Flood Control and Environmental Improvement of Hankou Beach

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1 Hankou beach

1.1 Current situation

Hankou beach is located on the left bank of Changjiang(Yangtze) River, in the central section of communication and business of Wuhan City, and outside the concrete flood wall. It starts from Wuhan Passenger Wharf (downstream), to Fuhuan river mouth (downstream of Houhu Shipyard), with the total length of about 9.4km, and the elevation of 20m—24m (the Huanghai sea datum plane as elevation; the freezing Wusong datum plane as water level, the reduction formula: Huanghai elevation = Wusong elevation –2.09m), below the flood control level of 25.00m. The average width of border beach is about 300m, and the area is 3km^2 around.

The soil and water loss in Wuhan City belongs to water erosion, with the soil erosion modulus of 3,308t/(km^2 • a). Through the historical evolution of many years, such as the river fluctuation, water erosion and scour & silting, the Hankou bank side in the left of Changjiang River has become a large river beach nowadays. Every kinds of buildings are densely arranged 2km upstream of the beach (from Wuhan Passenger Wharf to Yiyuan Road), and there is a park. In the middle of 1.5km long (from Yiyuan Road to the 2nd Changjiang River Bridge), there are lawn, vegetable plot and sports ground, in the lower stretch of 3.5km long (from the 2nd Changjiang River Bridge to Houhu Shipyard), besides sand beach and small scale recreation ground, there are wave protection forest zone and low land. See Fig.1.

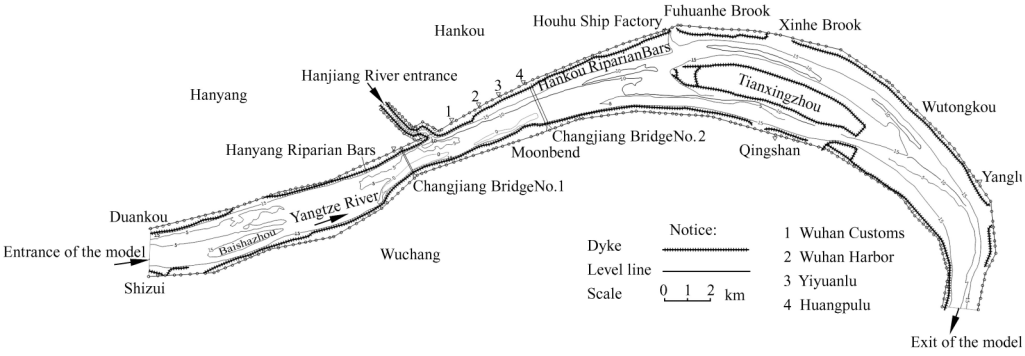

Fig.1 Sketch picture of the model plan layout in wuhan reach

1.2 Evolution

In the earliest geomorphologic map (1858—1880), the Hankou beach appeared in an embryonic form. In the recent 50 years, the maximum area of the beach is 7.6km^2 (in 1981) and the minimum is 1km^2 (in 1954).

The annual variation of river beach: (1) the head of beach is deposited in dry season, scoured in the early of flood season, lengthened by silting in flood season and scoured in the end of flood season; (2) when the head and end of beach are scoured, the middle of beach will be silted; (3) when the head and end of beach are silted, the middle of beach will be scoured. (4) the silting of beach head in dry season and flood season is influenced by the incoming sand of Hanjiang River and the scour of Hanyang beach. Generally, the secular change regularity is as follows: the beach is lengthened by silting after low flow

year, while reduced after high flow year. The cause is, Hanyang beach is lengthened by silting in low flow year, and moved downstream to Hankou beach in flood season of next year. And the situation is on the contrary in high flow year.

1.3 Outstanding issues

1.3.1 Flood control

Wuhan City, with important geographical position, is the center of politics, economy and culture in Hubei Province, the especially big city and a hub of communication in the middle of China. Hankou and Hanyang, situated at the confluence of two rivers, are low in terrain, lower than the mean annual flood level of 25.5m for most of parts, and protected by levee completely. However, the existing levee can only withstand the flood of 20—30 years frequency, for the severe flood (29.73m) as in 1954, flood diversion measures shall be taken, with the flood diversion and storage of $68\times10^8m^3$, that means much more flood diversion and storage areas shall be established near Wuhan City.

