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Application of Mobile Formwork Cast-In-Situ Beam Technology in Bridge Construction

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Abstract: The application of mobile formwork cast-in-situ beam technology is conducive to providing quality assurance for bridge constructions. At the same time, it can improve the overall mechanization level of the construction process and further accelerate the construction progress, so as to shorten the construction period and improve the economic benefits of enterprises. In fact, this construction method has been widely applied. In order to assure a positive outcome from the use of this technology, this paper analyzes the application of mobile formwork cast-in-situ beam technology in bridge construction to provide reference.

Keywords: Bridge construction; Mobile formwork; Cast-in-situ beam technology; Application measures

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1. Introduction

The mobile formwork cast-in-situ beam technology requires the assistance of corresponding platform equipment, which can move freely along the axis of the bridge in the application process. The support beam must be built using steel truss and steel box girder while creating the mobile formwork. The movement can begin after the pouring above the bridge is completed. The movable formwork method is the optimum approach for cast-in-situ beam construction, despite the fact that there are numerous technical methods. It improves the mechanization level, expands the construction scope, and ensures the construction quality. It also improves the construction efficiency, reduces the construction cost, shortens the construction period, ensures the safety of workers, and improves the economic benefits of enterprises. At present, much attention has been paid to the mobile formwork cast-in-situ beam technology in bridge construction; therefore, it will be valuable to carry out an analysis on it.

2. Project overview

The project is to build a large bridge, in which the upper part of the bridge is made up of prestressed reinforced concrete continuous box girder with 54 connections and 206 holes. The mobile formwork cast-in-situ beam technology is applied.

3. Plans in the application of mobile formwork

In the actual construction process, the bridge is composed of several parts: the straight-line section, variable section, and connecting line bridge. The straight-line section includes the double width single box single chamber continuous box girder, with a width of 18 m. The width of the variable section is more than 18 m, which includes the double width single box multi-chamber continuous box girder, with a width of less than

18 m. The connecting line bridge includes the double width single box multi-chamber continuous box girder, with a width of 11 m. According to the regulations, the construction period is short, and the requirements for construction quality and progress are relatively high, but the construction process is cumbersome. Therefore, in order to improve the construction efficiency and ensure the full implementation of the construction work within the specified time as well as the quality of the bridge, it is necessary to apply the mobile formwork method in each bridge section.

3.1. Installation of mobile formwork

In the construction process, the selected mobile formwork is the through-type mobile formwork. The minimum weight of the whole machine is 400 t, whereas the maximum can be 460 t; the power is 55 kW, the adaptive slope is 2%, the longitudinal moving speed is 0.6 m/min, the adaptive curve radius is more than 2,100 m, and the maximum reaction force of the fulcrum can reach up to 5900 kN. The through-type mobile formwork mainly includes the main beam, guide beam, cross beam, and other parts. The through-type mobile formwork has a large volume, so it is impossible to be installed in the workshop; rather, it needs to be divided into multiple parts and transported to the construction site and subsequently installed there. Pressure test is carried out first to confirm that the results comply with relevant requirements before it can be officially put into construction. When installing the through-type mobile formwork, the steps are as follows: (1) adjust the instruments and equipment that will be used during the construction; (2) set up the bracket; (3) set up the main beam; (4) set up the beams; (5) reasonably adjust the system. In addition, it is also necessary to place the mobile formwork in a suitable position and set up the support for the external formwork prior to setting up the latter; then, carry out the pressure test and overall hoisting, and finally set up the C-beam and rear cross beam [1].

3.2. Displacement and removal of mobile formwork

3.2.1. Lateral movement of bracket and falling formwork

When all construction procedures, such as duct grouting and concrete pouring, have been implemented, the corbel can be moved laterally, and the formwork can be dropped. In the process of moving and dropping the formwork, the operation process is relatively simple. Only the jacking oil cylinder is required. In addition, the dropping can also realize the separation between the formwork and the bridge body, so that the main beam can move to the lower part. The bracket can also be separated from the pier, drawn out from the pin beam, and hung above the main beam using the action of the oil cylinder.

3.2.2. Movement of bracket

As the oil cylinder can generate a large amount of force, it can propel the bracket in any direction, and the movement process is unrestricted.

3.2.3. Bracket, main beam, and formwork

Two brackets are set under the bridge at the same time. When both brackets are located at the pier of the bridge, the bracket can be moved by the force generated by the oil cylinder. In that case, the bracket can be gradually moved to the pier. This principle can also be applied when the bracket is embedded. Moreover, as long as the corbel can be inserted into the pier, the information of the position of the corbel can be obtained. Finally, the transverse opening of the formwork can be controlled with the help of the transverse hydraulic system, and the main bridge beam can then be pulled.

3.2.4. Forward movement of the main beam

With the traverse hydraulic system, the main beam is moved forward.

