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Analysis of Roadbed Splicing at Hub Interchanges

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Abstract: This article discusses the roadbed splicing for hub interchanges. The article starts with a description of the characteristics of junction roadbed splicing. The application of splicing technology is explained using a subgrade splicing scheme of a project. Roadbed splicing involves stepwise excavation and preparative measures like surface cleaning and backfilling. This article serves to provide a valuable reference for road and bridge construction and improve the quality of China's road and bridge projects, so as to achieve sustainable development of the road and bridge engineering industry.

Keywords: Hub interchange; Roadbed splicing; Construction preparation; Stepwise excavation; Roadbed filling

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1. Introduction

Mastering roadbed splicing of hub interchanges is of great significance for ensuring the construction quality of hub interchanges, improving traffic efficiency, and ensuring traffic safety. Roadbed splicing is an important part of hub interchange reconstruction that involves many aspects such as the bond between different materials, the technologies used, and the formulation of construction plans. By mastering hub interchange roadbed splicing, problems like loosening, cracking, damage, horizontal imbalance, and other problems can be prevented. reduce the incidence of traffic accidents, and at the same time provide citizens with a better travel experience.

2. Characteristics of hub interchange roadbed splicing project

Based on the records of many hub interchange projects, there are several common characteristics of these kinds of projects.

(1) Complex road surface shape

The pavement shape of the hub interchange is complex and ever-changing, with a heavy traffic flow. It must adapt to different vehicle speeds, vehicle models, and road conditions. The splicing project should provide a smooth and safe traveling experience. Therefore, there are high requirements for roadbed splicing solutions and materials.

(2) Diversified material structure

A variety of composite materials are needed to splice the roadbed of hub interchanges, such as asphalt concrete, reinforced concrete, rubber, etc. It is also necessary to consider the process of connecting different materials to each other, such as welding, fixing, slotting, etc., to ensure that the parts are connected properly [1].

(3) High quality requirements

As an important node of urban transportation, quality is of utmost importance in the reconstruction or renovation of interchange hubs. The end product of roadbed splicing should be both functional and aesthetically pleasing. It is necessary to design the construction plan in advance and allocate a suitable number of construction personnel and equipment to ensure construction quality and progress while ensuring safety [2].

(4) Reasonable technical solution requirements

It is necessary to formulate a suitable plan for the roadbed splicing at hub interchanges. Methods such as natural transition, gradual transition, or artificial transition can be adopted according to the terrain and soil conditions. Technical solutions should be formulated based on the actual conditions and advanced technologies should be compo

(5) Refined construction management requirements

Interchange transformation projects are usually large-scale, time-consuming, and complex. Strict specifications need to be formulated for every link and detail in the construction process, including construction design, material selection, on-site construction, etc. Factors that need to be considered in construction management are time, cost, quality, and other factors [3].

3. Research on construction technology of subgrade splicing for hub interchanges

3.1. Project overview

In order to objectively grasp the hub interchange roadbed splicing construction technology, this article uses the H hub Interchange Project (Project H) as an example to discuss the application of roadbed splicing in interchange hubs.

H is located at the transportation hub of a certain city, connecting the city center to surrounding areas. It is an important transportation hub for the upper and lower urban areas of the city. The project covers an area of approximately 35,000 square meters, including 9 ramps and 4 bridges, with a designed traffic flow of approximately 5,000 vehicles per hour. Project H was designed based on factors such as the terrain and traffic flow of the area. Two different materials were selected to form the roadbed: reinforced concrete roadbed and asphalt concrete pavement. “Asphalt pouring + reinforced concrete + asphalt or rubber” was adopted to ensure the quality of the end product and the smoothness of the surface.

3.2. Roadbed splicing plan

A reasonable splicing scheme can not only ensure the traffic operation efficiency of hub interchanges but also improve the safety and reliability of its roads [4]. During the formulation of the roadbed splicing plan, the main points are the rationality of the road alignment, material selection and splicing, construction quality control, and environmental protection.

3.2.1. Road alignment

Due to the busy traffic and complex road conditions at the H Hub Interchange, the rationality of the route directly affects the stability and smoothness of the entire road surface. Therefore, the roadbed splicing scheme was designed collaboratively by the construction and design units. This approach ensured that the road alignment was considered and that sharp turns, steep slopes, complex intersections, and small turning radius, were avoided to the greatest extent [5].

3.2.2. Material selection and material splicing

The selection of base materials is the key to ensuring the quality of hub interchange roads. Common materials for roadbed construction include reinforced concrete, asphalt concrete, cement, etc. During material selection, it is essential to consider factors such as traffic flow and the road's surrounding environment. At the same time, the junction of different materials must be tightly paved, and strict construction management is required [6]. In this project, the roadbed was filled with natural gravel materials, and geogrids were paved at the same time. The base and roadbed were laid uniformly to increase the integrity of the old and new roadbeds even out the natural gravel roadbed (**Figure 1**).

