the tourism area makes full use of Marine resources to develop characteristic tourism projects, setting up far-reaching sea resort Marine manor, deep sea bathing, far-reaching sea fishing ground for tourists' leisure and entertainment, as well as submarine restaurants equipped with deep-sea elevators. Visitors can step out of the hotel to the resort estate, which offers a seaside pool for large gatherings and a lecture hall for networking meetings; Visitors can choose to take the deep-sea elevator to enter the submarine restaurant during the meal, where

you can enjoy the underwater scenery while eating.

The business district, as shown in Fig 8, combines the functions of production and transportation. Relying on the unique geographical advantages of the platform located in the deep sea, it can deeply develop deep sea water resources, increase and add value to deep sea water and small-scale deep sea water fisheries and aquaculture, and sell high value-added products such as deep sea water processing products such as deep sea water masks and deep-sea aquatic products to tourists, or transport to other places through the cargo terminal.



Figure 7: Tourist area layout



Figure 8: Layout of the business district

From the above analysis, it can be seen that the platform designed in this paper can basically guarantee normal production and life in structure, and realize multi-purpose life, tourism, business and production in function.

3. Innovative Features of Offshore Platforms

In response to the national Marine power strategy, focusing on the efficient development and utilization of far-reaching seawater resources and making full use of Marine resources, based on the green concept, the team creatively designed a Marine complex platform that integrates life, tourism, production and new energy utilization, and can be operated and service for a long time, providing a way of thinking for the high-quality use of water resources, the development of the ocean and the utilization of the ocean.

3.1 "Offshore energy for offshore use" to achieve platform energy self-sustaining

In terms of energy supply of the platform, the electric energy converted by temperature difference energy, wave energy and solar energy production device is directly applied to the production and processing of deep sea water and tourism and life services of the platform, as shown in Fig 9. While fully utilizing the energy of deep sea water, it is transformed into fresh water and deep-sea aquatic products for human use ^[10]. It greatly reduces the loss caused by the transmission of electric energy and the pollution of the Marine environment caused by the production of fresh water, reflects the high-quality use of deep sea water, realizes the energy self-preservation of the long-term operation of the platform, and reduces the operating cost of the platform.

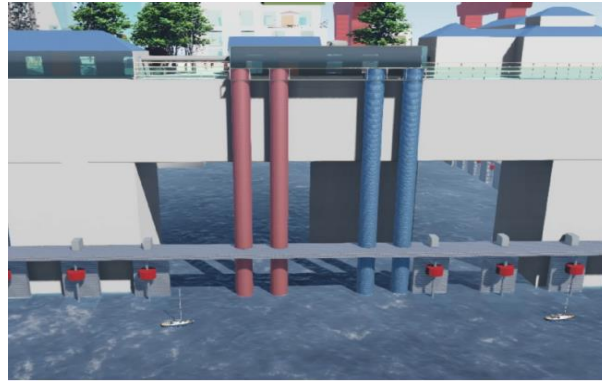


Figure 9: Water resource utilization map

3.2 "Focus on the deep sea" and develop deep sea water resources

Based on the special geographical advantages of the deep sea, it innovatively develops deep-sea aquatic products, deep-sea aquaculture ^[11], deep-sea bathing beach and other deep-sea characteristic projects, deeply excavates the rich nutritional resources of deep sea, and makes full use of the significant advantages of deep sea. While realizing the innovation of deep-sea aquatic products, it also broadens the commercial value of the project.

3.3 "Facing the far sea", developing characteristic tourism projects

In terms of tourism integration, it innovatively develops deep sea parks, deep sea baths, far-reaching sea fishing grounds, underwater sightseeing restaurants and other places as characteristic tourism projects, providing value-added points for building the platform into a tourism gathering place. From overlooking the ocean to sightseeing under the sea, from personal recreation to holding large-scale conferences, the platform can provide all-round three-dimensional services. It plays an exemplary role in promoting the ocean and developing Marine tourism resources, as shown in Fig 10.



Figure 10: Overall map of tourist area

4. Conclusion

In terms of offshore tourism features, the platform has set up undersea sightseeing restaurants, far-reaching sea resort offshore manor, deep sea bathing, far-reaching sea fishing ground and other facilities, successfully framing the tourism system of the platform. After the operation of the tourism platform, it will attract a large number of tourists to travel, provide a reference example for the

development of the ocean and the use of the ocean, and become a model of Marine economic development.

In the development of deep sea water, the platform uses wave energy, temperature difference energy, solar energy, three green and clean energy to make full use of Marine energy. The oscillating float used in wave energy generation can effectively eliminate the impact of waves on the floating body of the platform, and the temperature difference energy can provide pre-processing for deep seawater production while generating electricity, so as to realize the self-sustaining power resources and water resources of the platform. In addition, this paper also innovatively develops the research and development and production of deep-sea facial mask, deep-sea fish oil, deep-sea moisturizing water and other products related to deep sea water. After processing, the appreciation service can be carried out on the platform, and it can also be transported to the land for sale based on the way of freight mail, so as to achieve the increase and value of deep-sea aquatic products and accelerate the high-quality development of Marine economy.

In terms of Marine scientific research, based on the unique geographical advantages of the far-reaching sea, this platform can carry out scientific research activities in the far-reaching sea, and make a breakthrough for China's deep blue.

References

- [1] Li Liangbi, Cao Jianfeng, Gu Haiying et al. Single module strength analysis of offshore very large floating structures based on direct calculation method [J]. *Marine Engineering*, 2015, 37(11): 67-71.
- [2] Wei Wei, Liu Chengming, Key points of ocean thermal energy generation technology [J], *China Shipping Survey*, 2021(12): 74-80.
- [3] Lu Longde, Xiong Ying. China's shipbuilding industry is facing great benefits [J]. *Guangdong Shipbuilding*, 2023, 42(03): 6-12.
- [4] Cui Weicheng, Wu Sheng, Li Runpei. Ocean Engineering, Key Technical Problems to be solved in the development process of ultra-large floating structures in the Ocean [J], *Ocean Engineering*, 2000(03): 1-8.
- [5] Guanghong Zheng. Anchor semi-submersible platform ability of typhoon influence factors analysis [J]. *Journal of Tianjin science and technology*, 2023, 50 (03).
- [6] Liu Jia, Ji Xiaomeng, Liu Xianming et al. Research context, hotspot and prospect of Marine tourism in China [J]. *China Eco-Tourism*, 2022, 12(05): 770-787.
- [7] Gong Jiayong, Liu Guoliang, *Transportation Enterprise Management*, Research on the Application of super-large floating bodies in water tourism [J], 2019, 35(04): 80-82.
- [8] Jing Jiajia, Huang Zeqi, Zhong Lin et al. Research on multi-energy integration development model facing the Deep Sea [J]. *China Heavy Equipment*, 2023, No. 156(02): 18-22.
- [9] Chen Fengyun, Peng Jingping, Liu Lei et al. Experimental study on seawater desalination system by low temperature thermal method based on ocean thermal power generation [J]. *Water Treatment Technology*, 2023, 49(05): 32-35.
- [10] Liu Qiang, Gao Xiang, Yu Guangxin et al. Research on engineering megawatt-level offshore thermal energy generation system [J]. *China Offshore Oil and Gas*, 2023, 35(01): 148-155.
- [11] Liu Yang. *Conceptual Design of Marine tourism Platform [D]*. Dalian University of Technology, 2019.