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# Developing trend of the construction types of inner river wharf with huge water fluctuation and their application

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## Abstract

This paper introduces the main construction types of inner river wharf, analyses the developing trend of the construction types of wharf in mountainous areas, and cites the application of wharf with huge water fluctuation in Chongqing and points out that suspended vertical wharf is the main construction type for deep-water, huge water fluctuation river terminals.

## Keywords

Huge water fluctuation, wharf types, developing trend, engineering application.

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## 1. Introduction

There are numerous rivers in Southwestern region of China where enjoys abundant water resources because of adequate rainfall, but most of them are mountainous rivers whose water level of the coastal wharf is very big along with the change of seasons. For example, the water level of the upper reaches of the Yangtze River port is generally 16 m ~30m, individual ports even reach 50 m. As early as 1960s, China put forward to the research problem related to construction types of wharf with huge water fluctuation and handling technology in Yangtze River, Xi Jiang River.

For these ports with huge water fluctuation, taking into account the geological, topographical, hydrological, investment and other conditions, most of them applied the slope type of wharf. The loading and unloading process and equipment of the traditional slope type container wharf no longer manage to meet the demand of the rapid growth of container traffic. Therefore, it is urgent to study and develop the economical and efficient construction types of wharf which are suitable for the ports with huge water fluctuation of Western region.

## 2. Brief introduction to the type of river wharf in mountainous area

Vertical wharf, sloping wharf and floating wharf are used frequently in mountainous rivers. Vertical wharf has the advantages of high degree of mechanization, high throughput and low labor intensity of workers. To ensure the normal operation of ship in dry season, dock should be built on the Bank of the dry, which makes the terminal near the river, it will have a certain impact on the River Flood in flood season. In addition, due to the huge water fluctuation, the construction of high vertical piers may lead to the vertical line of sight is too large, and workers cannot see the scene of loading and unloading situation, which will not only affect the efficiency of loading and unloading but also increased security risks. Sloping Wharf can well solve the problem result from large water fluctuation. but the job of shifting berth would be inconvenient especially in the flood season, it needs to move berth several times due to fierce fluctuation of water level. Even if the shift is not timely and may result in stranding. Floating wharf can well solve the problem due to variation of water level. The site and wind, waves will have a large impact on loading and uploading operations because it has to be carried out in the barge. In addition, through capacity is limited because of the barges and the shore are connected by approach span.

### **3. Development trend of the form of river wharf in mountainous area**

Before 1980s, wharf construction lack funds due to restriction of financial condition, so the sloping wharf with low cost are priority in structure selection. After 1980s, The quantity of the construction or alteration of the vertical terminal are increasing because of sloping wharf no longer meet the growing demand of inland waterway transport. At present, the proportion of the vertical wharf is higher than that of the Sloping Wharf.

Cao Zhou Hong investigated the relationship between the type of wharf and difference of water level and then put forward to the fact that When the difference of design water level in 10 m~20 m, vertical type wharf accounted for the highest proportion, in a dominant position; when the difference of design water level in the 20 m~30, sloping type wharf accounted for the highest proportion, in a dominant position; when the difference of design water level in more than 30 m, almost no other form of pier, sloping type wharf in dominant position. XU analysis the Structure form of inland river wharf and found out that sloping wharf accounted for about 2/3, most of them are solid slope, and the rest of them are pier, the classification of vertical, vertical and bridge cranes, etc. wharf structure basically are slope type in Port of Fen du, Chongqing, and Wan Zhou, few of them are steps float store type, stepping ladder, trestle type and vertical type and so on. At the same time, it is pointed out that the vertical pier especially suspended vertical pier will be the trend of development in the upper reaches of the Yangtze River, Three Gorges Reservoir area.

Along with the enhancement of our country's economic strength and the implementation of the western development strategy, the development of inland river ports in the western region is fast. The level of inland waterway continue to increase because of the channel improvement constantly carry on and some key projects have been completed and the task of Inland waterway shipping is also increasingly heavy. The suspended vertical wharf has shown a wide application prospect because it can well adapt to the variation of water level, and has high handling efficiency, large through capacity,. Therefore, suspended vertical wharf is a trend of structure form of wharf for the inland port in deep water and high water level in the future.

### **4. Structural characteristics of vertical type wharf with large water level difference in inland river**

No matter what sort of form of wharf is used, vertical type wharf of inland river with huge water fluctuation all have following characteristics:1) the height of wharf is large due to the duration of flood is short, and the variation of water level is fast. 2) Continuous or graded mooring facilities. The size of barges or container ship are usually small in the upper reaches of the Yangtze river result from the restriction of depth of river and navigation conditions. In order to meet the need of docking and mooring, mooring facilities of wharf need to be arranged correctly.3) Pile foundation. the bed of mountainous river show a trend of being eroded because of the frequent fluctuation of water level and the big velocity of flow. The formation of wharf area usually has the characteristics of thin overburden and shallow bearing stratum. Therefore, it is generally used as the foundation of the wharf.4) The wharf structure has obvious spatial characteristics.

### **5. Application of Wharf with huge fluctuation of water level in Chongqing area**

Chao tan Men ferry terminal which is located in the right bank of Jialing River in the downtown of Chongqing, and the design through capability of wharf is 490 million each year, the maximum capacity of passengers is about 6,000. There are three 3000t berth in water area. The length of berth is 255m and the total length of coastal line is 303m. There are multifunctional passenger terminal building and ticket hall in land area. The design high water level is 190.97m (Wu Song datum), the design low water level is 160.10m and the design bottom elevation is 15.71 m. it is typical wharf with huge fluctuation of water level. 3) container terminal of Huang QI, the main function of this wharf include container transport, Car transportation, Port logistics center. The total length of coastal line is 1462m, and the area is 1322acres. It has 5 3000 t class

container terminal berths. It is estimated that the total investment is 1 billion yuan. It is a wharf with huge fluctuation of water level because there is a big difference between the design high water level and low water level.

## 6. Epilogue

The suspended vertical type wharf has lots of advantages which can adapt to the change of water level and the loading and unloading efficiency is high, the capacity is large, the prospect of application is wide, and so on. So, suspended vertical wharf is a trend of form of wharf in the future for the port with huge fluctuation of water level.

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