Original Research Article

Construction technology of top pushing for railway prestressed concrete continuous box girder bridge

Benliang Qi[1], *Luming An*[2][*Corresponding Author]

1 PowerChina Beijing engineering corporation limited, No.1 Dingfuzhuang West Street, Chaoyang District, Beijing, P.R., 100024, China,

2 China railway construction bridge engineering bureau group co., ltd.300300, Tianjin

Abstract: This article elaborates on the top pushing construction technology of railway prestressed concrete continuous box girder bridges. Through in-depth analysis of various aspects such as engineering introduction, structural system, and construction technology points, this paper demonstrates the advantages and key operational processes of top push construction in railway bridge construction. The aim is to provide comprehensive and valuable technical information for relevant engineering and technical personnel, and promote the continuous development and improvement of railway bridge construction technology.

Keywords: Railway; concrete; Continuous box girder bridge; Prestress; Construction

1. Introduction to engineering

In recent years, with the astonishingly rapid development of railway transportation across the globe, bridge construction has emerged as an indispensably important component within the realm of railway engineering. It is constantly undergoing remarkable innovation and making significant improvements in its construction technology to adapt to the ever-evolving demands and challenges. Among the diverse construction techniques, the top pushing construction technology of railway prestressed concrete continuous box girder bridges has attracted widespread attention and has been increasingly adopted in a variety of complex terrain conditions.

When it comes to scenarios like crossing existing railway lines that are bustling with continuous train traffic, or when dealing with deep valleys where the terrain is extremely rugged and presents numerous difficulties for construction access, and even in the face of wide rivers that pose obstacles to the seamless connection of railway tracks, this top pushing construction technology demonstrates its unique advantages. It has the remarkable ability to carry out bridge construction operations without having to interrupt the existing traffic flow, which is of crucial importance for maintaining the normal operation of the railway network and minimizing disruptions to the transportation schedules of both passengers and goods. Moreover, it can also have a minimal impact on the surrounding environment. Unlike some traditional construction methods that might involve large-scale excavation or cause noise and dust pollution that would affect nearby communities and ecological systems, this technology is relatively environmentally friendly. By virtue of these characteristics, it effectively shortens the construction period that is often a key factor in railway project implementation. With a shorter construction time, the overall construction efficiency is improved substantially, allowing the railway project to be completed and put into use earlier. Additionally, it plays a vital role in ensuring project quality. Through precise engineering design and strict construction procedures in the application of this technology, the structural integrity and durability of the prestressed concrete continuous box girder bridges can be well guaranteed, enabling them to withstand the heavy loads and continuous usage over a long period of time. In a word, this top pushing construction technology is of great significance for promoting the development of railway bridge construction in various aspects.

The prestressed concrete continuous box girder bridge project of a certain railway stands out as a key node project in the entire railway line. This bridge is not an ordinary one but has a total length reaching up to 196 meters. It adopts a prestressed concrete continuous box girder structure, which is carefully designed with high precision to meet the specific requirements of railway operation. Its design load is formulated to meet the high standard requirements for railway train operation. This involves taking into account a multitude of factors. For instance, the axle load of the trains, which varies depending on the types of locomotives and carriages used, needs to be considered carefully. Different trains have different axle loads, and the bridge must be able to bear the maximum load that could potentially pass over it to ensure safety. Also, the train formation, including the number of carriages and their arrangement, affects the distribution of the load on the bridge. All these elements are comprehensively analyzed and incorporated into the design to make sure the bridge can function properly under the actual operating conditions of the railway.

Due to the rather complex situation at the project site, the use of top-down construction technology becomes an optimal choice. In the vicinity of the project site, there are existing railway lines that are constantly in use, carrying a large volume of trains every day. Any improper construction activities could easily disrupt the normal operation of these existing lines and lead to serious consequences for the railway transportation system. Besides, there are numerous buildings around, ranging from residential houses to commercial facilities. These buildings need to be protected from the potential impacts of construction, such as vibrations or ground subsidence that might be caused by certain construction operations. Furthermore, the geological conditions in the area are also quite complex, with possible issues like unstable soil layers or underground water problems. In the face of such a challenging environment, the top-down construction technology can minimize interference with existing facilities. It allows the construction work to proceed in a more orderly and controlled manner, reducing the construction safety risks that could otherwise arise from accidental damage to existing infrastructure or from unexpected geological hazards.

