Advances in Social Science and Culture
ISSN 2640-9682 (Print) ISSN 2640-9674 (Online)
Vol. 7, No. 4, 2025
www.scholink.org/ojs/index.php/assc

Original Paper

Research on the Cross-land Zhongwan River Bridge Plan of Haicang Road, Hangzhou Bay New District, Ningbo

Fajin Lin[1] & Tao Yang[1*]

[1] Central & Southem China Municipal Engineering Design and Research Institute Co.,Ltd., Wuhan, 430010, China

[*] Corresponding Author: Tao Yang (1990-), male, Master of Engineering, engineer, E-mail: 445991808@qq.com Research direction: Urban and highway road design

Received: May 19, 2025 Accepted: July 01, 2025 Online Published: July 24, 2025

doi:10.22158/assc.v7n4p32 URL: http://dx.doi.org/10.22158/assc.v7n4p32

Abstract

Through the analysis of the current status of the bridge around the proposed project, it can be seen that there are many forms of surrounding bridges, which also forms a certain sense of rhythm, enriching the architectural form of the water network system. Therefore, in this plan design, the bridge plan should continue the rhythm of the bridge combination, forming a combination layout with high and low, sparse and dense; finally avoid similarity with the built bridge and has landscape characteristics; Plan 1 takes the "shell" of marine culture as the design element, which looks like an open shell, with a unique shape, the bridge sidewalk is widened, the arc shape is perfectly coordinated with the open shell outline and pattern, and the high and low arch ribs give people a visual spatial effect of moderate opening and closing, highlighting the opening and closing of open space, The spirit of relaxation and progress, while listening to the wind and watching the scenery on the bridge, feel the unique charm of the bridge shape; Plan 2 takes the "fishing net" of marine culture as the design element, and the layout of the arch bridge boom adopts a grid-shaped Nelson system, which is perfectly combined with the "fishing net" of marine culture, like the scene of a harvest in the countryside of fish and rice, symbolizing the spirit of rich construction and pioneering, and the precipitation of local feelings. A plan comparison and research is conducted on the cross-land Zhongwan River Bridge of Haicang Road, Hangzhou Bay New District, Ningbo, and selects a suitable bridge shape.

Keywords

scheme design, shell, fishing net

1. Design Concept

1) Provide a design document that meets the project construction requirements according to the planning and design points, guide construction, and strive to achieve the design goals of planning satisfaction, environmental protection satisfaction, and owner satisfaction (including citizens' satisfaction, operation satisfaction, and project satisfaction).

2) Correctly understand and resolutely implement the idea of "people-oriented and circular development", focusing on the elements of driving, pedestrians, and environmental landscape elements.

3) Take into account both long-term development and short-term construction, and achieve a "combination of long-term development" to strive to be neither contradictory nor repeated investment in the long-term development nor repeated investment.

4) The project should compare multiple plans. Through the optimization and combination of design plans, control construction behavior and expected results of engineering behavior, measures and investment control standards should be proposed from the perspective of design.

5) Fully consider the implementation conditions of the project, project risks, and technical level of construction and installation to create conditions for the smooth implementation of the project.

6) The design should be carried out in accordance with the bridge's usage tasks, functions, properties and future development needs, and in accordance with the principles of application, economy, safety and aesthetics.

7) Make necessary explanations on construction technology, process flow, construction organization and acceptance standards. Strive to ensure accurate, reasonable and precise investment estimation.

8) Under the premise of safety and economicality, bridge engineering projects should use novel, beautiful and environmentally friendly materials as much as possible, so that after the project is completed, it can give citizens a bright, comfortable and bright feeling.

9) The design process instills and implements the concept and awareness of creating high-quality projects from beginning to end, encourages designers to explore ideas, constantly innovate, and produce more high-quality products to change the phenomenon of urban construction being the same, dull, and no new ideas.

2. Design Guidance Idea

After sufficient on-site survey and investigation, based on the characteristics of this project and combined with similar engineering design experience, the following overall design ideas of the bridge should be implemented in the design of this project:

2.1 Reflect the Importance of Landscape Design

1) Bridge landscape design and its content focus on the ontological landscape of the bridge. In bridge landscape design, the environmental landscape echoes the general background, adhere to the four principles of unity, coordination, balance and rhythm, and maintain the sustainable development of the landscape.

2) Through bridge landscape design, the spatial scale and landscape harmony of the surrounding

environment of the bridge and landscape and urban concepts are reflected, and the bridge landscape is attached to the suitability of the bridge landscape to the terrain and landform, and the respect and symbiosis of the bridge landscape for the cultural environment.

3) Carefully handle the positioning of the bridge image, and form a bridge landscape concept through urban spirit, citizen behavior code, urban development strategic goals, etc., and determine the markers, logo patterns and logo colors.

