

STUDY ON THE DESIGN SCHEMES OF MARINE WARNING AND FORECASTING SYSTEM PLATFORM

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ABSTRACT: The system platform of marine monitoring and disaster forecasting plays an important role in ocean observations, data collection as well as disaster prevention and mitigation. This paper discusses the necessity and significance of the system platform construction in Jiangsu Province, China. We take the construction of the observation platform as an example, considering the difficulties of the project design, analyzed the influence factors like wind, water level, tide, wave, earthquake and corrosion. On the basis, we study the platform's program layout, hydraulic structures scheme, layout of main observation devices, power supply and lightning, construction scheme. The research results can provide a reference for the design of the subsequent ocean observing platform, and can be further applied in other related design of observation platform.

Keywords: Observation platform, warning and forecasting, general layout, hydraulic structures.

INTRODUCTION

The full length of coastline of Jiangsu province is 953.9 kilometers, with the length of islands shoreline 27 kilometers, which means the ocean creates positive conditions for the development in littoral area of Jiangsu province. In recent years, national economy of three littoral cities, which rely on marine economies, has increased rapidly. In 2011, the gross domestic product of three littoral cities of Jiangsu province, which had a 12.4% rise, was 8262.7 billion yuan. It is higher than the provincial mean level about 1.4%, thus making littoral economy the new resource of economic development of Jiangsu. However, marine environment changes unpredictably, bringing calamities frequently, which not only threatens the safety of people's lives and fortune directly, but enormously obstructs fishery, marine transportation, marine engineering and exploitation of maritime resources(Lu Liyun et al. 2002). Marine disasters hampers the development of sustainability, stability and health in coastal areas to some degree, which make it a formidable mission to prevent and mitigate disasters there(Sun Ruijie et al. 2010). It is quite important and meaningful to design and build marine monitoring and forecasting system, to conduct studies and monitor, and to master the law of marine environment's change accurately.

At present, China has preliminarily built a marine monitoring and forecasting system of four ranks, including national marine forecasting center, sea area forecasting centers, provincial marine forecasting stations (central station) and parts of municipal marine forecasting stations (marine station). The marine

monitoring and forecasting system undertakes the responsibility of field observation, data collection and information transmission to central station(Han hua et al. 2008), therefore the design and construction of the system platform is extremely significant. This article takes the construction of the observation platform in Jiangsu province as an example(Survey and Design Institute of Nanjing Hydraulic Research Institute, 2012), analyzing several important factors which could influence the general layout of system platform and the design of hydraulic structures, including wind, water level, tide current, wave, earthquake, etc. Besides, general layout, hydraulic structures, layout of main observation devices, power supply and lighting, as well as project construction scheme, have been studied deliberately, which could provide reference to other related projects.

PROJECT OVERVIEW

Project Location and Observation Requirements

This project locates in Yellow sea area in Jiangsu, 10 kilometers away from coastline.

This project is an all-weather unattended observation station of succession and synchronization, mainly referring to the terms about hydrology, meteorology, sediment, water quality and ecology. The main items to be observed are tide level, temperature, salinity and ecological water quality.

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Analysis of Difficulties

The new-built observation platform locates in offshore area, needing the powerful capacity of resisting horizontal thrust and corrosion of sea water. Equipments like observation sensors for tide level, temperature, salinity and ecological water quality should be set, and the facilities should be installed in the roof observation field, such as meteorological observation sensor, solar energy module, communications antenna, lightning arrester, etc. In addition, supporting pile, observation device host, communication system, equipments for maintenance should be arranged properly. Berthing condition for small vessels is required. Main designing difficulties include:

Lack of basic data

Observing basic hydraulic and meteorological data is one of the purposes of building a marine observation platform, on which, however, construction of a project usually rely, including wind conditions, tidal current and wave. First-hand hydraulic and meteorological data is needed for the determination of design high and low water level, calculation of structural strength, design of structural safety and stability, elevation of related observation devices. It's one of the first issues in design phase that how to deal with such a contradiction.

Corrosion in open sea area

The marine environment is highly corrosive to structures. Accordingly, in such an environment, sea water itself works as strong corrosive media, while wave and tidal current will generate low-frequency reciprocating stress and impact. Besides, acceleration of corrosive process could be directly or indirectly ascribed to marine microorganisms and fouling organisms. Anticorrosion is another problem in design phase.

Power supply guarantee

Marine observation platforms usually lie far on the sea, falling short of ordinary means for power supply. It's unavoidable that how to deal with power problem, guaranteeing moderate lighting and keeping observation devices working steadily and consistently.

Construction program

The project is 10 kilometers away from coastline, with water open and unsheltered. Comparatively high stormy waves, far distance to land, small mass of buildings and tough condition for construction should also be counted. The way to maintain the safety and quality of construction is the priority to be considered.