2. Overview of Structural System Overview of Structural System

This section focuses on the structural components of the railway prestressed concrete continuous box girder bridge. The upper structure is a prestressed concrete continuous box girder with its form determined by span and load, using high-strength concrete and prestressed reinforcement for stability. The lower structure consists of piers and abutments, with diverse foundation forms based on geology. Temporary piers play a key role in construction, and steel guide beams are crucial for reducing deflection and guiding the box girder during top pushing.

2.1. Upper structure

The upper structure of the railway prestressed concrete continuous box girder bridge is a prestressed concrete continuous box girder. The cross-sectional form of box girder is usually determined based on factors such as bridge span and load level, and generally adopts single box single room or single box multi room structure. The concrete strength grade of box girder is relatively high to meet the requirements of structural bearing capacity and durability[1]. Pre tensioned steel bars are arranged inside the box girder to pre tension the concrete before bearing loads, effectively improving the crack resistance and bearing capacity of the structure. The arrangement of prestressed reinforcement includes longitudinal prestressed reinforcement, transverse prestressed reinforcement, and vertical prestressed reinforcement, which work together to ensure the integrity and stability of the box girder structure.

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2.2. Lower structure

The lower structure is mainly composed of bridge piers and abutments. The bridge piers are made of reinforced concrete or prestressed concrete structures, and can be designed in different forms such as column piers, thin-walled piers, or solid piers according to factors such as bridge height, span, and geological conditions. The bridge abutment plays a role in connecting the bridge and the roadbed, bearing the load transmitted from the upper structure of the bridge and transferring it to the foundation. The foundation forms of the lower structure are diverse, commonly including pile foundations and expanded foundations. Reasonable selection should be made based on geological survey results to ensure that the foundation has sufficient bearing capacity and stability, providing solid support for the upper structure.

2.3. Temporary pier

During the top-down construction process, temporary piers play a crucial role. The location and quantity of temporary piers should be determined comprehensively based on factors such as bridge span, jacking weight, and site conditions. Temporary piers are generally made of steel structures or steel-concrete structures, which have high strength and stability. The top of the box girder is equipped with a sliding device to provide a sliding support surface for the top pushing of the box girder, ensuring that the box girder can move smoothly forward during the pushing process. At the same time, the temporary pier also needs to have sufficient rigidity to resist the horizontal and vertical forces generated during the pushing process of the box girder, and prevent excessive deformation or displacement of the temporary pier.

2.4. Steel guide beam

Steel guide beam is a temporary structure connected to the front end of the box girder, whose main function is to reduce the cantilever length during the pushing of the box girder and reduce the downward deflection deformation at the front end of the box girder. Steel guide beams are usually made of variable cross-section steel structures, with a length generally ranging from 0.6 to 0.8 times the top push span[4]. The connection method between it and the box girder needs to ensure that the connection is firm and reliable, and can effectively transmit the load during the pushing process. The self weight of steel guide beams is relatively light, but they have high strength and stiffness, which can guide the box girder smoothly into the slide during the initial stage of top pushing, and work together with the box girder throughout the entire top pushing process to jointly bear various loads.

3. Key points of construction technology

3.1. Construction preparation

In the pre-construction preparation stage, it is of utmost importance to meticulously organize construction technicians to engage in a comprehensive and in-depth review of the design documents. This step serves as the foundation for a successful construction project, as it enables the technicians to thoroughly understand the unique characteristics of the bridge structure design. They need to carefully analyze details such as the overall layout, the structural components' interconnections, and the specific load-bearing mechanisms designed for the bridge. Moreover, a profound familiarity with the requirements of the top-down construction technology is essential. This includes grasping the key principles, procedures, and technical parameters associated with this particular construction approach. Additionally, construction technicians must be well-versed in all relevant technical standards and specifications. These serve as the guiding rules to ensure that every aspect of the construction adheres to the industry's best practices and meets the necessary quality and safety benchmarks.

