Research on the Alignment Scheme of the Tourism Highway in Taihang Mountains with Cliff Terrain

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Abstract: In my country's infrastructure construction, highway construction has always been more important. The cliff-like terrain of Taihang Mountain is typical, the terrain changes obviously, the regional terrain is steep, the natural transverse slope is relatively large, and the terrain drop is also obvious. The local vertical drop can reach a maximum of 200-300 meters. In this paper, according to the characteristics of the cliff-like terrain of Taihang Mountain, some tourist areas are selected as cases, and the route selection scheme of tourist highways is formulated according to the terrain conditions, and the corresponding quality control measures are put forward..

1. Introduction

When designing a tourist highway in the Taihang Mountains, the route determination is the core part, and many factors need to be considered, including technical indicators, regional location, geological conditions, and surrounding environment. Maximize the convenience, environmental protection, safety and comfort of its operation. The driving safety of mountain roads has always been the focus of attention. The mountain routes should be scientifically and reasonably designed to provide relatively safe guarantees for drivers. At the same time, safety and quality control should be strengthened to reduce the probability of traffic accidents as much as possible. For the cliff-like terrain of Taihang Mountain, the terrain conditions are relatively complex, the geological conditions are relatively poor, and the longitudinal drop of some special road sections is large. road route.

2. Road Section Overview

Zuoquan County Red Taihang Baili Gallery Tourist Area Lianhuayan-Longquan Park Tourist Road Construction Project For the circulation section, the total length of the route selected in this paper is 13.282km. The route is roughly from northwest to southeast, starting from Shanshen Temple in the west, connecting with the north line of the branch line of Taihang No. 1 tourist highway under construction, and after passing Majiabei Mountain to the east. The north slope of Shuijingbei Mountain takes advantage of the favorable terrain to turn back and extend the route to Guandaogou, at the intersection of three ditch (open area) in the middle of Guandaogou to the bottom of the ditch, continue to route along the south side of Guandaogou to the mouth of the valley, and set it on the platform of the mouth of the valley. After the tourist service center, it is connected to the south line of the branch line of Taihang No. 1 tourist highway. The key control point of the project, Guandaogou, belongs to the cliff-like terrain of Taihang Mountain. The whole is relatively special, and the construction is difficult and there are relatively many control factors.

3. Line Selection Control Factors

3.1 Environmentally Sensitive Area

Among the routes selected in this paper, there are the National AAA-level Lotus Rock Scenic Spot and the National AAAA-level Longquan Forest Park Scenic Spot, which play a decisive role in the selection of the “Jingjingtong” route plan for the tourism sector in Taihang, Shanxi Province. Both are located in the national forestry ecological red line control. Within the area, it is necessary to conduct a review of the “Proposal for the Inevitable Demonstration of the Occupation of the

Ecological Protection Red Line" and the "Report on the Ecological Function Impact of the Project Occupied the Ecological Protection Red Line". If designing a road route, not only consider providing a golden channel for the scenic spot to achieve the purpose of improving tourism, transportation and sightseeing conditions; at the same time, it should also consider that it will not cause ecological damage to the scenic spot and ensure the sustainable development of forestry ecology. Tourism is a local pillar industry, so it has received the attention of the local government. It can be seen that the concept of road and landscape integration should be firmly established, road landscapes should be planned with high standards, and the integration of road landscapes with beautiful landscapes, coordinated with the human environment, and tourists. Adapt to the needs, promote the transformation of tourist roads to road tourism, and create a landscape corridor that is pleasant to the eyes, eye-catching, dynamic and static through the selection of routes that are suitable for the ecology, to meet the needs of tourists for leisure sports and tourism, and strictly follow the "green roads, ecological roads". "Basic Principles.

3.2 Terrain Conditions

From the basic situation of this section of the route, it is located in the middle of the Taihang Mountain ridge and the middle reaches of the Qingzhang River. The terrain is relatively steep, the vertical drop of the cliff can reach 200-300 meters, and the natural slope is relatively steep, mostly 90° or overhanging. This type of terrain is a typical cliff-like terrain. This type of terrain is relatively complex, which makes it difficult to plan according to conventional routes. From the current point of view, the only road in this section is the wall-hung road when entering and leaving the original natural village. It was excavated on the cliff, and most of them were chiseled against the wall, mainly for the convenience of construction and to meet the needs of ventilation and lighting. In this section of the highway, there are more than 10 meters apart, and windows are opened on one side. It can also be seen that the terrain complexity and construction difficulty of this area are.