The mean annual precipitation of Wuhan City is 1,205mm, and concentrates during April to September. The peak appears in July and August, with high flood peak, a great amount of flood and long time, and contradicting the safety discharge of Changjiang River channel. The Three Gorges Project will be helpful to the dispatching, peak reduction and flood retention of the flood in the upstream of Changjiang River. However, the flood control capacity is insufficient relatively, a catchment basin of $800,000km^2$ exists in the downstream, and the storm region centralizes in distribution. In the upstream of Wuhan City, the large tributaries such as Qingjiang River, Dongting Lake water system and Hanjiang River flow into the Changjiang River, so the flood is great and the flood component is complex. Therefore, the situation of flood control is still grim in the middle and upper reaches of Changjiang River Basin including Wuhan City.

1.3.2 Environment

The continuous silting up of Hankou beach results in the inconvenience for Hankou port and wharf, brings about difficulties in operation of facilities in water works intake, and produces great effect on the investment environment of industry and commerce and the sustainable development of society in Wuhan City.

On the beach above the elevation of 23.0m, every kinds of buildings are arranged densely, including 70 mid- and small-sized industries, with the building area of $100,000m^2$. In addition, more than 40 administrative departments, state enterprises and collective enterprises, 10 wharves, parks, stockpiles and recreation grounds etc. total up to $160,000m^2$. The above mentioned buildings block flood in flood season, and do harm to flood control. The buildings look crude and disorderly, the garbage are piled up everywhere, the waste water overflows everywhere, and the sewage ports are arranged densely, so the impact of pollutants on the Changjiang river increases, and with the small water body and low flow velocity near bank, the dilution capacity of water body is limited, therefore, a pollution zone is formed near bank side, which disrupts the environment and harms the appearance of city.

The sewage of $7.87\times10^8t/a$ (in 1999) in Wuhan city was discharged by the sewage ports of beach. In order to improve the key function of core littoral region, it is necessary to carry out flood control and environment improvement, solve the problem of serious environmental pollution.

Wuhan City is an old epidemic area of schistosomiasis, it is investigated that there was an area of $13,830hm^2$ full of Oncomelania, the patients with schistosomiasis of more than 5,700 in 1999. Therefore, the prevention of schistosomiasis also shall be performed.

2 Regulation scheme

2.1 Regulation purpose

Wuhan City is one of the key flood control cities approved by the State Council; Wuhan river stretch is one of the important stretches to be harnessed. The regulation task determined in the “Planning Report” is : “to make the bank line stable, ensure the river channel open to flood discharge, bring the

preponderance of water transportation and water supply of the Changjiang into full play, develop and utilize the water and soil of the river stretch economically and rationally, and make Wuhan city get rid of the restriction of twisting river."

2.2 Engineering measures

The regulation works will put the flood control, environmental improvement and landscape establishment along the banks first, also give consideration to navigation, bank line utilization, urban communication, and schistosomiasis prevention. The project involves beach clearance, channel dredging, hydraulic fill of beach, bank line protection and landscape establishment.

The length of regulation: from Wuhan Passenger Port (downstream) to Houhu Shipyard, with the length of 7,007m.

The width of regulation: calculated by the width at Yiyuan Road, the width will be 120m, 150m,160m, and 190m respectively.

The elevation of regulation: the beach elevation will be 26.19m (freezing happens in Wusong at 28.28m, which is the observed max. flood level in 1931), 26.71m (freezing happens in Wusong at 28.80m, which is equal to the level of 10—15 years frequency flood), and 26.91m.

The range of channel dredging: in order to guarantee the overflowing sectional form of regulated channel favorable to the increase of overflowing capacity, and improve the water body conditions of navigation channel and port and wharf further, the river channel near the beach will be dredged essentially.