Subsequently, a detailed construction organization design plan needs to be developed. This plan is the blueprint that will govern the entire construction process from start to finish. Firstly, it should clearly outline the top-down construction process. This involves breaking down the construction into sequential steps, specifying the order in which different parts of the bridge will be constructed, and defining the critical milestones along the way. For example, it will detail when the installation of temporary piers commences, followed by the positioning of the steel guide beams, and then the actual top-down pushing of the box girder sections.

Secondly, design calculations for temporary piers and steel guide beams are an integral part of the plan. Rigorous calculations are required to determine the appropriate dimensions, load-bearing capacities, and structural configurations of these temporary structures. For temporary piers, factors such as the maximum load they will need to support during the construction process, the soil conditions at their installation sites, and the anticipated horizontal and vertical forces need to be taken into account. Similarly, for steel guide beams, considerations include their length, cross-sectional properties, and connection details to ensure they can effectively reduce the cantilever length and control the downward deflection deformation during the pushing of the box girder.

The selection and configuration of construction equipment also play a crucial role in the construction organization design plan. Different types of machinery and tools, such as cranes with specific lifting capacities, jacking systems for the top-down pushing operation, and concrete mixing and pouring equipment, need to be carefully chosen based on the project's scale and specific requirements. Their proper configuration on the construction site, including their placement and access routes, must be planned to ensure efficient operation and avoid any potential interference during the construction process.

Furthermore, a well-structured construction schedule should be established. This schedule should be realistic and take into account various factors such as the availability of resources, weather conditions, and any potential delays that might occur. It should clearly define the start and end dates for each construction phase, allowing for effective project management and timely progress monitoring.

Quality control measures are another vital aspect of the plan. These measures should cover every stage of the construction, from the inspection of raw materials to the final acceptance of the completed bridge structure. For instance, during the concrete pouring process, strict quality control procedures should be in place to ensure the correct mix proportions, proper curing conditions, and the achievement of the required concrete strength. Similarly, for the installation of prestressed reinforcement, precise positioning and tensioning procedures need to be followed to guarantee the structural integrity and durability of the bridge.

Safety assurance measures cannot be overlooked either. Construction sites are inherently hazardous environments, and thus, comprehensive safety plans need to be formulated. This includes providing appropriate personal protective equipment for workers, implementing safety training programs, and establishing emergency response procedures. Additionally, safety inspections should be regularly conducted to identify and address any potential safety hazards promptly.

To address potential technical challenges that may arise during the construction process, conducting technical discussions and scheme demonstrations in advance is a prudent approach. These discussions should involve experienced engineers, construction experts, and relevant stakeholders. By analyzing similar projects' experiences and potential difficulties specific to the current project, various solutions can be proposed and evaluated. Through this process, the feasibility and reliability of the construction plan can be ensured, minimizing the risks of encountering unforeseen problems during the actual construction phase.

According to the top-down construction plan, accurately determining the positions of temporary piers, slipways, and bridge piers, and conducting layout and positioning is a critical task. The precise positioning of these elements is essential for the smooth progress of the construction and the structural stability of the bridge. The location of temporary piers needs to be carefully calculated based on factors such as the bridge span, the weight of the box girder sections to be pushed, and the site's topography. Slipways should be designed and positioned to provide a smooth sliding surface for the box girder during the top-down pushing process, ensuring minimal friction and stable movement. Bridge piers, on the other hand, need to be located in accordance with the overall bridge design to effectively bear the load from the upper structure and transfer it to the foundation.

Figure 1 illustrates the standard cross-section of the project. This visual representation provides a clear understanding of the bridge's internal and external structural details, helping construction technicians and other relevant personnel to better visualize how different components fit together and how the construction should proceed in relation to these specific structural features.