Figure 1. Schematic diagram of geogrid laying on roadbed

3.2.3. Construction management and quality control

Good construction management can effectively improve construction efficiency and quality and ensure road safety and stability. Construction management and quality control were emphasized in Project H. Technical training, construction material selection, transportation management, and construction supervision were all documented clearly to ensure the road conditions meet the design requirements.

3.2.4. Environmental protection

Environmental protection is one of the key points in the construction of road projects. During the construction of Project H, all pollutants involved in the construction process were supervised in accordance with relevant laws and regulations to minimize the impact on the ecological environment and living environment around the hub interchange [7].

3.3. Stepwise excavation and construction plan

In order to effectively improve the overall stability of the new and old roadbed, before filling, the construction unit excavated the old roadbed slope into a step shape and then widened and heightened the first step to reach 300 cm wide and 100 cm high. The subsequent upper steps were 200 cm wide and 100 cm high. At the same time, the construction unit removed the over-excavation and backfilling of the old road surface and installed geotechnical barriers.

3.4. Preparation for roadbed splicing construction

Hub interchange roadbed splicing is a complex and systematic process, so sufficient preparations are needed before construction to ensure high-quality and smooth construction. In Project H, proper preparations were made before splicing construction, which is summarized below.

(1) Conductor point retest

The conductor points in the design were retested and accurately arranged at the project site before construction to ensure consistency between the design and the actual construction site [8].

(2) Placing the total station at the edge

After laying out the wires, a total station was used to trace points at specified intervals outside the reinforced concrete subgrade part of the road to pave the way for subsequent construction.

(3) Roadbed surface retest

The roadbed surface was retested to determine its height difference and flatness to ensure the construction quality.

(4) Base soil testing

Before laying the roadbed, foundation testing was conducted to ensure that the roadbed could meet the design requirements and that soil treatment could be carried out in advance.

(5) Setting up warning signs

Warning signs were set up at the construction site to ensure the safety of the passersby and the boundaries of the site were set to prevent outsiders from intruding on the construction area [9].

(6) Technical briefings

The construction personnel were given a technical briefing on the overall process, methods, and requirements of the project.

3.5. Surface cleaning and backfilling

The smoothness and quality of the roadbed are essential in roadbed splicing projects. Surface cleaning and backfilling are important links to these kinds of projects. In Project H, before the construction started, debris such as weeds and branches within the base area were removed. Besides, in order to ensure the smoothness and strength of the roadbed, humus soil and topsoil were removed. By doing so, a new roadbed could be placed evenly.

Secondly, the scope of the cleared site was clearly defined, and ensured that it was within the designed scope of the roadbed to avoid shifts in the center of gravity. After completing the surface cleaning, the road pavement was compacted to ensure the smoothness and strength of the road surface.

Areas with high water content were excavated and dried. (1) The base with higher water content was dug out to increase the surface area of the wet area. (2) Drying: The dug base was exposed to the sun to allow the water to evaporate to achieve the desired water content. (3) Trimming: The dried base was trimmed to meet the requirements of roadbed design. (4) Backfill: The modified base was backfilled to the original height of the road and compacted to ensure the smoothness and quality of the roadbed.

3.6. Stepwise excavation

The slope of the old roadbed slope was cleared before excavation. After cleaning the slope, each excavation line was marked accurately. After excavating and joining the steps at the base of the roadbed, the height and position of the steps were determined according to the fill height of the roadbed. The step surface was defined as a step when the distance between it and the base surface of the subgrade was less than 130 centimeters. If it exceeded 130 centimeters, it was divided into two step heights: 100 centimeters and greater than 130 centimeters. The specific excavation position was set at 30 centimeters outward from the inner edge of the old road's hard shoulder, with a step height of 80 centimeters.

In addition, the excavation was immediately halted when a large-scale soil displacement was discovered and the reason behind the displacement was analyzed. Corresponding measures were formulated to avoid landslides. Besides steel-wood support was installed to protect the back of the old roadbed structure and the roadbed was filled with gravel materials.

3.7. Roadbed filling

3.7.1. Filling material selection

The materials used for roadbed filling mainly include soil, stone, bricks, etc. The materials were selected based on comprehensive considerations of the usage requirements, site conditions, and cost. Since Project H was constructed in autumn, the air was dry and the soil was stable, so ground gravel was used as filling material to improve the stability and drainage of the filling layer.