3 Model test

3.1 Purpose for test

The author analyzes and studies by the experiments of immovable and movable bed. By the immovable bed experiment, the change of the water level, velocity, flow shape and diversion ration between the left and right braided channel in Tianxingzhou is researched after the project actualized; by the movable experiment, the river regime, the channel change of scour and sedimentation and the back deposition problem of the dredged region are studied in different and typical hydrology-year.The researches provide the scientific groundwork for the scheme choice and decision-making of the project.

3.2 Model design

In order to guarantee the similarity of water-sediment movement between model and prototype, make clear the variation of hydrologic condition and river regime in the upper and lower of this river stretch before and after regulation works through model test, the simulated range of model is: for the main stream of Changjiang River, from Dunkou of Hanyang to Yangluo of Hankou, overall length of 47.8km; for Hanjiang River, from 500m upstream of the 1st Jianghan Bridge to confluence mouth, totalling about 1.56km long. The model is a geometrically distorted one, with the plane and vertical scale of 450 and 120 respectively, and the distortion ratio of 3.75. At the same time, the model will simulate the similarity of sediment suspension movement, taking wood dust as model sand, with the weight ratio of 1.05. It is determined through verification test that, for the model bed, the sand size scale is 0.30, the sand content scale is 0.44, the silt transfer coefficient scale per unit width is 532, and the scour and silting time scale is 650.

3.3 Hydrologic condition for test

(1) Immovable bed model test: 2 kinds of hydrologic conditions have been selected for model test (see following Table).

(2) Mobile-bed model test: according to the observed hydrologic data, the more safe serial hydrologic process of typical silting composition is selected, namely 1957 type (moderate-flow and

moderate sand year) +1984 type (moderate flow and plentiful sand year) +1998 type (high flow and plentiful sand year) +1979 type (low flow and moderate sand year), to study the change of river regime and bed scour & silting, and the problem of back silting in dredged area after beach regulation.

Table Hydrologic condition of the immovable bed model test

Discharge at Wuhanguan (m^3/s)	Discharge of Hanjiang river(m^3/s)	Water level at Wuhanguan Freezing at Wusong(m)	Water level at Yangluo Freezing at Wusong(m)	Remarks
71,100	6,070	29.41	28,069	The max. discharge and the corresponding level observed in 1998 flood
84,000	2,000	30.50	30.04	Designed flood of 300 years frequency, the situation of Wuhanguan when flood diversion according to the plan.

3.4 Test for regulation scheme

(1) Schemes 1—5: the width of regulation is 120m, 160m and 190m (at Yiyuan Road), the length is 7,007m (from the downstream of Wuhan Passenger Port to Houhu Shipyard), the elevation is 28.28m and 28.80m. The test boundary condition: the dredging is carried out in construction section, with the dredging depth of 3.6m. Each scheme is composed of different width and 2 kinds of elevation. The stress has been put on schemes 1, 3, and 4 though optimization. See Figure 2.

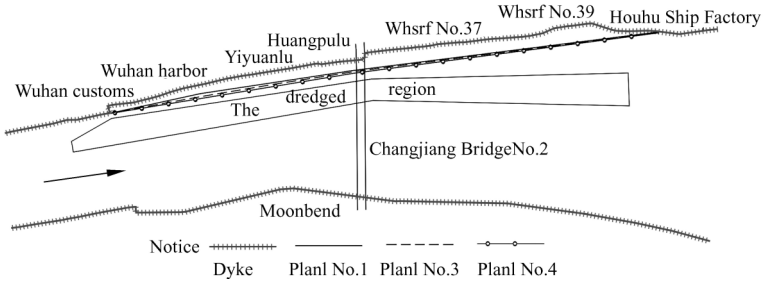

Fig.2 Plan sketch picture of the regulation line (plan 1— 4)

(2) Schemes 6—8: the width of regulation is 120m, 150m and 190m (at Yiyuan Road), the length is 7,007m (from the downstream of Wuhan Port to Houhu Shipyard), the elevation is 28.28m and 29.00m. The test boundary condition: the dredging is not carried out in construction section; current situation: in the upstream of Yiyuan Road, the overflowing will not be considered, while 40% of water blockage will be considered for the downstream of Yiyuan Road; planning: no water retaining structure will be arrange on the beach. Each scheme is composed of different width and 2 kinds of elevation. See Figure 3.

