Research on key technology of construction of long span continuous beam of high speed railway

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Abstract: After entering the new era, China's railway transportation industry has developed rapidly, and many high-speed railway projects have been emerging. Compared with ordinary railways, the trains on the high-speed railway have higher running speed, which need higher requirements on the rigidity of the bridge. In response to this situation, long-span continuous beam construction techniques are widely used in high-speed railway projects. Based on engineering cases, this paper analyzes the key technology for high-speed railway long-span continuous beam construction.

1. Introduction
It is found that the high-speed railway long-span continuous beam construction technology has very complicated operation steps and processes. Once quality problems occur during construction, it will have a direct impact on the overall quality of the high-speed railway project. Therefore, it is necessary to deeply study the key technology of high-speed railway long-span continuous beam construction and improve construction quality.

2. Preparation work and construction technical characteristics before construction of long span continuous beam of high speed railway

2.1 Engineering measurement
Before the construction of high-speed railway long-span continuous beams, we must first comprehensively and thoroughly investigate the climate and geological conditions of the construction area, and deeply understand and master the local environmental characteristics, and comprehensively analyze and evaluate various information obtained by using science and technology. The design department combines these survey information to develop a scientific construction plan, scientific selection of construction materials, and facilitate the smooth implementation of subsequent construction. Although high-speed railway bridges belong to the category of bridges, there are many differences. The requirements for general bridges are less complicated, while high-speed railway bridges have high requirements in terms of safety index and scientific construction, and require high engineering cost. Therefore, in addition to in-depth understanding of general bridge construction experience, it is necessary to conduct an in-depth investigation on the site.

2.2 Engineering design
The design guides the implementation of the follow-up construction activities and needs to be paid full
attention to. In the specific design practice, it is necessary to effectively avoid the national forest protection areas and residential areas in combination with the actual situation, so that the input cost can be reduced, and the excessive influence on the external environment can be avoided. In addition, the fault zone needs to be avoided as much as possible, otherwise natural disasters are easy to occur, which in turn can adversely affect the operating life of the high-speed railway.

2.3 Technical characteristics
Firstly, in the aspect of deep water cap, the effect of water flow will seriously affect the foundation of the cap, which will adversely affect the smooth implementation of the project. Hydraulic pressure can significantly reduce the spacing of bored piles and increase the size of caps. Therefore, do not carry out the construction process of wooden piles underwater as far as possible, but use steel boxes and other tools to reduce the impact of water pressure.

3. Key technology for construction of long span continuous beam of high-speed railway

3.1 Concrete pouring technology
It is found that one of the most important technologies in the construction of high-speed railway long-span continuous beam project is concrete pouring, which will have a direct impact on the overall construction quality and progress of high-speed railway project. Generally speaking, in order to shorten the construction time, one-time pouring technology is often used in the construction of high-speed railway long-span continuous beam. In the specific construction practice, the concrete mix ratio should be strictly controlled to ensure that it is in conformity with the design plan and the actual situation. Otherwise, it will affect the solidification time of the concrete, which is not conducive to the smooth construction of the subsequent projects. Secondly, in accordance with the actual situation of the project, the number of machine and equipment should be appropriately increased, which will promote the productivity and transportation capacity of concrete. Finally, it is necessary to enhance the sense of responsibility of the construction personnel, so that they can carry out the construction of each link in strict conformity with the relevant regulations, and ensure the overall quality of the concrete pouring project.

3.2 Linear control technology
Linear control is the key point in the construction of long-span continuous beam of high-speed railway. It refers to in-depth analysis of the measurement results at various construction stages, comparison of the previous model predictions, and identification of large deviations. Then, by means of in-depth analysis and research, targeted optimization and solution are carried out by combing with the actual situation of the project. At the same time, it is necessary to reasonably estimate and plan the construction of the subsequent stages. After each stage of the construction task is successfully completed, the model must be recalculated and revised to match the construction of the subsequent stages. In the revised practice, the concrete, construction period, concrete capacity and so on are taken as the key contents to compare with the various data obtained during the actual test process, including the height of the beam top and the concrete pouring, etc. Through the application of linear control technology, the beam closure process can be successfully completed.

3.3 CRTS plate beam surface control technology
In the process of box girder pouring, CRTS plate and beam surface control technology play an important role. At the same time, it is difficult because it requires accurate measurement of data, comparative analysis of standard data and measurement data, rough and flattening process. Through rough leveling, the difficulty of leveling construction can be reduced and the smooth implementation of leveling work can be promoted. In the process of flattening, the precision of manual leveling is higher than that of mechanical leveling. Combing with engineering experience, it is easy to have system problems in the machinery flattening process, and then appear errors and other problems. After
that, the scraping surface inspection is also an important process, and it is generally carried out by using a 4m ruler. If the measurement result conforms to the standard data, the process can be successfully completed.

3.4 Continuous beam swivel construction technology
The implementation of the bridge trial transfer process is mainly to test the safety and reliability of the bridge system, and comprehensively inspect the swivel structure system and traction power system of the bridge to keep it in good condition. After the trial transfer, the official operation of the bridge can be achieved.

