Journal of Architectural Research and Development, 2022, Volume 6, Issue 3
http://ojs.bbwpublisher.com/index.php/JARD
ISSN Online: 2208-3537
ISSN Print: 2208-3529

Discussion on Construction and Erection Technology of Bridge Precast Box Girder

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Abstract: At present, the precast construction technology has been widely used, especially in the process of bridge construction, where the precast box girder construction and erection technology has attracted more attention compared to other available methods. In order to effectively improve the application effect of this technology, and the overall quality of the bridge, this paper discusses the advantage and disadvantage of implementing the precast box girder construction and erection technology in the bridge construction.

Keywords: Bridge construction; Precast box girder construction; Erection technology

Online publication: May 31, 2022

1. Introduction

Currently, the construction of the bridge with the precast box girder has been widely used, however, there are still deficiencies in this method which will be discussed in this paper, by using the construction of a long-span concrete bridge as an example. The superstructure of the bridge is constructed as a small box girder. The component prefabrication, is made at the designated position, subsequently after the prefabricated construction is completed, the components are transported to the installation site, and finally, the installation work is carried out with the help of a crane.

2. Precast box girder construction

2.1. Base support construction

Before the construction of the bottom formwork, the bottom surface will be excavated to the excavation depth of 30cm, further formwork will be filled with gravel soil in layers respectively, and finally, the surface of the formwork will be rolled by a road roller, to maintain the flatness and compactness of this part. The C30 concrete type should be used to fill the formwork and the thickness of the concrete used should be 10cm below the ground, and 20cm above the ground. During the filling of the construction base, a PVC pipe with the specification of 50mm is embedded every 1m to allow the pull rod to be carried out during the formwork erection. A seamless steel pipe of 30mm in size, is arranged longitudinally at the position about 10cm below the pedestal bottom formwork, to improve the efficiency of the water supply and the cooling. In addition, for the bottom tire, a steel plate with a thickness of at least 3mm is installed at the bottom formwork of the beam body and the side formwork, meanwhile for the core, a customized steel formwork is used. Further, the non-stress reinforcement is needs to be bound. When installing the bellows, the joint position is sealed with plastic tape, to avoid the infiltration of cement slurry of the concrete into the duct. A full-length PVC pipe, is placed inside the bellows as a liner, to increase the support, and the

deformation resistance of the bellows. Next, the installation of the formwork core and reinforcement binding will be carried out, followed by the establishment of the side and end formwork. Finally, the concrete filling is carried out after the supervisor checks the quality of the reinforcement formwork [1].

2.2. Concrete construction

For the concrete preparation, the concrete is first to be vibrated by using the immersion vibrator and attached vibrator. The concrete filling step, should adopt the layered continuous pouring strategy, which is carried out symmetrically, and evenly on the both sides of the inner formwork, to ensure that the stress of the inner formwork is balanced to avoid the displaced due to concrete pouring and vibration. After the filling work is completed, the scraping and roughening operation is carried out immediately, and the concrete on the top of the beam should be treated reasonably. Additionally, after 24 hours of completion of the filling, a reasonable time for the core removal is selected according to the actual situation, and comprehensive maintenance work is carried out. Moisturizing measures should be taken for the box girder concrete during the high temperature period, where a thermal insulation and moisturizing measures such as covering should be taken, to avoid cracks in the box girder concrete, due to the surface water loss and temperature stress. Finally, when the concrete strength rises to the consistent state with the design strength, the stress construction will be carried out.

2.3. Prestress tension

After the steel strand is bundled, it is threaded into the pre-stressed duct and the appropriate length at the both ends is preserved to facilitate the subsequent construction. Before tensing the stressed steel strand, firstly it is necessary to comprehensively check whether, the jack, oil pump, and the pressure gauge are in normal operation, and then it is necessary to apply a simultaneous tensioning mode at the both ends of the construction. It should be noted that, during the tensioning process, the concrete strength must be consistent with the design strength, and the concrete age should be at least 7 days during the tensioning process. Additionally, during the whole process of construction, protective nets, and relevant safety signs must be placed correctly, to ensure personal safety. After completing the tensioning work, it is important to check the end, and relevant parts before the completion of the construction to make sure that there are no cracks.

2.4. Grouting and anchor sealing treatment

Within 48 hours after the completion of tensioning operation, grouting treatment will be carried out for the duct. The water binder ratio in the slurry, should be below the body concrete, and should not be exceed 0.4. In order to avoid bleeding and sedimentation of the cement mortar, it is important to re-filter the cement slurry, that has been continuously mixed it in the slurry storage barrel. Interruption and unevenness should be avoided during the mixing process. Further, it is necessary to conduct smooth exhaust operation. After the cement slurry, with the specified fluidity emerges at the other end, the exhaust hole can be closed, further the pressure is needed to be maintained at the level of 0.5 MPa, and after 5min the grouting hole can be sealed. After grouting, the exposed pre-stressed reinforcement outside the beam body should be cut off with some specification, where it is forbidden to use arc cutting, and the exposed length after cutting should not be less than 1.5 times of the diameter of the pre-stressed tendon, and should not be less than 30mm, and lastly, the anchor head is closed with a concrete that is not less than 80% of the strength, compared to the structural concrete.

