Applied Mechanics and Materials
ISSN: 1662-7482, Vols. 416-417, pp 1781-1785
doi:10.4028/www.scientific.net/AMM.416-417.1781

Online: 2013-09-10

Discussion on the Application of the Concrete-filled Steel Tube in Civil Engineering

Chao ZHAO

Xuchang University, Xuchang, Henan 461000, China

Keywords: Civil Engineering; Concrete-filled Steel Tube; Application Analysis

Abstract. Concrete-filled steel tube, as a main bearing component, can be temporarily used as the building support of other components. In this paper, the key and difficult points in the construction of concrete-filled steel tube in underground civil engineering, how to use the key technologies in the construction process, and the quality control problems and development prospects are mainly introduced.

Introduction

The structure of concrete-filled steel tube features high bearing capacity, excellent toughness and plasticity, easy-to-construction, and good fire-resistant performance, so that it is more suitable for the application to the underground projects with great load bearing. This application is analyzed and discussed first in this paper.

Concrete-filled Steel Tube construction characteristics and difficulties in underground projects

During the construction of underground structure, the main construction characteristics of concrete-filled steel tube are as follows: the empty steel tube is installed first, and then the horizontal components such as beam and slab are put in the construction, and finally the concrete is poured in the core parts. In the whole construction process, empty steel tube needs to bear the construction loads, the self-weight of beam and slab, and the hydrostatic pressure caused in the pouring of the concrete, so the steel tube has endured certain deformation and become deformed when it has been not put in use.

The basic construction flow of concrete-filled steel tube and the construction sequence of underground structure

The construction flow is as follows: the empty steel tubes are made and processed first, and then the steel tubes in the first player are hoisted, and then the lower and upper steel tubes are jointed and hoisted after anchor becomes solid, and finally the core concrete is poured.

In the construction sequence, a commonly used method is cover-excavation, which includes two main ways (i.e. the same-direction construction, and the reversed construction). The same-direction construction has been applied the most early. In figure 1, the same-direction construction is shown. The reversed construction of the cover-excavation method is also classified into full-reversed construction and semi-reversed construction. In figure 2, the semi-reversed construction flow is shown.

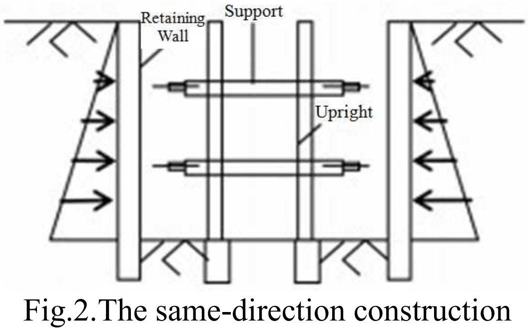

Fig.2.The same-direction construction

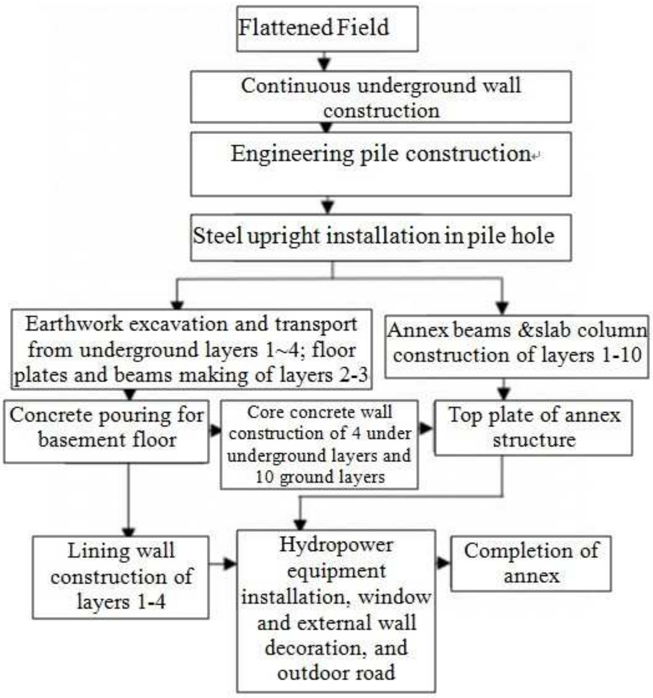

Fig.2.The reversed construction

The key technologies of concrete-filled steel tube in the construction of underground projects

First of all, in processing and checking the empty steel tubes, it is more complicated in loading welding studs and plates in comparison with the ground buildings because the size of cross section is big, and also the technical quality is required very highly, the quantity of welding joints is large, and it is easy for deformation to occur. Thus, How to do this work has become the emphasis and difficulty in the construction. Small holes should be reserved on the surface of steel tubes.