3.3 Scenic Wiring

In this section of the route, the project connects the national AAA-level Lotus Rock and the national AAAA-level Longquan Forest Park. It is the main channel forming the Baili Gallery in the east area of Taihang Mountain, Shanxi Province. The important support of the base, after the investigation by the professional survey and design department, in this project, the project area is located on the west side of the main peak of Taihang Mountain, with many mountains and few rivers. The highest point in the area is located near the starting point, the ground elevation is 1810 meters, and the lowest point is located in the valley at the end point, with an elevation of 1226 meters. It is necessary to solve the intersection of the three valleys in the middle of Guandaogou of the highway (open area). The problem of the height difference of the wiring to the bottom of the ditch 584m.

3.4 Engineering Scale

The cliff-shaped terrain is relatively special, and under the influence of the terrain, in the plan of this route, there are 4 bridges of 1973.47 meters across the line, of which the extra bridge (Panlong Bridge) is 1735.5 meters/1, and the bridge is 106.0 meters/1. The middle bridge is 132.0 meters / 2, and 66 new culverts are built. The proportion of bridges is relatively high, and the scale of the project is relatively large. At the same time, in order to reflect the characteristics of the tourist road, there are 5 service facilities on the whole line, which are the first-class station of Shanshen Temple, Majiabei RV camp, the second-class station at K5 km, the viewing platform at the spiral bridge and the tourist service center at the terminal. It can be seen that the scale of the entire project should be reduced as much as possible on the basis of technical feasibility and the sustainable development of the scenic spot, which is also an important factor to be considered in the process of plan selection.

4. Route Design Points

4.1 Highway Graphic Design

In the design of cliff-type highways, the graphic design should strictly follow the corresponding road design specifications. In the actual design, the specified standards should be used as the basis. The design parameters should also be strictly controlled, so as to achieve the purpose of meeting the driving requirements of the vehicle. From a practical point of view, many existing design schemes in our country lack attention to the parameter problem. For highway route design, the actual mountainous terrain should be referred to, and the transition section of the highway should be calculated more accurately, and the minimum distance in districts and counties should be strictly controlled. Combined with the actual design scheme, the road quality can be improved to the greatest extent.

4.2 Highway Longitudinal Control

For the longitudinal design of the highway, the factors of overloading and the slope of each section should be fully considered, and the set value of the longitudinal slope value should be determined repeatedly. If the designed slope of the highway route is too large, traffic accidents will easily occur and threaten the life and health of drivers. It can be seen that when designing long-distance steep slopes, more attention should be paid to the average longitudinal slope, and combined with the actual situation in mountainous areas. Analysis, and then strengthen the rationality of mountain road routes. Since it is difficult to formulate a unified standard for the design of long and steep slopes, it must be combined with the actual local conditions. For some relatively special mountainous areas, it may be possible to avoid the appearance of long slope sections as much as possible. Therefore, during the actual design period, several different schemes should be proposed. Compare the options and choose the most reasonable option.

5. Route Design and Plan

In this paper, combined with the actual situation of the road section, a number of schemes are formulated, and three of the most advantageous routes are selected for comparative analysis.