DESIGN OF PROJECT

Analysis of design conditions

Wind conditions

According to the data of measured wind conditions of islands adjacent to project, the all-year constant wind direction in water area of project is SSE, the measured maximum average wind velocity in 10 minutes is 18.3m/s. As the result of study, given that the project locates in open sea, structure is designed in accordance with the standard for resisting 12-class wind.

Tidal level and design water level

The sea area of project is dominated by tidal wave system of Yellow Sea, taking on phenomena of non-formal semidiurnal. In the basis of measured data of islands adjacent to project and comprehensive analysis, related tidal and water level are put as follows (85 Elevation System):

Mean sea level for many years:	0.43 m
Design highest stage:	3.34 m
Design lowest stage:	-2.02 m
Extreme high water level:	3.63 m
Extreme low water level:	-2.94 m

Tidal current

Measured maximum vertical velocity of island adjacent to project in high tide is close to 1.0 m/s, along with the one in ebb tide 0.84 m/s. Design velocity of flow is 2.5 m/s.

Wave

Referring to statistical results of nearby projects, wave data of constant wave direction is adopted as NE, due to deficiency of long-range wave data in sea area adjacent to projec(CCCC third flight engineering survey and design institute Co., LTD., 2010). Maximum $H_{1\%}$ in NNE direction is 6m, and the average period is 4.3s.

According to the Development Plan for Inning of Coastal Intertidal Zone of Jiangsu Province(Hohai University, 2010), the average wave height is 3.2m, while calculated $H_{1\%}$ is 7.10m.

On the basis of wave data above, referring to research of Nanjing Hydraulic Research Institute about Xuwei harbor in Lianyungang, design wave factors of one-in-fifty years are valued as below:

Extreme high water level:	$H_{1\%}=7.00$ m
Design highest stage:	$H_{1\%}=6.76$ m
Design lowest stage:	$H_{1\%}=5.05$ m
Extreme low water level:	$H_{1\%}=4.69$ m

Project geology

As surveys suggest, the soil layers from top to bottom in project area include: silty clay, silt, silt and fine sand. Silt is selected as bearing stratum of piles.

Earthquake

The earthquake fortification intensity in Yellow Sea area is 7 degree, and design basic earthquake acceleration value is 0.1g. The earthquake fortification intensity of the project is adopted as 8 degree.

General Layout

On the basis of constant and strong wave direction, observation platform is fixed from northeast to southwest.

According to requirements of observation device arrangement, Platform could be divided into upper and lower ones, whose structural plane measurement is 8m*8m. The lower platform is allowed to withstand wave forces considering ships' docking in condition of small waves. In accordance with standards (PR.China, 1999), platform surface elevation is calculated based on design high water level, and rechecked based on extreme high water level. The surface elevation of lower platform is 4.50m.

Observation room is built in upper platform, designed to be open type and non-immersible. Given that platforms should be safe and eye-catching, the surface elevation of upper platform is 9.50m.

Hydraulic Structures

The lower platform is designed as high pile pier structure. Steel pipe pile of 1500mm diameter is adopted for pile foundation, with cast-in-situ reinforced concrete pier for platform, and frame structure for upper platform. For the berthing of small work boats, rubber fenders (rubber ramps), bollards and mooring rings are installed in the forefront of the platform. Stainless steel railings are set in the edge of the platform (as shown in Fig.1).

Layout of Main Observation Devices

Shafts of observation well for tidal level, temperature, salinity and water quality are installed at the bottom of the platform. In the first floor of platform, tide gauge, sensors for related items and battery packs are laid. Observation device hosts and communication system are set in the second floor, with interface are reserved for instruments of departments of earthquake, maritime affairs, environment protection, meteorology and water resources. Besides, sensors of meteorological observation instruments, solar energy module, communication antenna, lightning arrester and beacon are installed in the roof observation field.

Observation wells of temperature, salinity and water quality

Observation wells of 500mm inner diameter are set for temperature, salinity and water quality separately, with availability for setting up several relevant equipments, and porous installing flange are reserved in wellhead for fixation. The bottom of wells should be no less than 1m below the water surface (ebb tide), and water holes of appropriate amount are needed on the submerged part of well bores.

Tidal well

Tidal wells are set for offsetting the influence to buoy of wave surface, with inner diameter designed as 1m. Reinforced concrete, cast-iron pipe, steel pipe, rigid plastic tube and glass fiber reinforced plastics are all suitable for the material of choice. For the convenience of fixation and extreme water level observation, wellhead should be 1.5m higher than the highest water level ever, and the bottom should be 1.5~2.0m below the lowest stage. Four to six inlet openings are carved at the bottom of wells to keep the interior and exterior water surface changing consistently.

