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Research on the Design Scheme of Ningbo Jiulong Avenue Expressway

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Abstract

This paper takes the design scheme of Ningbo Jiulong Avenue Expressway as an example, this article compares and selects the most reasonable scheme based on the project's planning and current situation, combined with traffic volume forecast and current situation analysis, through comprehensive comparison of schemes, covering aspects such as scheme feasibility, traffic function, and economy.

Keywords: elevated road, interchange, comprehensive selection

1. Introduction

As Ningbo's urban space expands northward, the transportation demand between the central city area and the Yuyao-Cixi sub-city has seen a sharp increase. The traditional road network faces challenges such as insufficient traffic capacity, tight land resources, and fragmented multi-mode transportation systems. Against this backdrop, the Jiulong Avenue Expressway was launched. As an important thoroughfare running through the Jiulonghu Town area and connecting the northern Yuyao-Cixi urban area with the central city area of Ningbo, the completion of the Jiulong Avenue Expressway will be of great significance for enhancing Ningbo's urban level, promoting regional integrated development, and building a modern coastal metropolis urban pattern. This article aims to deeply analyze its design logic and technological breakthroughs, with a view to providing a paradigm for the construction of high-density urban transportation infrastructure. (Ningbo, 2022).

2. Construction Background

Ningbo is accelerating the construction of a "modern coastal metropolis", with the northern Yuci region (Yuyao, Cixi) being positioned as a sub center of the city. However, the central urban area and the Yuci sub city are separated by a geographical barrier of about 420 square kilometers, lacking efficient direct connecting channels, which restricts the two-way flow of industries, population, and resources. As a key project of Ningbo's 14th Five Year Plan, Jiulong Avenue Expressway aims to connect this key corridor and form a 30 minute transportation circle between the central urban area and Yuci Sub city, promoting Ningbo's transformation from a single core city to a multi cluster urban circle.

The planning and construction of Cuiping Mountain Central Park in Ningbo requires the support of a rapid transportation network to enhance its ecological and tourism functions. Jiulong Avenue runs through the Zhenhai Jiulong Lake tourist area. After completion, it will optimize the transportation environment of the Jiulong Lake area, alleviate holiday congestion, and strengthen the cultural and tourism linkage in the Cuiping Mountain area.

3. Engineering Overview

The Jiulong Avenue Expressway Project is located in Jiangbei District, Zhenhai District, and Cixi City of Ningbo City. It starts from Wencheng Middle Road in the south and ends at Longdu North Road in the north, with a total length of about 11.3 kilometers. The scope of this study is the section of Jiulong Avenue (Ring Expressway Zhenpu Road), which starts from the Ring Expressway in the south and ends at Zhenpu Road in the north, with a total length of about 2.6km.

4. Overall Program

4.1 Technical Standards

1) Road grade : The project plans to adopt the construction form of "mainline elevated+ground auxiliary road", and partially adopt the construction form of "ground expressway". The main road is classified as an urban expressway; The ground auxiliary road is classified as an urban main road.

2) Design speed: The mainline design speed is 80km/h; The design speed of the ground auxiliary road is 50km/h; The design speed of the ramp is V=40~50km/h.;

3) Clearance height: not less than 4.5m for motor vehicle lanes; not less than 2.5m for pedestrian and non motor vehicle lanes (*Specification*, 2009).

4.2 Road Cross-section Arrangement

According to the traffic volume forecast, the peak hour traffic flow by the end of the year (2045) will be approximately 4500~5000 pcu/h, and the main line will need to adopt a dual six lane road to meet traffic demand; According to the current development status and road network planning on both sides of the road section, the construction scale of the ground auxiliary road is 4-6 lanes. The overall service level is level three, and the road adaptability is good.

Construction form of "mainline elevated+ground auxiliary road": The elevated mainline is an urban expressway, adopting a full frame structure, with six lanes in both directions, a standard cross-sectional width of 25.5 meters, and a cross-sectional layout of 25.5m (cross-sectional width)=0.5m (crash barrier)+0.5m (curb)+11m (motor vehicle lane)+0.5m (curb)+0.5m (central divider)+0.5m (curb)+10.5m (motor vehicle lane)+0.5m (curb)+0.5m (crash barrier); The ground auxiliary road is a main urban road with six lanes in both directions, with a standard cross-sectional width of 46.0 meters. The cross-sectional layout is as follows: 46m (cross-sectional width)=2.5m (sidewalk)+3.5m (non motorized vehicle lane)+2m (side median)+11m (motorized vehicle lane)+2m (side median)+3.5m (non motorized vehicle lane)+2.5m (sidewalk).