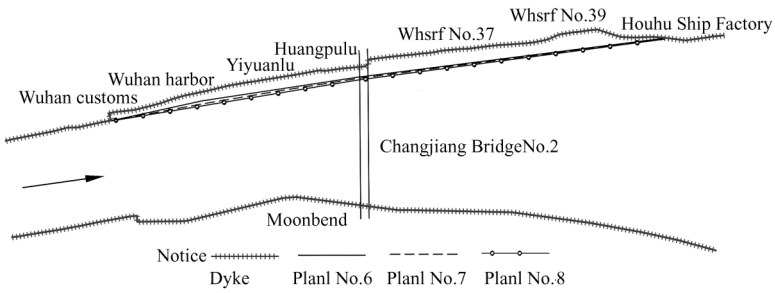

Fig.3 Plan sketch picture of the regulation line (plan 6—8)

4 Desired effect

(1) Flood control benefit

Wuhan has experienced serious flood disaster constantly. In 1931, 32,600 peoples died of flood, hunger and pestilence in Hubei Province. In the flood of 1935, the land of 427,000hm^2 was inundated, 3,700,000 peoples were hit by flood, and 80,000 peoples died, including 60,000 peoples in Hunan Province.

The new China has experienced several catastrophic floods, Wuhan has not fallen, but put in tremendous cost, for example, in the flood of 1954, the affected population reached to 85,000, the direct cost for dealing with emergency and relieving and compensation due to flood diversion totaled up to 2×10^8 yuan RMB. In the flood of 1998, in order to defend Wuhan City, 70 polders around were broken, which resulted in affected population of 1,777,000, the collapsed housing of about 10,000, the besieged population of 166,000, the inundated farmland of 148,700hm^2, the affected enterprise of 2,100, and the economic loss of 41.3×10^8 Yuan.

Through the regulation works of Hankou beach, the flood obstacle will be cleared away, the bank line will be straightened, the flow condition will be improved, the flood control pressure and expenditure will be reduced. Therefore, it will produce tremendous economic benefit.

(2) Environmental benefit

Through comprehensive regulation, a green space with the area of 170,000m^2 will be established along the river, which will play an important role in easing the serious shortage of public green land and rest space in urban area along the river, improving the surroundings, raising the living quality, and achieving the sustainable development of economy and environment.

(3) Social and economic benefit

After the improvement of flood control capacity, the lives and properties can be protected strongly. And the economic value of land resources will be increased greatly.

(4) Promote unified planning and arrangement of water supply and sewage discharge, improve the water source and quality in intake

After the hydraulic fill of beach will have been carried out, the original jagged sewage drain ports will be blocked.

(5) Others

It also will produce active influence on urban communication and schistosomiasis prevention.

5 Conclusion

(1) According to the test results in immovable bed and mobile bed, scheme 3 (with the regulation length of 7km, the width at Yiyuan Road of 160m, the elevation of 28.80m, and dredging in the construction section) is recommended because its better comprehensive economic benefit. However, the back silting will happen in the dredging area, with the back silting of about 20% in common hydrologic year. Therefore, the dredging measure shall be taken to ensure the flood control benefit of regulation works.

(2) The regulation works of Hankou beach is determined to put the flood control, environmental improvement and landscape establishment first, also give consideration to navigation, bank line utilization, urban communication, urban reconstruction planning and schistosomiasis prevention. The green riverside park, putting rest and recreation first is designed. After completion of the works, the environmental benefit, flood control benefit, and social and economic benefit will be great. The regulation works of Hankou beach will be the precedent of channel regulation for riverside cities along Changjiang main stream, it is an event of profound significance.

(3) The unifying of human being and nature, the protection of water resources and ecological environment are the targets of sustainable development in the new century and the trend of world development. The human activities must be coordinated with the development of river. The environment is the essential guarantee of sustainable development, so the sustainable development shall be on the basis of constantly available resources and fine ecological environment. The flood control and environmental improvement of Hankou beach conform to the above mentioned views.

References

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