Wave absorber must be installed in wells to eliminate the impact of wave to water level, with infundibular adsorber adopted usually. The head of wave absorber should be 0.5m lower than the lowest water level ever, and the diameter of inlet pipe should stay proper, in case pipes get jammed for narrow diameter or

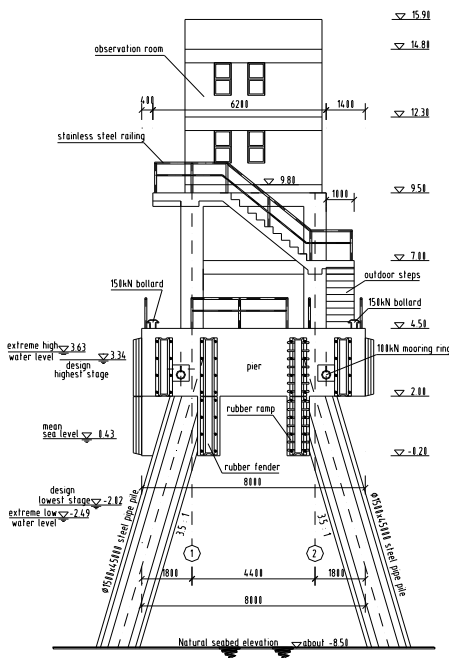


Fig. 1 Elevation of observation platform

inefficient to absorb wave for being too wide. In this project, diameter of inlet opening of wave absorber is valued as 4.5cm.

Power Supply and Lightning

Solar power generation is adopted in this project for safety, environmental protection and energy saving.

Power redundancy should be strived for to ensure the continuation and reliability of power supply to observation devices. Solar module consists of about 24 monocrystalline silicon panels altogether, one of which has 200 watts of power, as the full capacity designed to be 5kW. Solar panels are placed by two rows, reserving appropriate distance to meteorological devices in the upper part of the platform, which ask a stringent requirement of placement angle, being best to be 47 degree. The distance between two rows could be altered referring to the real gauge of platform.

Lead-acid battery is selected as energy storage element of power supply and distribution system, whose capacity could stand working in five successive rainy days. According to calculation, in this project, 32 single cells are connected in parallel, making the full capacity 6400Ah.

Durability Design

In this project, anticorrosive measurements are taken as below:

A combination of reserving corrosion allowance, coating and anode sacrifice protection is adopted to protect steel pipe piles. The calculated thickness of steel pipe piles is 22mm, with 4mm corrosive allowance reserved in upper parts and 2mm in lower parts. Anticorrosive coating in tidal range and splash area is sprayed by Sa2.5 class, with HNFF-H53-101 coating blade coated twice from the top of the piles to 2m lower than the mud surface. Aluminium alloy (Al-Zn-In-Cd) is picked to make sacrificial anode(as shown in Fig.2).

High-performance concrete is adopted with strength class no less than C40. DSF22 concrete anticorrosive coating is coated on the surface of reinforced concrete members in the tidal range and splash areas.

Construction Scheme

The project is comparatively far away from coastline, with water open and unsheltered, as well as high stormy waves. The order of construction are determined as follow: piles sinking, pouring pier, installing upper structure. The upper structures could be lifted by large floating cranes after being poured in land and transported to construction site as a whole. To ensure the successful installation of upper structures,

lifting must be conducted when waves are comparatively small or none.

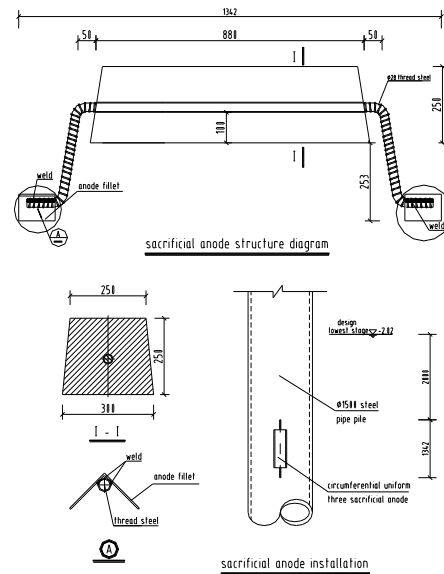


Fig. 2 Sacrificial anode structure diagram

CONCLUSION

This article takes the design of a marine observation platform in Jiangsu province as example, studying several key parts of project on the basis of difficulties in construction. This project has been completed now, which manifests the reasonableness and feasibility of design. The research results can provide a reference for the design of the subsequent ocean observing platform, and can be further applied in other related design of observation platform.

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