Finally, in accordance with the design requirements, qualified raw materials such as steel, cement, sand and gravel, and prestressed reinforcement are purchased. Strict inspection and testing procedures are then implemented to ensure that the performance indicators of these raw materials meet relevant standards and specifications. For steel materials, inspections may include checking for proper tensile strength, hardness, and corrosion resistance. Cement should be tested for its setting time, strength development properties, and chemical composition. Sand and gravel need to meet specific gradation requirements to ensure good workability and strength of the concrete. Prestressed reinforcement, which plays a crucial role in enhancing the structural strength of the bridge, must undergo meticulous testing to verify its prestressing properties and compliance with the design specifications. Only by ensuring the quality of these raw materials can the foundation for a high-quality bridge construction be laid.

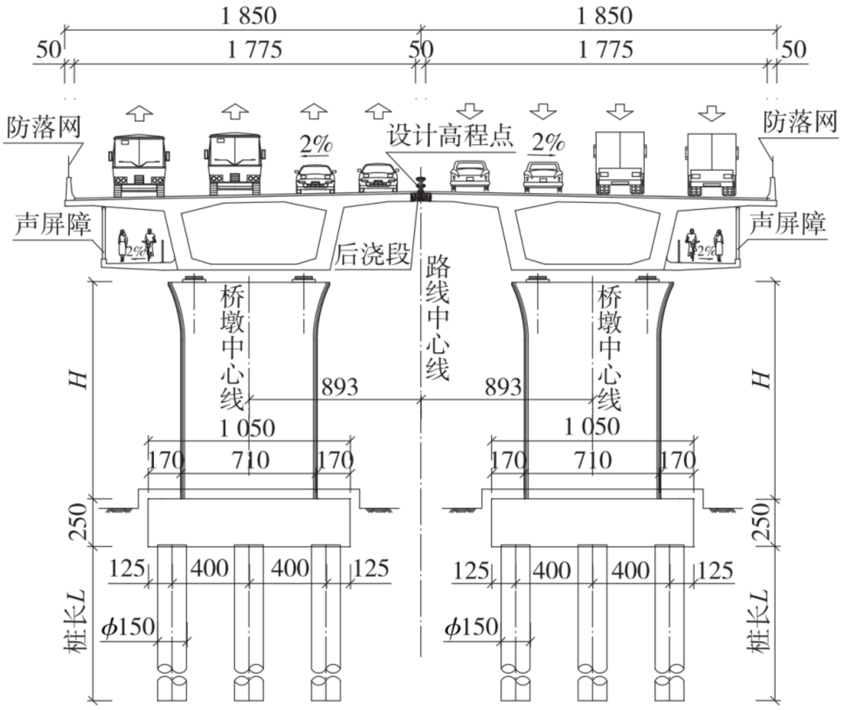

Figure 1. Schematic diagram of standard cross-section.

3.2. Positioning and installation of corrugated steel belly plate

In the construction of railway prestressed concrete continuous box girder bridges, the corrugated steel web plate is a vital component that has a significant impact on the stress performance and overall quality of the bridge structure. Hence, the accuracy of its positioning and installation is of great importance.

Before installing the corrugated steel belly plate, it is necessary to fabricate and process its components either in the prefabrication yard or on the construction site. During this process, strict attention must be paid to ensuring that their dimensional accuracy and welding quality meet the design requirements. For the dimensional accuracy, precise measurements and cutting are essential to make each component conform to the exact specifications. Even slight deviations in dimensions like length, width, and corrugation details could lead to fitting issues during installation and subsequently affect the bridge's stress transfer and load-bearing capacity. Meanwhile, regarding the welding quality, professional welders following strict procedures are involved. They carefully adjust and monitor welding parameters such as current, voltage, and speed to create high-quality welds, as the quality of these welds is crucial for both the individual component's integrity and its effective functioning within the bridge structure. Table 1 provides detailed specifications and quality requirements regarding the fabrication and welding of the corrugated steel belly plate components, serving as a reference guide throughout this critical stage of the construction process.

When it comes to the installation, appropriate lifting equipment is used to lift the corrugated steel belly plate to the design position. The choice of lifting equipment depends on factors like the size and weight of the components. Cranes with sufficient capacity and suitable boom lengths are often employed to accurately position the plate at the required location within the bridge structure. Once at the approximate position, precise measurement and positioning are carried out by experienced technicians using specialized tools. They make meticulous adjustments to ensure that the corrugated steel belly plate tightly adheres to the steel reinforcement skeleton or the concrete structure of the box girder. This tight attachment is vital for effective stress transfer and to avoid any potential gaps or misalignments that could cause stress concentrations or reduced load-bearing efficiency.