5.1 Route Design

(1) A-line scheme

Line A chose the spiral bridge scheme, completely avoiding the excavation of the mountain, mainly to overcome the impact of the height difference. Among them, the height difference between the start and end points of the project is relatively large. The route follows the exhibition line of Majiabei Mountain and Shuijingbei Mountain 1st Road to the hillside on the north side of Guandaogou, crosses to the platform at the intersection of Guandaogou and Sangou, and finally passes through the spiral bridge to the The bottom of the ditch, and then naturally stretch the line to the end of the ditch. There are several reasons for the location of the spiral bridge: firstly, the height difference can be quickly reduced by using the spiral line; secondly, a spiral bridge with a radius of 80 meters is set up on the platform according to the terrain, making full use of the space of the plot; The bridge will cause less damage to the surrounding mountains, and part of the construction access road can be retained, which can be used as a rescue channel when necessary. After completion, it will form a kind of “the embrace of green hills by the bridge, peach blossoms and flowing water under the bridge”, which will be in harmony with the natural landscape, and combined with the viewing platform under the bridge, it will be the finishing touch for the entire tourist road. Although the construction is relatively difficult, the ecological damage is minimal, and it can also become the brightest tipping point for the tourism industry in the entire region, and the comprehensive value and benefits are relatively high.

(2) B-line scheme

The B line scheme is different from the A scheme in that the spiral bridge is mainly replaced by the winding roadbed. The scale of the whole project is relatively large, requiring a large area of

excavation of the stonework in the mountain. At the same time, because the various ravines on the line are V-shaped or U-shaped, the longitudinal slope at the bottom of the ditch is steep, and the longitudinal slope at the bottom of the ditch reaches 35%. More than 20 meters, the maximum filling height after grading is more than 32 meters, and the maximum horizontal distance is more than 69 meters. The subgrade slope seriously squeezes the main channel of the gully, which affects the flood discharge of the main channel. On slopes, there is a safety risk to the stability of the roadbed, and a lot of forest land is occupied, which does not meet the requirements of ecological protection in the ecological red line control area.

(3) M line scheme

The M-line scheme is different from the A scheme in that it mainly replaces the spiral bridge with a tunnel group. The scale of the whole project is relatively small, but the construction difficulty is the same due to geological factors, and the later maintenance costs are basically the same. In addition, the tunnel must be equipped with special auxiliary tunnels for ventilation, and the construction is relatively large. At the same time, the M-line scheme also has a big drawback. The tunnel mainly passes through the edge of the Longquan Forest Park scenic area, and is designed in the form of a tunnel group. It will cause certain damage to the ecological environment of the scenic spot. Moreover, there is also obvious glare effect at the out-of-order tunnel entrance, which is not conducive to the safety of driving.

5.2 Route Selection

On the basis of fully researching and proving the feasible route plan, through a large-scale field survey and investigation, in order to rationally utilize the corridor resources and not omit better plans, we have carried out multi-plan line layout and implementation of road sections that are technically feasible and possible to implement necessary trade-offs. In this route design, by repeatedly optimizing the route plan on the 1:10000 and 1:2000 topographic map, after the route at the starting point passes through Majiabei Mountain, the mountain has a steep ridge with a height of about 30 meters. Plan A, which is balanced and passes above the steep ridge; the route at the end passes through Guandaogou. Various comparisons are proposed, such as Plan B and Plan M, which naturally extend along the branch of Guandaogou to the Mizoguchi.

According to this route, it belongs to the basic supporting facilities of the Red Taihang Baili Gallery Tourist Area Project in Zuoquan County. In the overall design, the new design concept should always be implemented, adhere to the terrain as the basis, the geology as the premise, and the environmental protection as the purpose, adhere to the combination of the geological route selection and the environmental protection route selection, and follow the “people-oriented” and “safety, environmental protection, comfort, The new concept of “harmony” fully considers the use characteristics of the project, combines the construction conditions of the project area, geology, environment and other construction conditions as well as the needs of social and economic development, attaches great importance to ecological environmental protection, and focuses on the needs of road users (tourists and tourist vehicles) , flexibly select technical standards, try to control the scale of the project, strengthen the use of new technologies, new materials, and new processes, pay attention to scientific and technological innovation, carry out technical research and development work on major technical difficulties in combination with the actual design and construction, and strive to build this project into a high-tech project. A high-quality, ecological and environmentally friendly tourist road truly reflects the idea of harmony between the road and tourists, scenic spots, environment and nature. The route of the route A is obviously the best.