3.2.5. Close the formwork when the main beam is at the specified position

The pouring point of the second hole is the designated arrival position of the main beam. When the main beam reaches this position, the transverse formwork clamping work can be carried out. Then, the main beam needs to be lifted to the designated position with a jack along the vertical direction, and detailed adjustments shall be made according to relevant requirements. When moving the main beam, professional technicians must carry out real-time monitoring and on-site guidance; there should not be any obstacles in the moving path, so as to avoid the moving support being restrained by other substances. In fact, there are numerous harmful factors present during the movement of the support, so it is necessary to improve the safety supervision and address any unsafe factors as soon as possible. For example, in case of machine failure, the construction personnel should stop the construction immediately until the unsafe factors are fully dealt with, so as to reduce the incidence of accidents [2].

3.2.6. Remove the mobile formwork

The mobile formwork itself has a large volume. In order to avoid overcrowding at the site, the mobile formwork should be removed by using hangers and transported back to the workshop upon the completion of the box girder construction.

4. Procedures in the application of mobile formwork cast-in-situ beam technology in bridge construction

4.1. Reinforcement

During the construction of the bridge, reinforcement construction needs to be carried out in two parts: (1) in the workshop, reinforcement and relevant blanking treatment should be fully implemented; in this process, the position of the reinforcement joint must be consistent with the construction requirements; (2) after the reinforcement is transported to the construction site, it is necessary to implement reasonable treatment for the reinforcement at the end beam and the web; it should be noted that when connecting the main reinforcement, the thick straight thread of the pier must be used.

4.2. Concrete pouring

Before concrete pouring, the preparation work should be improved to confirm that the embedded parts, bellows, formwork size, reserved holes, and so on fully meet the relevant requirements. It is also necessary to pay attention to the cleaning of oil, sundries, garbage, and so on at relevant positions. If there are deficiencies, they should be treated as soon as possible.

When the concrete is vibrated, the mechanical equipment with the highest frequency is the plug-in vibrator and plate vibrator. For concrete vibration, the main requirement is to improve the compactness of the concrete itself. Concrete pouring is a job that must be accomplished all at once. According to the construction plan, the pouring work must be carried out in sequence based on the construction sequence of bottom plate, web plate, and top plate; the pouring method must be gradually promoted. However, in the process of pouring, continuous pouring is still the main pouring method to avoid defects. It needs to be segmented in the longitudinal direction and layered in the horizontal direction to ensure the concrete pouring effect. The length of sections is determined according to the weather during construction and the initial setting time of concrete. The pouring work should not be carried out blindly in order to improve the construction efficiency. The pouring of a new layer can only be carried out after confirming that the poured concrete has been fully solidified [3].

In the concrete curing process, spraying water and wrapping with formwork are generally used for moisturizing to ensure the continuous wetting of the formwork joints. Usually, the concrete curing time lasts for 28 days, and the curing water temperature is controlled at about 15°C.

4.3. Prestress

In prestressed tensioning construction, YCD40 Jack and single tensioning are used for transverse tensioning, YCW500 Jack and single end tensioning are used for longitudinal tensioning, and steel tendon tensioning is carried out in the form of graded loading. It should be emphasized that the rate at which the load is applied must be gradual. During the construction process, the weight and degree of tensioning, corresponding anchoring, oil return, and so on should be carried out in accordance with relevant regulations, along with safety monitoring. Construction should be halted promptly if safety hazards are discovered until the potential hazards have been completely eliminated, in order to safeguard the safety of construction workers.

4.4. Elevation control

In applying the mobile formwork cast-in-situ beam technology in bridge construction, it is very important to effectively control the elevation because the setting of the formwork camber is difficult and cumbersome, and the whole process of construction needs to be monitored to ensure that the pouring of concrete on each pier top meets the relevant requirements. The camber of tensioning and the deformation amplitude of formwork before and after construction should be measured, and the difference between the actual bridge elevation and the design elevation should be controlled within ± 5 mm [4].

5. Conclusion

The application of mobile formwork cast-in-situ beam technology in bridge construction can effectively save the construction cost, reduce work intensity, ensure construction safety, display the characteristics of modernization in the overall construction, and improve the quality of the project. However, in the construction process, the construction plans and procedures must be consistent with the requirements, so as to fully exploit the function and benefits of this technology.

Disclosure statement

The author declares no conflict of interest.

References

[1] Liu H, 2020, Discussion on Cast-In-Situ Beam Technology with Mobile Formwork in Bridge Construction. East China Science & Technology: Synthesis, 2020(3): 0223-0223.

[2] Chen M, 2020, Discussion on the Application of Mobile Formwork Cast-In-Place Beam Technology in Bridge Construction. Construction Materials and Decoration, 2020(30): 259-260.

[3] Yan S, Wei Z, Mao Z, et al., 2021, Key Technology of Construction of Cast-In-Place Beam with Large Longitudinal Slope and Small Curve Moving Formwork Frame. Journal of China & Foreign Highway, 41(6): 166-170.

[4] Wang X, 2021, Research on Construction Technology Application of Continuous Box Girder Moving Formwork in Bridge Engineering. Transpoworld, 2021(18): 52-53.