Moreover, to prevent displacement or deformation of the corrugated steel web plate during concrete pouring, temporary support and positioning fixtures are utilized. These fixtures are carefully designed and placed at key points along the plate to counteract the forces from the flowing concrete and maintain the plate's position stability within the structure.

The connection between the corrugated steel belly plates is also a critical aspect. It usually adopts either welding or high-strength bolt connection methods. For welding, it needs to be done with high precision and follow strict standards. After welding, a series of strict quality inspections are conducted. Visual inspections are first carried out to check for visible defects like cracks, porosity, or incomplete fusion. Then, non-destructive testing methods such as ultrasonic testing or radiographic testing may be used to detect internal flaws that are not visible to the naked eye. In the case of high-strength bolt connections, bolts are carefully selected based on design requirements and proper torque is applied during installation using calibrated torque wrenches. After installation, inspections are also done to check the tightness and integrity of the bolted connections.

Table 1. Quality requirements for installation of corrugated steel webs.

Item	Inspection Items	allowable deviation
1	span L	-20~+50
2	elevation	±10
3	web center distance	±20
4	cross-sectional diagonal difference	±30
5	arching degree	+10、-5
6	twist	every 1m≥1, every segment≤10
7	connection (weld size)	meet the design standards
	connection (weld flaw detection)	

3.3. Main embedded parts installation and embedding

In the construction process of railway prestressed concrete continuous box girder bridges, the installation and embedding of pre-embedded parts play a pivotal role. This is because a significant amount of such work is involved, covering various types including support pre-embedded parts, prestressed pipeline pre-embedded parts, and temporary consolidation device pre-embedded parts, among others. These embedded parts are integral to the bridge structure, and their position as well as installation accuracy hold the key to determining the overall installation quality and the subsequent functional utilization of the bridge.

To begin with, accurate measurement and setting out based on the design drawings are essential prerequisites before commencing the installation of the embedded parts. The design drawings serve as the blueprint that precisely defines the position coordinates of each embedded part within the bridge structure. Professional surveying and measuring teams or technicians are typically employed to carry out this task with the utmost precision. They use advanced surveying instruments such as total stations or theodolites to measure distances, angles, and elevations accurately. By carefully comparing the actual site conditions with the design requirements, the position coordinates of the embedded parts are determined. This step is crucial as even the slightest deviation in positioning could lead to a series of problems during the later stages of construction and the bridge's operation, potentially affecting its structural stability and the proper functioning of related components.

Once the positions are determined, using templates or positioning brackets to fix the embedded parts becomes a necessary measure. Templates are usually custom-made according to the specific shapes and sizes of the embedded parts and the design requirements. They are carefully placed at the predetermined positions to provide a stable and accurate positioning reference for the embedded parts. Positioning brackets, on the other hand, are designed to firmly hold the embedded parts in place, ensuring that they do not shift or move during the concrete pouring process. This is of great significance because the flowing concrete exerts significant forces and vibrations, which could easily displace the embedded parts if they are not properly fixed. By using these fixing devices, the position integrity of the embedded parts is maintained, laying a solid foundation for the subsequent construction steps and the proper functioning of the bridge structure.

When it comes to the pre-embedded parts of prestressed pipelines, special attention needs to be paid to ensuring the smoothness and sealing of the pipeline. The prestressed pipeline is a critical component in the bridge structure as it provides the necessary path for the prestressed reinforcement. During the concrete pouring process, if the pipeline is not smooth, it may cause difficulties in the insertion and tensioning of the prestressed reinforcement later. Moreover, any lack of sealing could allow cement slurry to enter the pipeline. Once cement slurry infiltrates the pipeline, it can accumulate and solidify, reducing the effective cross-sectional area of the pipeline and potentially blocking the passage completely. This would have a direct negative impact on the tensioning effect of the prestressed reinforcement, thereby affecting the overall structural strength and durability of the bridge. To prevent such issues, strict quality control measures are implemented during the installation of the prestressed pipeline pre-embedded parts. Workers carefully check the pipeline for any burrs or irregularities on the inner wall that could impede the smooth flow of the prestressed reinforcement and use appropriate sealing materials and techniques to ensure a tight seal at the joints and connections of the pipeline.