At the same time, the choice of the A-line scheme, compared with the B-line scheme and the M-line scheme, fully considers the natural conditions such as topography, landform, hydrology and geology along the line, as well as environmental protection, coordination of the route and the surrounding landscape and other factors, and the design makes full use of The corridor has favorable terrain, reasonable wiring, and minimizes high filling and deep excavation to ensure the safety, stability of the project and save project investment; it also complies with the technical standards determined in “Gong Ke”, and flexibly uses technical indicators on the premise of

meeting the standards. , to minimize the interference to the Mengxinnao Nature Reserve, reduce the occupation of woodland along the line and the larger support projects, so as to achieve the complex terrain where the project is located, there are many ravines, and the route layout can focus on adapting to the terrain, Reasonable selection of the horizontal and vertical technical indicators of the route, emphasis on the three-dimensional linear design, requiring the linear shape to be suitable, balanced, economical, reasonable and feasible, and to do a good job of horizontal, vertical and horizontal comprehensive coordination; The principle of the line, try to avoid the route crossing the bad geological road section. Make the highway line position as much as possible within the limited corridor width to “seek advantages and avoid disadvantages”, so as to ensure the safety and stability of roadbeds, bridges and protection works, and also reflect the “environmentally friendly, close to nature, and no damage is the greatest protection”. The concept of environmental protection is to minimize the adverse impact of highway construction on the environment, minimize high fill and deep excavation, and protect the ecological environment as much as possible.

6. Key Points of Highway Quality Control

6.1 Strictly Control the Quality of Roadbed Construction

The roadbed is the foundation for ensuring the quality of the road surface. To make the road surface structure more stable, the density of the roadbed itself must be increased to make it more stable and balanced. The subgrade design must be combined with the actual local geological conditions, select a reasonable subgrade cross-section method, reasonably determine the slope of the slope, ensure the integrity of the vegetation as much as possible, and maintain the stability of the mountain. In this route design, it involves soft soil subgrade, loess subgrade, and expansive soil subgrade, so for different subgrades, the emphasis is also different. (1) Soft soil roadbed. The soft soil roadbed should be judged and analyzed in combination with the actual geological conditions, and a relatively reasonable construction plan should be determined through the soil quality and route distribution of the soft soil roadbed itself; (2) Loess roadbed. For the loess roadbed with relatively low humidity, it is necessary to use the treatment methods of dynamic compaction and heavy compaction, and add appropriate lime soil to seal it. For the loess roadbed with low humidity, lime piles should be used, and a water barrier should be added for settlement observation; (3) Expansive soil roadbed. The road subgrade can not only use expansive soil as the filling material, but also the roadbed can be filled with non-expansive soil or ash.

6.2 Strictly Control the Security Design of the Spiral Bridge

The spiral bridge super bridge designed for this route is a double-layer spiral girder bridge, with a total length of 1558.97 meters, a bridge width of 9.2 meters, and a span combination of 4x40+72x19.333m. The upper structure adopts cast-in-place continuous box girder, and the lower part adopts hollow Thin-walled piers, square-column frame piers, pile-connected girder abutments, seat abutments, and piers and abutments all use pile foundations. The intersection angle of the bridge is 90 degrees, and the piers are arranged radially. The maximum pier height of the whole bridge is 67m (three floors), the height difference between the start and the end of the bridge is about 48m, and the longitudinal slope is 3.1%. Therefore, in the security design, the width of the bridge deck is appropriately increased. The width of the bridge is 9.2 meters, of which the width of the carriageway is 2x3=6 meters, and the width of the road surface is 1.2 meters (the radius of the horizontal curve at the spiral bridge is R=80 meters, and the second-class plus width value), the lateral safety distance on both sides of the traffic lane is 0.5x2=1 meter, and the width of the crash barrier is 0.5x2=1 meter. The side guardrails of the bridge are made of SS-class anti-collision guardrails.