4) Landscape bridges are not only limited to meeting the basic functions of bridges, but also highlighting the structural technology, morphological aesthetics, and material texture research of bridge landscape design, thereby improving the overall environmental quality.

5) Take into account the landscape effects of day and night, use local characteristics and lighting effects, and combine them through different techniques to create a multi-level and rich color changes. It can not only fully reflect the culture with the characteristics of new cities, but also be full of modern and fashionable atmosphere. Through the organic combination of soft landscape and hard landscape, it integrates each other, making the bridge landscape a whole.

2.2 Reflect the speed of bridge construction

With the construction and development of the new city, the new city is expanded to the north, and the new industrial transformation base will rise rapidly. The bridge across Shitang Hengjiang should also be opened to traffic as soon as possible. The bridges will connect regions and connect the economy. As a pilot zone for Ningbo's future industrial transformation and upgrading, it is of great significance to the development of this block. Therefore, the design of this project should fully consider the construction speed to ensure that the bridge is completed as soon as possible.

2.3 Reflect the Importance of Environmental Protection

Environmental protection is a basic national policy of our country and an eternal theme in the process of social development. This project is located in Ningbo Hangzhou Bay New District. Its superior geographical location, natural conditions and strong cultural heritage objectively put forward higher requirements for environmental protection, soil and water conservation and humanistic environment protection in the project design. Therefore, during the design process of this project, we must be ahead of time, emphasize environmental protection, achieve green energy conservation, reduce bridge maintenance costs, reduce automobile exhaust emissions, and reduce driving noise. We must strive to build this project into a modern bridge project integrating ecology, environmental protection, beauty and economy.

2.4 Absorb Successful Experience in Bridge Constr Uction

Fully absorb the successful experience of urban bridge construction at home and abroad, earnestly design the bridge plan, and lay the foundation for building this project into a high-quality project with high-quality technical quality, investment and good efficiency.

In addition to focusing on implementing the above guiding ideology in design, the following issues should also be considered in specific application: safety of bridge operations; excavating sea coating

culture and introducing the concept of dynamic design; determining reasonable construction standards and controlling engineering investment.

3. Overall Landscape Analysis

3.1 Master Plan Analysis

Hangzhou Bay New District is located at the south bridgehead of the Hangzhou Bay Cross-Sea Bridge, in the northern part of Ningbo City, and central cities such as Shanghai, Hangzhou, and Ningbo are within their two-hour access range, with superior location conditions. The area has rich tidal flat wetland resources and dense water networks, rich land resources and reserves, and extremely good ecological environment.

The plan positions the development of Hangzhou Bay New Area as: Ningbo North New City, Ecological Hangzhou Bay. It is emphasized that the new district is the "frontier" connecting with Shanghai and the core of leading the development of Ningbo's northern wing. It focuses on realizing the coordination of production, life and ecological environment in the new district, highlighting ecological construction, and creating a high-quality new city with cultural characteristics, waterfront landscape, and comprehensive modern functions.

3.2 Surrounding Environment Analysis

The plan analyzes and sorts out the unique seawall culture and water culture of Hangzhou Bay New District. The area east of the Cross-Sea Bridge and west of the Luzhong Bay River is the new business city area, and builds a new city-level core area around the central landscape lake Shengxi Lake, focusing on the layout of business office, livable life, green ecology and other functions.

The Haicang Road cross-lu Zhongwan River Bridge designed in this plan is adjacent to Ningbo Hangzhou Bay New District Sports Park and Hangzhou Bay Haipi Island Scenic Area, and to the east side of Ningbo Engineering College. Haicang Road is an urban secondary road running through the core block of the new business city area and an important connection with the high-end industrial zone on the east side. Therefore, this bridge plan requires the end point to consider the landscape effect of the bridge.

3.3 Peripheral Bridge Type Analysis

Due to the developed water system in the area and many bridges, in the bridge design, the surrounding areas should be investigated for planning and building bridges to guide or eliminate some solutions that are not suitable for this bridge shape, avoid the duplication of bridge shapes, and thus achieve the best regional and landscape value of the bridge.

Through the analysis of the current status of the surrounding bridge, it can be seen that there are many forms of surrounding bridges, which also forms a certain sense of rhythm, enriching the architectural form of the water network system. Therefore, this bridge plan should continue the rhythm of the bridge combination and form a combination layout with high and low, sparse and dense; secondly, add bridge structural forms, such as suspension bridges, cable-stayed bridges, etc.; finally avoid similarity with

built bridges and have landscape characteristics.

4. Bridge Design

4.1 Bridge Design Principles

(1) The bridge plan should implement the technical goals of "functional application, structural safety, cost economy, structural durability, aesthetic shape, and environmental coordination" and engineering implementability.