After the concrete pouring is completed, it is of equal importance to conduct timely inspections and cleaning of the embedded parts. The inspection process involves a comprehensive check of the position, integrity, and functionality of the embedded parts. Technicians use various inspection tools and methods, such as visual inspections to look for any visible signs of damage or displacement, and in some cases, non-destructive testing techniques may be employed to detect any internal defects that are not apparent on the surface. Any problems found during the inspection, whether it be a slight misalignment of the support pre-embedded parts or a potential blockage in the prestressed pipeline pre-embedded parts, need to be dealt with promptly. For instance, if an embedded part is found to have shifted slightly, appropriate corrective measures such as realignment or reinforcement may be taken. In the case of a blocked prestressed pipeline, specialized cleaning procedures or repair methods are implemented to restore its smoothness and ensure that it can function properly for the subsequent tensioning operation of the prestressed reinforcement. Through these meticulous post-pouring inspection and prompt problem-solving steps, the quality of the embedded parts is ensured to meet the requirements, safeguarding the overall quality and performance of the railway prestressed concrete continuous box girder bridge.

3.4. Concrete pouring

In the construction of railway prestressed concrete continuous box girder bridges, concrete pouring is a critical procedure that directly impacts the final quality and performance of the bridge structure. It demands meticulous attention and strict adherence to a series of technical requirements and procedures to ensure that the concrete can fulfill its intended functions within the box girder.

Firstly, based on the design requirements and the unique characteristics of the construction process for the box girder structure, the concrete mix design assumes great significance. The box girder, as a key component of the bridge, is subjected to various forces and environmental influences during its service life. Consequently, the concrete used for its construction must possess multiple desirable properties. It should have high strength to bear the heavy loads that will be applied to the bridge structure over time, whether it's the static weight of the trains passing over or the dynamic loads generated during their movement. Good durability is equally essential as the box girder will be exposed to external elements such as moisture, temperature variations, and chemical substances in the air for an extended period. This durability ensures that the concrete can resist deterioration and maintain its structural integrity over the years. Moreover, excellent workability is required to facilitate the pouring and compaction processes during construction, enabling the concrete to fill every corner and void within the complex shape of the box girder structure without difficulty.

During the process of mix design, numerous factors come into play and need to be carefully considered. The type of cement chosen has a profound impact on the properties of the concrete. Different cements have varying setting times, strengths at different curing stages, and chemical compositions that interact differently with other components of the concrete mix. For instance, Portland cement might be preferred in certain situations due to its well-known strength development characteristics, while in some cases, special cements with enhanced durability features might be more suitable depending on the specific environmental conditions the bridge will face.

Aggregate gradation also plays a crucial role. The size distribution of aggregates, including coarse and fine aggregates, determines the packing density of the concrete mix. A well-graded aggregate combination allows for better filling of voids between particles, resulting in a denser and more stable concrete structure. If the aggregate gradation is too coarse or too fine, it can lead to issues such as reduced workability or decreased strength. Additionally, the dosage of admixtures cannot be overlooked. Admixtures are added to the concrete mix to modify its properties. For example, water-reducing admixtures can improve workability while maintaining the desired strength by reducing the amount of water needed in the mix. Superplasticizers can further enhance the flowability of the concrete, making it easier to place in complex forms like those of the box girder. Through a series of carefully designed experiments, which involve varying the proportions of these components and testing the resulting concrete mixtures for their strength, durability, and workability under different conditions, the optimal concrete mix ratio is determined. This experimental approach ensures that the final mix can precisely meet the specific requirements of the box girder structure.