6.3 Strictly Control the Quality of Asphalt Concrete Pavement

This route design involves cliff-like terrain. The mountainous terrain is relatively complex, and the quality of the asphalt concrete pavement must be strictly controlled. (1) Class III highway. For

this part of the road, the concrete materials for construction of asphalt should be mixed at the construction site, and this method can ensure the quality of various proportions before mixing, thereby improving the quality of the construction itself; (2) The transportation of asphalt concrete materials should be controlled. After the material ratio is completed, suitable transportation means should be selected and transported to the construction site. The transportation cost must be strictly controlled, and based on this, the quality of the asphalt mixture should be guaranteed; (3) The paving of asphalt concrete should be strictly controlled. . In actual construction, two paver equipment should be used at the same time. Between two adjacent roads, there must be 5-10cm of overlapping paving. The distance between construction echelons should also be strictly controlled to ensure that the two are within 10-30cm. Scope, and strictly control the construction top surface elevation, surface layer, and slope; (4) The rolling link should be strictly controlled. For the rolling of asphalt concrete, the temperature should be strictly controlled. The initial rolling of the third-class highway can improve the smoothness and stability of the road surface, and after the initial rolling, static pressing is required to ensure the road itself. (5) Strictly control the road surface inspection work, in which attention should be paid to the inspection of road surface deflection, smoothness, etc., which is the basis for effective guarantee of driving safety.

6.4 Good Soil and Water Conservation

The main reason is that the construction of mountain roads is easily affected and disturbed by climate, which leads to a series of geological disasters on mountain roads. In the process of actually grasping the quality of mountain roads, the staff should proceed from the overall situation and carefully consider the construction. Based on the basic conditions such as terrain and overall climate along the road section, comprehensively consider the soil erosion and other issues of the construction road section, and then combine the comprehensive protection standards to formulate comprehensive protection measures such as biological protection and engineering protection, and pay attention to soil and water conservation. For the road sections that are prone to geological disasters, biological protection measures can be used, regular inspections can be made, and reasonable plans can be formulated to improve the safety of road construction and subsequent use.

6.5 The Route Should Be Adjusted According to the Actual Situation

The terrain conditions in mountainous areas are complex, and most of the routes appear in the form of interchanges and tunnels. Therefore, the selection of routes needs to comprehensively consider various factors. It is necessary to carefully consider whether the relevant routes are suitable for the establishment of interchanges, bridges and tunnels, etc., and conduct route design. In the actual construction process, it is also necessary to comprehensively consider the actual situation of the route traffic, pay close attention to the traffic flow, conduct an actual analysis of the flow direction, and then determine the construction method. There will also be various practical problems in the construction process. Therefore, the route should be adjusted appropriately according to the actual situation and the problems encountered, and the problem of excessive excavation of the mountain should be avoided as much as possible, which will also increase the difficulty of the slope protection work.

7. Conclusion

The cliff-like terrain conditions of Taihang Mountain are relatively special, and the selection of highway routes needs to consider environmental conditions, terrain conditions and other factors, especially terrain conditions, which play a decisive role. The particularity of the cliff-like terrain features determines that the route cannot be presented in a conventional way. It is necessary to fully consider and learn from the experience of wall-hung highways, and select the route in two ways: spiral tunnels and tunnel groups. In this paper, a comprehensive comparison of these two schemes is carried out, and it is found that each has advantages and disadvantages, but combined with the actual situation of the route scheme in this section, the tunnel group scheme is more feasible and has more obvious advantages. Only when the actual situation is selected can we reduce costs and

increase efficiency and achieve the purpose of promoting economic development.

References

[1] He Ansheng, He Ying, Liao Xin. Research on highway route scheme under complex mountainous terrain conditions [J]. Smart City, 2020(21):2.

[2] Chen Yingfeng, Cheng Xuan, Sheng Rong. Analysis of the overall design of expressway lines based on engineering examples [J]. Highway Engineering, 2020, 045(006):143-148.

[3] He Ansheng, He Ying, Liao Xin. Research on highway route scheme under complex mountainous terrain conditions [J]. Smart City, 2020(000-021).

[4] Liang Hongtao, Ba Kewei, Sun Zhao. Discussion on Expressway Route Selection and Route Design under the System of Territorial Spatial Planning [J]. Highway and Automobile Transportation, 2021, 000(003):58-60.

[5] Wei Xiaoliang. The influence of unfavorable geology on expressway route plans and suggestions for plan comparison and selection [J]. Metallurgical Series, 2022(007-005).

[6] Chen Gongyu. Optimization research on route design scheme of expressway in complex mountainous areas: Taking Yansong Expressway as an example [J]. Metallurgical Series, 2022(007-008).