3.5 Steel beam adjustment and closing
In the construction of this process, when the steel beam is adjusted, the cantilever can be installed on the front pier to carry out the construction work of the subsequent process. If the front fulcrum has a large offset on the lateral level, the necessary adjustments and repairs are required before the top is taken. If the front fulcrum has a large offset on the longitudinal plane, the temperature difference can be fully utilized during the adjustment process. It is necessary to strictly control the safety during the adjustment process to ensure that the bolts are always in a tight state. Otherwise, under the action of the force, it is easy to have the spindle tortuosity problem. In the process of closing, it is necessary to pay full attention to the length of the cantilever, and fully take into account the influencing factors such as deflection and rotation angle of the closed section. According to engineering practice, high-speed railway long-span continuous beams have more closing points, which are easily affected by some factors, such as temperature factors and installation loads and so on, and have greater difficulty in closing. In the construction of the project, the position of the closing should be accurately grasped so as to ensure the quality of the construction.

4. Engineering cases analysis

4.1 Overview of engineering
Taking a high-speed railway project as an example, the total length of the section is 284.33m, involving 53 large and medium-sized bridges, three of them are over 10km in length.

4.2 Construction scheme
Combining with the requirements of construction organization and design, the cast-in-place method of shaving is used in the construction of long-span continuous girder bridge, and the cantilever pouring method is used to carry out the construction of other continuous girders. This long-span continuous beam bridge is divided into four segment-type, as shown in figure 1.

![Figure 1 Segment layout of continuous beam construction](image)

Combining with the content of the design scheme, the B/D section is first poured, then the C section is poured, after closing, the pre-stressing tendons are tensioned, and finally the A section is poured.

4.3 Key technology of construction of long span continuous beam of high speed railway
Firstly, the design of cast-in-place continuous shaving frame. In combination with the actual situation
of the project, the bowl-type scaffolding, steel pipe and bailey beam are used as the main forms of the truss, and the cast-in-place construction technology of the full hall support is adopted. The two-hole door portal is reserved for crossing the road section, and the door portal specification is controlled according to the standard of 4*5m, and the door portal column is set by using materials such as steel pipes. Among them, the bracket design is shown in figure 2. In combination with the requirements of the program, all the brackets are strictly checked and found to be suitable for strength, stiffness and standard requirements.

![Figure 2 Bailey beam bracket schematic](image)

Secondly, concrete pouring technology. The concrete one-casting technology is applied to the construction of the project. Combined with the actual situation of the project, it is found that there is a large concrete volume and long pouring time. In order to ensure the quality of the concrete pouring of the beam body, a series of measures have been taken to optimize the construction organization plan. In the first place, the concrete mix ratio is optimized, and the initial setting time of the concrete is adjusted by the standard science of 15h to promote the concrete pouring time requirement. In the second place, the concrete mixing ability should be enhanced. In order to achieve the realization of the concrete production target, the construction unit, the offline unit and the beam yard mixing station can be fully combined to achieve a production capacity of more than 220m3/h. In the end, the transportation efficiency has been greatly improved. In combination with the engineering situation, in the concrete transportation, about 20 concrete transport vehicles will be used, and when pumping into the mold process, five automobile pumps will be used, so that the transportation time and the transport times of the concrete are greatly reduced, which can significantly improve the quality of concrete pouring.

Thirdly, the truss cast-in-place continuous beam construction monitoring technology. In order to ensure the safety of the bracket, the continuous beam construction monitoring work is carried out scientifically. Combined with the actual situation of the project, the high-precision steel-string strain sensor is applied to the monitoring, which can monitor the stress changes of the concrete roof and the bottom plate during the construction phase and the strain state of the steel pipe column and the bailey beam. This can ensure the safety of the box girder bearing bracket during the construction phase. In the prestressed tensioning process, the distribution of the box girder's own weight can also be monitored in real time. The embedded steel string strain gauge is used to carry out the box girder strain test process. Three measuring points are arranged respectively in the middle cross-span and middle support cross-section position. In order to grasp the change of the bearing force during the concrete pouring and tensioning process, the externally attached steel string strain gauge is reasonably arranged on the key column to monitor the strain change of the column in real time. During the tensioning process, the data of each strain sensor is collected periodically every day.

Fourthly, linear control technique. Through the implementation of the linear control process, the beam body closing process can be successfully completed, the reliability and stability of the track line are enhanced, and the safety and comfort of the high-speed driving are guaranteed. The linear control technology of common bridges is not suitable for high-speed railway, and it is necessary to use a
variety of high-tech for linear control, among which plane and elevation control, beam linear prediction and monitoring are all very important contents. The implementation of the linear control process can obtain a large number of beam deformation observation data, and then find out the shrinkage and creep laws of the beam body, and combine the measured data and laws to scientifically correct the theoretical value.

Fifthly, CRTS plate and beam surface control technology. In combination with the actual situation of the project, the flattening machine is used to carry out the roughing process, and the flattening process is carried out manually. Under the influence of the lateral slope of the wall, the flattening machine in the market can not meet the actual engineering standards, and it is necessary to scientifically reform the flattening machine. At the same time, in combination with the requirements of the engineering design plan, the elevation control points are pre-buried, and after the flattening process is completed, the scraping surface inspection process is completed by using a 4 m ruler.

5. Conclusion:
In summary, it is found that the long-span continuous beam has been widely used in the construction of high-speed railway projects because of its many advantages, which has promoted the overall improvement of the construction quality of high-speed railway engineering. However, the construction of long-span continuous beam is difficult with very complicated construction procedures. It still needs to continue in-depth research and relevant personnel should summarize construction experience, properly grasp key technology, and promote smooth construction of high-speed railway projects. In the future development, the electronic, mechanical and automatic level of high-speed railway long-span continuous beam construction technology will continue to improve, and further promote the development of China's high-speed railway engineering industry.

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