(2) The layout form of bridges should fully consider factors such as the feasibility, operability and socio-economic benefits of the project, adapt to local conditions, combined with the topography, landforms, rivers, etc. within the scope of this project, and reasonably arrange them according to the requirements of the overall planning. On the premise of ensuring traffic functions, the impact on the surrounding environment and the overall planning should be minimized as much as possible, and the impact on the surrounding environment and the overall planning should be optimized through multiple plans, and the near- and long-term functional planning of the road should be fully considered.

(3) The bridge plan and construction plan must achieve technical goals based on the full study of their feasibility.

(4) Pay full attention to bridge landscape design, strive to be beautiful in shape, coordinated in the surrounding environment, and reflect the characteristics of the times.

(5) The impact of natural disasters on bridge structure should be fully considered.

(6) The structural types and materials used by bridges must be fully considered to ensure the anti-corrosion of the structure, improve the durability of the structure, and ensure the normal service period of the bridge for 100 years.

4.2 Bridge-type Solution Design Ideas

(1) Bridge type feasibility analysis

Based on the current situation of Hangzhou Bay New Area, a specific analysis of the feasibility of bridges was conducted, as shown in the table below:

Project	Haicang Road Crossing Luzhong Bay River Bridge
Current Situation Analysis	Adjacent to the Ningbo Hangzhou Bay New Area Sports Park and Hangzhou Bay Seapanda Island Scenic Area on the west, and Ningbo University of Technology on the east. It is an important channel connecting the business district and industrial area, with a river width of 165m.
Functional Positioning	Located in the business new urban area, the regional bridge must fully consider its landscape effect while meeting transportation and under-bridge navigation functions.

Project	Haicang Road Crossing Luzhong Bay River Bridge
Commonly Used Bridge Types	Prestressed concrete continuous beam, arch bridge, cable-stayed bridge, suspension bridge.
Feasibility Analysis	1. All commonly used bridge types can meet transportation function requirements, but small-span precast beams have some impact on navigation. 2. Suspension bridges are generally only suitable for super-large spans and crossing rivers, other rivers, or structures; the small span here cannot achieve the expected landscape effect. 3. Arch bridges and cable-stayed bridges have strong spanning capabilities and are suitable for this bridge. 4. Given the special location of the bridge and the effects of existing bridge types, the landscape effect of the bridge must be prioritized.
Construction Difficulty Analysis	Arch bridges, cable-stayed bridges, and suspension bridges generally have large spans and use steel beams or steel-concrete composite beam structures, requiring high construction standards. Prestressed concrete continuous beam bridges have mature construction techniques and lower difficulty.
Cost Analysis	Arch bridges, cable-stayed bridges, and suspension bridges generally use steel beams or steel-concrete composite beam structures, with higher costs. Prestressed concrete continuous beam bridges have lower costs.

(2) Overall concept

Through feasibility study and overall planning analysis, the business new urban area where Haicang Road crosses the Zhongwan River Bridge is located emphasizes the organic combination of ecological construction and quality life. It is adjacent to Ningbo Hangzhou Bay New District Sports Park and Hangzhou Bay Haipi Island Scenic Area on the west side, and to Ningbo Engineering College on the east side, which is an important channel connecting the business district and the industrial district. High requirements are put forward for the design of bridge landscape. In the design, we should combine actual conditions, follow the concept of adapting to local conditions and sustainable development, and use "water, ecology, and humanities" as the design concept to build an international new urban area with a modern urban atmosphere and rich pastoral scenery, which is livable, business-friendly and

business-friendly.

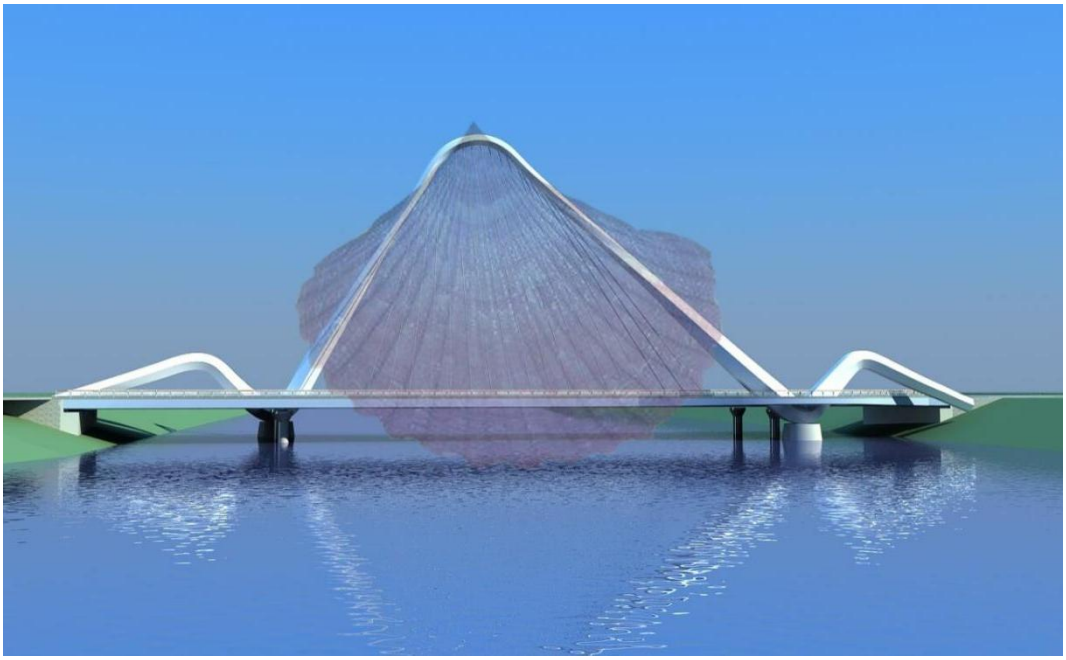
4.3 The plan of Haicang Road cross-land Zhongwan River Bridge