3.7.2. On-site investigation

On-site investigation and measurements are necessary before the construction starts to determine the thickness and slope of the filling layer. The measurements include the height and width of the roadbed. In order to improve construction accuracy, the construction unit arranged for construction personnel to use a total station for stakeout.

3.7.3. Paving

In Project H, after the materials were laid, the bottom of the roadbed was cleaned to ensure that the bottom of the filling layer was smooth and free of debris and water puddles. Besides, in order to increase the stability of the filling layer, the bottom of the roadbed was compacted. The roadbed was paved evenly and lightly compacted. Subsequently, it was leveled and adjusted to achieve the desired thickness and slope. After the paving was completed, moderate compaction was carried out to improve the stability and density of the roadbed.

3.7.4. Adjusting the water content

Moderate water content can increase the stability and fluidity of the filling layer, but excessive water content will cause damage to the roadbed. In order to ensure that the water content is within the acceptable range, the test block method was employed to measure the water content. The optimum water content was approximately 2% level. The water content was adjusted according to the acceptable range to ensure the quality and stability of the filling layer. For areas where the water content is less than the optimum level, sprinkler trucks were used to wet the area.

3.7.5. Filling and rolling

A rolling plan and the required equipment were determined based on the test section before filling and rolling the roadbed. A road roller was used for rolling. In the rolling stage, the maximum driving speed of the equipment was ≤ 4km/h. Straight sections were rolled from the edge of the widened roadbed towards the joint of the old roadbed from low to high [10]. In addition, the roller was equipped with a half-width wheel, and rolling was performed from slow to fast and light to heavy. The degree of compaction was increased at the junction of the new and old roadbed. In areas such as steps and blind spots, heavy-duty steel rollers and small impact compactors were utilized for compaction.

3.8. Dynamic compaction and treatment of the roadbed

During the construction phase of the roadbed splicing at the interchange, dynamic compaction was carried out on the top of the roadbed. This was done to prevent settlement of the new roadbed of Project H and to avoid longitudinal cracks at the junction of the new and old roadbeds.

During the operation stage, the joint between the old and new roadbed was treated to ensure a smooth surface. Debris, gravel, and other materials were cleared, any possible gaps were filled, and stains adhering to the subgrade were cleaned. The top of the roadbed was then compacted. During the construction period, the ramming rhythm and ramming speed were strictly controlled to ensure consistency and uniformity of tamping. It is necessary to avoid compaction at a pace that is too rapid, which could lead to insufficient compaction or cause cracking in the new and old roadbeds.

4. Conclusion

In summary, this article takes Project H as an example to analyze roadbed splicing at hub interchanges. There are five main characteristics of these kinds of projects: complex road surface, diversified material structure, high standards, the need for reasonable technical solutions, and the need for refined construction management. This article serves to provide ideas on improving the quality of roadbed splicing at interchanges by analyzing Project H, so as to improve the safety of highways.

Disclosure statement

The author declares no conflict of interest.

References

[1] Ding J, 2023, Research on Roadbed Splicing Construction Technology and Benefits in Highway Reconstruction and Expansion Projects. Value Engineering, 42(24): 20–22.

[2] You X, 2022, Research on Highway Hub Interchange Scheme. Shanxi Transportation Science and Technology, 2022(04): 42–44.

[3] Wang T, 2022, Research on Fenyang South Hub Plan of Fenshi Expressway. Northern Communications, 2022(07): 69–71.

[4] Zhu G, Liu Z, 2021, Research on the Design Scheme of Highway Hub Interchange Roadbed Splicing in Mountainous Areas with Complex Terrain and Geological Conditions. Western Transportation Science and Technology, 2021(12): 18–21.

[5] Yuan B, 2022, Research on Roadbed Splicing Construction Technology for Highway Interchange Projects. Science and Technology Wind, 2022(13): 66–68

[6] Mao W, 2023, Roadbed Splicing Construction for Municipal Road Reconstruction and Expansion Projects. Architecture Development, 7(1): 4–6.

[7] Li J, 2022, Application of Subgrade and Pavement Splicing Construction Technology in Highway Reconstruction and Expansion Projects. Sichuan Building Materials, 48(1): 147–148 + 152.

[8] Guo H, 2023, Research on Splicing Construction Technology of New and Old Roadbeds in Highway Widening Projects. Transportation World, 2023(8): 82–84.

[9] Chen J, Yang Q, 2023, Roadbed and Pavement Splicing Construction Technology for Highway Reconstruction and Expansion Projects. Engineering Machinery and Maintenance, 2023(2): 72–74.

[10] Cui J, 2022, Construction Technology for Splicing New and Old Roadbeds in Highway Reconstruction and Expansion Projects. Heilongjiang Transportation Science and Technology, 2022(5): 45.