Second, the foot of the concrete-filled steel tube is fixed with anchor. The load quantity of the concrete-filled steel tube in underground projects is relatively large, so the filling pipe of a large diameter is generally used, and the foot of the concrete-filled steel tube can be fixed in the way of inserting and then can become more reinforced.

Third, flange connection is commonly used for the on-site installation and splicing joint of some concrete-filled steel tubes' basic components. That is, flange plates are set in the ends of the steel tubes, and sometimes the feed-through way will be used for enhancing the stiffness of the steel tube joints in the on-site connection, and also the centerline and height should be marked when each section of steel tube is hoisted. After the upper and lower steel tubes are overlapped with the centerline, the verticality of steel tubes and also the elevation can be adjusted, and bolts can be fixed after all requirements are fulfilled.

Fourth, beam and upright are connected. The node connection ways, which are commonly used for beam and upright, include the double-beam nodes of reinforced concrete, the variable width beam nodes of reinforcing steel bar, the connecting nodes of reinforcing steel bar, the node ringing beams, the enhanced ringing nodes, etc.

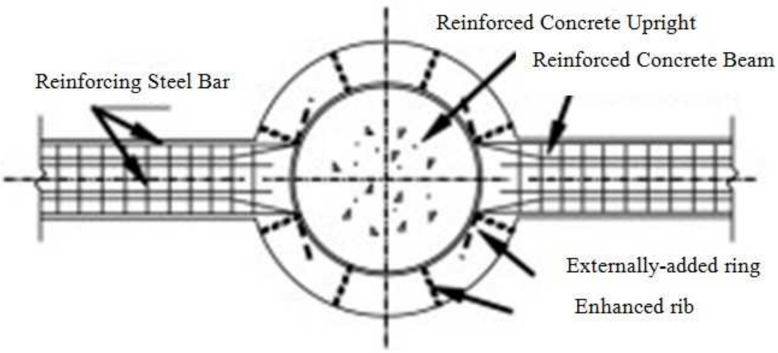

Fig.3.The enhanced ringing nodes

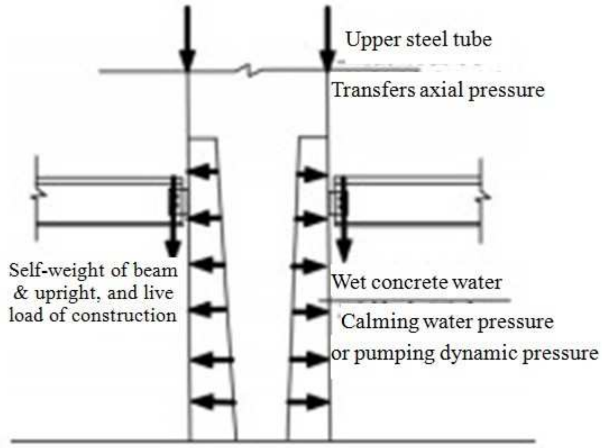

Fig.4.The stress in the construction stage

Fifth, the core concrete should work with steel tubes together when the concrete in steel tube is poured and the concrete shrinkage is compensated. For the inner core of steel tube, micro-expanding concrete is generally used, and the scope of reasonable slump is 12~18cm. If the slump is too large, segregation will occur in concrete, and then the viscous resistance will increase after a period of time, so that the pumping pressure is affected to some extent.

The quality control key points and matters needing attention in the construction of concrete-filled steel tube

In quality control, important aspects should be mainly focused. First, the quality control should be implemented well in making the steel tubes: the size and height position should be accurate, and the reverse welding construction is implemented using the DC arc welding machine when manual welding and tube rolling on rolling bed are implemented. Second, the accuracy should be strictly controlled when steel tubes are installed, jointed, and hoisted. In the jointing, the welded steel tubes should be kept flat and straight, the geometry size and the effect of tubes on geometric deformation should be strictly controlled, and also the symmetry in welding should be focused. Finally, the quality of the concrete pouring construction in steel tubes should be controlled, and the continuity of construction should be kept, and also the speed of pouring should be properly controlled.
The matters needing attention can be concluded mainly from the following aspects:

The principle of full-sending pressure and uniform symmetry should be always persevered when concrete is pumping. Thus, the compactness of concrete can be effectively guaranteed, and also the mixing ratio of concrete can be well controlled, and then the emergence of cracks can be effectively prevented.