Furthermore, it is necessary to adjust the concrete mix proportion appropriately according to the construction season and changes in environmental temperature. In hot weather conditions, the evaporation rate of water from the concrete mix increases, which can lead to rapid drying and cracking if not properly addressed. To counteract this, adjustments might include increasing the amount of water-retaining admixtures or reducing the water-cement ratio to maintain the necessary workability while minimizing water loss. In cold weather, on the other hand, the setting and hardening processes of the concrete can be significantly slowed down or even halted due to low temperatures. In such cases, measures like using antifreeze admixtures or providing additional heating and insulation during the curing process can be employed to ensure stable construction performance of the concrete. These seasonal and temperature-based adjustments are crucial for guaranteeing that the concrete can be poured and cured successfully regardless of the external environment.

When it comes to the actual concrete pouring process, a layered and segmented pouring method is typically adopted. This approach is based on the structural characteristics of the box girder and aims to ensure the uniformity and quality of the concrete placement. Generally, the pouring sequence starts with the bottom plate of the box girder. Pouring the bottom plate first provides a stable foundation for the subsequent construction of the web plate and top plate. It also allows for better control of the concrete flow and distribution within the lower part of the structure. After the bottom plate is successfully poured and begins to set to an appropriate degree, the web plate is then poured. The web plate, with its vertical orientation and often complex reinforcement layout, requires careful attention during pouring to ensure that the concrete fills all the spaces around the reinforcement bars evenly and without leaving any voids. Finally, the top plate is poured, completing the enclosure of the box girder structure.

During the pouring process, the concrete is transported to the pouring site by a concrete pump. The concrete pump offers several advantages in terms of efficiency and precision. It can continuously supply the concrete to the desired location within the box girder, even in areas that are difficult to access by other means. Once the concrete reaches the pouring site, it needs to be compacted by a vibrator to ensure its compactness and uniformity. The operation of the vibrator during this process is a delicate task that demands strict control. Attention must be paid to the insertion depth of the vibrator. If the insertion depth is too shallow, it may not be able to effectively vibrate the concrete at deeper layers, resulting in insufficient compaction and potential voids in the interior of the concrete mass. On the other hand, if the insertion depth is too deep, it might cause over-vibration near the bottom or sides of the formwork, which can lead to segregation of the concrete components or damage to the formwork itself. Similarly, the vibration time needs to be carefully regulated. Insufficient vibration time may leave the concrete under-compacted, while excessive vibration can cause the concrete to lose its workability and lead to a decrease in strength due to the separation of aggregates and cement paste. By precisely controlling these aspects of the vibrator's operation, the compactness and uniformity of the concrete can be ensured, contributing to the formation of a high-quality box girder structure.

3.5. Pre stressing construction

The production of prestressed steel bars should be carried out in a dedicated processing site, strictly following the design requirements for length, specifications, and quantity for cutting, bundling, and processing. Pre stressing tensioning is one of the key links in the construction of railway prestressed concrete continuous box girder bridges, and its tensioning control stress and tensioning sequence must be strictly in accordance with the design requirements. Before tensioning, it is necessary to calibrate and verify the tensioning equipment to ensure its accuracy and reliability. During the tensioning process, jacks and oil pumps are used to perform graded tensioning on the prestressed reinforcement. The stress of each stage of tensioning should be stable for a period of time before proceeding to the next stage of tensioning. At the same time, close attention should be paid to the deformation of the beam during the tensioning process. If any abnormalities are found, the tensioning should be stopped immediately, the cause should be identified, and corresponding measures should be taken. After the tensioning is completed, the prestressed reinforcement should be anchored in a timely manner, and the shrinkage of the prestressed reinforcement after anchoring should meet the design requirements. Timely grouting of the ducts should also be carried out to prevent corrosion of the prestressed reinforcement and to ensure that the prestressed reinforcement and the concrete structure are subjected to joint force as a whole.

4. Epilogue

In summary, the top pushing construction technology for railway prestressed concrete continuous box girder bridges is an advanced, efficient, and environmentally friendly bridge construction technology with broad application prospects in the field of railway bridge construction. In the actual construction process, only by strictly following the design requirements and construction specifications, strengthening quality control, safety management, and technological innovation during the construction process, can the smooth progress of top pushing construction be ensured, and the high-quality and high-efficiency development of railway bridge construction be achieved.

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