Design theme—Bei Hai Shizhen

The plan takes the "shell" of marine culture as the design element, which looks like an open shell with a unique shape.

The bridge sidewalk is widened, with arc shape, perfectly coordinated with the spread shell contours and patterns. The high and low arch ribs give people a visual spatial effect of moderate opening and closing, highlighting the spirit of openness and enterprising. On the bridge, you can feel the unique charm of the bridge shape while listening to the wind and watching the scenery.

The shape of the bridge is in harmony with the surrounding environment, showing the integration of the romantic city and the spirit of struggle and innovation, symbolizing the shining of the new city like a pearl in a shell; it also symbolizes the development of the ocean with a vast world and infinite space.



Concept diagram

A bird's-eye view of the plan

Plan a train rendering

One-day perspective effect diagram

One-night scene renderings

4.4 Plan 2 of Haicang Road Cross-land Zhongwan River Bridge

Design theme - Fishing Sea Style

This plan takes the marine culture "fishing net" as the design element. The layout of the arch bridge boom adopts a grid-shaped Nelson system, which is perfectly combined with the marine culture "fishing net" and is like a scene of a harvest in the countryside of fish and rice, symbolizing the spirit of rich construction and pioneering, and the precipitation of local feelings.

Schematic diagram of modeling concept

Arch bridge is the earliest and most widely used bridge type in the history of world bridges. The arc of the arch is beautiful, gentle, simple and elegant, and has the artistic characteristics of the Chinese national arch-style architecture. It also has the characteristics of being compatible with the coordinated beauty of human landscape and natural landscape. The arch contains a sense of tension and rhythm of vivid force, which makes the bridge show a vibrant and tenacious temperament and a powerful and magnificent momentum. The arch bridge crosses the river in a graceful posture, like a long rainbow lying on the waves, with a strong sense of signification and space.

Plan two-day view bird's eye view

Side view of the two-day scene

Solution 2 night scene rendering

5. Conclusion

The comprehensive comparison of Plan 1 and Plan 2 is made from the aspects of landscape characteristics, superstructure form, lower structure form, construction difficulty and maintenance requirements, etc. as follows:

Project	Scheme 1	Scheme 2
Bridge Layout	50+85+50m	1×175m
Landscape Characteristics	The scheme uses "shell" as a design element from marine culture, resembling an open shell. It showcases the blending of a romantic city and the spirit of striving and innovation, symbolizing the new city shining like a pearl in a shell and development as vast and boundless as the ocean.	The scheme uses "fishing net" as a design element from marine culture. The arrangement of the arch bridge's suspension rods uses a grid-shaped Nielsen system, perfectly combining with the "fishing net" of marine culture, resembling a bountiful harvest scene in a land of fish and rice, symbolizing the spirit of prosperity,

Project	Scheme 1	Scheme 2
		construction, and pioneering, as well as the precipitation of local sentiment.
Superstructure Form	Adopt special-shaped arch bridges, with steel main beams and orthotropic bridge decks.	Adopt tied arches, with suspension rods using the Nielsen system, steel main beams using a longitudinal and transverse beam system, and concrete bridge decks.
Substructure Form	Column piers, abutments with seat slabs, and bored pile foundations.	Abutments with seat slabs and bored pile foundations.
Construction Difficulty	Relatively difficult	Difficult
Maintenance Requirements	General	General
Construction Period	22 months	24 months
Project Cost	121.702 million yuan	129.045 million yuan
Comparison Result	Recommended	Not recommended

References

Overall Planning of Ningbo Hangzhou Bay New Area. (n.d.).

Regulatory Detailed Planning of Ningbo Hangzhou Bay New Area. (n.d.).