The construction form of the "Ground Expressway": the main road has six lanes in both directions, and the auxiliary road is a mixed traffic lane (double four+non motorized vehicle lane). The standard cross-sectional width is 55 meters, and the cross-sectional layout is: 55m (cross-sectional width)=2m (sidewalk)+10.5m (auxiliary road)+2m (side divider)+12m (motorized vehicle lane)+2m (central divider)+12m (motorized vehicle lane)+2m (side divider)+10.5m (non motorized vehicle lane)+2m (sidewalk).

4.3 General Arrangement

The Jiulong Avenue (Ring Expressway Zhenpu Road) section project starts from the Ring Expressway in the south and adopts a ground expressway form to cross the expressway and expressway interchange. After passing through the interchange, it extends to Zhenpu Road in an elevated form, with a total length of about 2.6km. There are 2 pairs of parallel ramps and 1 hub.

Figure 1. Overall Design Scheme Elevated Scheme Schematic Diagram

4.5 Major Interchange Node Schemes

4.5.1 Current situation analysis

Current situation around the node: According to the aerial photos taken during the on-site survey, the current situation is a high-speed interchange. The current situation is that Jiulong Avenue passes under the Ring Expressway and intersects with a single horn interchange on the north side of the Ring Expressway, passing through the Jiulonghu Expressway toll station. The surrounding land of the project mainly consists of wasteland, agricultural and forestry land, and industrial land.

Figure 2. Current Satellite Map

Figure 4. Option 1

Option 1: A new single horn interchange will be built on the intersection of Jiulong Avenue and the Ring Expressway, connecting the expressway with the elevated road. The connection form between the ground auxiliary road and the highway toll gate remains unchanged in this plan, with a two-way six lane scale and single horn interchange; Build a new elevated single horn interchange to connect with highways and toll stations; It is necessary to expand the toll station appropriately. It is recommended to change the original "four in and six out" to at least "six in and eight out";

Scheme features: Strong transportation function, large land occupation, and high cost.

Option 2: Jiulong Avenue will pass through an interchange, and then the elevated road will cross over the ring expressway node. The existing ground interchange will be renovated, and the ground expressway will use a single horn interchange system to connect the expressway and the highway; The auxiliary lane system is expanded on the basis of the original slow lane system, with a two-way four lane scale. On the east side of the ground auxiliary road, enter and exit the highway entrance and exit on the right side. On the west side, you need to detour to the next intersection and then turn around to enter and exit the highway entrance and exit.

Program features: Strong transportation function, minimal land occupation, and steep slope of elevated sections.

Figure 4. Option 2

Figure 5. Option 3

Option 3: Jiulong Avenue passes through an interchange and expressway, and the ground expressway uses a single horn interchange system to connect the expressway and expressway; The auxiliary lane system is expanded on the basis of the original slow lane system, with a two-way four lane scale. On the east side of the ground auxiliary

road, enter and exit the highway entrance and exit on the right side. On the west side, you need to detour to the next intersection and then turn around to enter and exit the highway entrance and exit.

Program features: Strong transportation function and small land occupation.

Table 1. Comparison and Selection Table of Schemes

form	Option 1	Option 2	Option 3
functionality	Both the main line of the expressway and the ground auxiliary roads can directly connect with the expressway toll station, ensuring high traffic conversion efficiency	The mainline of the expressway directly connects with the toll station of the expressway, while the auxiliary ground roads enter and exit the mainline through parallel ramps at the front and rear before connecting with the toll station of the expressway	The main line of the expressway communicates directly with the toll station of the expressway, and the ground auxiliary road communicates with the toll station of the expressway after entering and exiting the main line through parallel ramps
Linearity indicator	Both the main and auxiliary roads can directly achieve traffic conversion through directional ramps, with good linear indicators	The auxiliary road needs to detour and connect to the toll station, with poor linear indicators	The auxiliary road needs to detour and connect to the toll station, with poor linear indicators
cost of construction	Highest cost	High cost	Lowest cost
conclusion	Symmetrical cloverleaf interchange is recommended for this project.		

5. Conclusion

This article takes the Kowloon Avenue Expressway as an example, based on the project's planning and current situation, combined with traffic volume forecasting and current situation analysis, through comprehensive comparison of schemes, the most reasonable scheme is selected from multiple aspects such as feasibility, traffic function, and economy.

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