3. Precast box girder erection

In this project, the length of the precast box girder is 30m, where 36m^3 concrete is required for each side of the beam, and 33.136m^3 concrete is used for each middle beam. The total weight of the precast box is about

81t. The girder erection starts from 50 abutment to 0 abutment, and the box girder start from 45 to 50 abutment is hoisted with the help of two gantry crane with 80t. Between 0 to 45, the erection work is carried out with the help of the double guide beam bridge erecting machine. Firstly, the bridge deck assembled between the 45 and 48 pier is carried out on the ground with the help of the bridge erecting machine. The erection direction should start from the 45 to 0 abutment, and the erection is carried out in the form of full width. Finally, the gantry crane combined with the beam transport gun truck is used to carry out the beam transport and the feeding [2].

3.1. Construction preparation

After the installation of the beam, the sundries, and the garbage on the top surface is removed in time, and the measurement and the setting should be carried out to support the center. After the installation of the support, the beam side line is snapped with the ink line according to the transverse axis of the support, to ensure the elevation of the top surface of the support is accurate and confirmed, followed by the installation. Additionally, in order to ensure that the bearing surface is completely flat, horizontal installation style should be adopted. Lastly, before installing the box girder, it is important to comprehensively review the standards of the pier, abutment line, and the benchmark.

3.2. Support installation

The rational application of temporary bearings, can provide a foundation for the continuous construction of the box girder. Before the erection of the precast box girder, the permanent bearings should be installed, followed by installation of the temporary bearings and the bottom formwork of cast-in-situ section. The beam frame is placed on the upper part of the temporary support, to form a 'simply supported' state, and the bridge deck and end beam reinforcement should be connected in time. In the process of filling, the pouring work should be carried out initially, for the continuous section of pier point, followed the tensioning operation should be carried out for the negative moment beam, and lastly, the temporary support is removed to form a continuous system. After the completion of the bridge erection, the fabrication of the cast-in-place section will start immediately. After the strength of the bridge deck concrete slab, the negative moment tensioning and grouting of the cast-in-place, the temporary support can be removed to fully implement the transformation of the system.

3.3. Box girder transportation

Gantry crane, truck crane (or crawler crane), bridge erecting machine, gun truck, and other mechanical equipment is used for the lifting of the box girder. The equipment should be inspected before the construction, to ensure its' safety. The gantry crane has a high requirement for the foundation, therefore, it is important to treat the foundation according to the construction load, by calculating and checking the section, and finally, the reinforcement of the foundation concrete beam, is carried out by preparing a feasible scheme, to ensure a reasonable and safe design.

According to the scheme design, all the weak soil layers under the gantry crane track should be excavated, and filled with aeolian sand and gravel soil. The thickness of aeolian sand and gravel soil should be 1m and 30cm respectively. Next, the road roller is used for layered rolling, and to maintain the flatness under the gantry crane track, and the bearing capacity is increased to at least 300kPa. The reinforced concrete beam should be filled with C30 concrete, and the temperature joint should be reserved according to the specification. The top surface of the concrete, is leveled, and embedded with a steel rail fixing device, to ensure the stable placement of the gantry crane track in the later stage.

According to the overall arrangement, the box girder of 45 to 50 pier platform, is hoisted and installed by the gantry crane from the beam storage area, and the 45 pier to 0 box girder is erected by the bridge erecting

machine. Two gantry cranes are used to transport and load the beam to the beam transport gun truck of 48 to 50 piers bridge from the beam storage area. The beam transport gun truck transports the box girder, that has completed the erection operation to the left and right sides of the bridge, and feeds it into the bridge erecting machine.

In the process of beam erection, two gantry cranes and two truck cranes are used to carry out double crane lifting. The side beams should be erected first, far from the access road, followed by the other box girders. It should be noted that before carrying out the box girder erection work, it is necessary to carefully detect the flatness, and the top elevation of the bearing pad stone, set out the end, and the side line of the beam and slab, and confirm that all indicators meet the relevant requirements before the erection work is carried out [3].

3.4. Beam erection

The front end of the beam body is transported to the position between the rear tail frame, and the middle cross the beam of the bridge erecting machine. The front lifting beam truss truck is used to bundle the front end of the beam body. The steel wire rope is prepared in advance according to the shape and the weight of the beam body and its length. When carrying out a beam binding operation, the beam protection work must be improved. After confirming that the beam protection patch is intact, and the beam body is lifted with completely consistent with the falling conditions. If there is no beam piece at the lower end, it is necessary to lower its overall height, and keep a distance of 2-3cm between the beam body and the support. If there is a large difference between the beam body and the installation position, the beam should be moved appropriately to reduce the distance between them, to realize the positioning of the beam body. Welding is carried out immediately, after the beam body is in place. It is important to ensure that, the beam body in the beam transport lane is at least 2/3 of its diaphragm has been dry.

3.5. Bridge erecting machine moving forward

After the erection of a span box girder is complete, the track on the bridge erecting machine should be re-laid at the beam end, and the top of the pier cap in front, to erect the beam body on the next hole. According to the construction experience, if one wants to effectively improve the quality and the efficiency of the box girder erection construction, we need to comprehensively check the electrical system, and the traveling system of the bridge erecting machine before crossing the hole. Before completing the crossing work of the bridge erecting machine, the laying of the transverse track should be improved. After the bridge erecting machine completes the hole crossing, the front outrigger is supported, to ensure the safety and stability of the bridge erecting machine during the operation [4].

4. Conclusion

The rapid economic development in contemporary China, leads to high requirement in the development of roads and bridges, which subsequently, promotes the development of the bridge construction. Therefore, precast box girder has been more widely used. In this paper, according to the actual construction situation, the fabrication, and the erection of the bridge precast box girder is discussed comprehensively, and the feasible construction measures are summarized, hoping to increase the application level of the bridge precast box girder.

Disclosure statement

The author declares no conflict of interest.

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