Steel tubes should be examined before concrete is poured, and there are no sundries and rust within steel tubes. Thus, steel tube and concrete can be effectively adhesive, and also interface agent can be brushed on the inside of the steel tubes.

The continuity of concrete pouring should be maintained, and the time should be no more than the solidification period of concrete if there is a pause in the midway for preventing the emergence of cavities.

Some problems and development prospect in the application of concrete-filled steel tubes

Structure maintenance problems

After the completion of concrete construction, the daily management should be enhanced, and inspection and maintenance should be made at a regular time, so that the design service life can be further extended. Therefore, the standardization of the management structure as well as how to standardize it remains to be a problem necessary to study and solve further.

Necessary to improve testing technology

The existing testing methods mainly include ultrasound test, artificial tapping, surface wave test, and optical fiber sensor testing system. In these test methods, the development important trend is the scatheless testing method from economy and complete structure. However, the measuring accuracies of these methods are very low. To achieve more accurate results, the combined role of many methods should be used. Therefore, it is necessary to study the accuracy of test for making the test demands fulfilled.

Necessary to improve the nodes

The key for concrete-filled steel tube to work safely and maintain the normal structure lies in node. In the current actual construction, the forms of nodes are various, but their application effects are not very good, which are reflected from complex construction, inflexible application way, and simple researches of results and theories, etc. In the studies of concrete-filled steel tube structure, the forms should be new and own a higher bearing capacity, and more reasonable and clearer stress and force, so that the construction becomes more convenient, and the structure is simpler.

Necessary to study the overall fire-resistance problem of concrete-filled steel tube

Currently, certain achievements have been made to the fire resistance of concrete-filled steel tube, but are only limited to components. Because the structure system of concrete-filled steel tube is statically indeterminate, the resistance decline of each component in a fire accident will make the internal force of the structure system redistributed, and certain internal forces will be produced from the temperature rise (expansion) and temperature drop (contraction) of materials and sometimes the distortion of beams and the instability of upright will be caused, so the study on the fire-resistance of concrete-filled steel tube is an important direction for the future development.

The application prospect and development of concrete-filled steel tube

Concrete-filled steel tube can be applied in the water conservancy projects, because it is very applicable to the projects of small partiality or forced axes. This structure is very common in the construction of water conservancy projects. For example, the structural upright of the underground powerhouses, aqueduct bent frame column, arched gate frame, and other components in hydropower station are reflected in China's south-to-north water transfer project. In the future development of water conservancy projects, the technology method and theory should be practiced and studied frequently, and also are gradually used in specific construction projects.

New types of concrete-filled steel tube should be also studied. The concrete-filled steel tube consists of concrete (the core) and steel tube, so these two elements can be applied to different aspects through a variety of forms and also their application scope can be further widened.

Conclusion

Relying on many advantages such as short time limit, saving materials in the construction structure, easy-to-construct, and high economic benefit, concrete-filled steel tube has been widely used in civil and industrial buildings. Thus, it owns a very broad application prospect in building structure engineering.

References

[1] Xiaoli Mo, Wenda Wang. The key Technologies of the Steel Tube Column in Underground Projects [J]. The Construction Technology, 2010 (2).

[2] Zhu LI, Wenda WANG, Qing YU. Fire Resistance Calculation and Practice of the Steel Tube Column in Underground Projects [J]. Railway Construction, 2009 (9).

[3] Wenda Wang, Xusheng Wang, Qing YU. Type Selection of Connective Structure between Concrete-filled Steel Tubular Column and RC (Reinforced Concrete) Beam in Underground Works and Its Mechanical Behavior [J]. Railway Construction, 2009 (8).

[4] Ying Liu. Analysis on the Application of the Steel Tube Concrete in Building Engineering [J]. China, 2012 (11).

[5] Yanbo LV. Mechanical Behavior of Conical Concrete-Filled Double-Skin Steel Tubular Stub Columns with Endplate under Axial Partial Compression [J]. Journal of Shenyang Architecture University, 2011 (11).

[6] Ting ZHOU. Study on Square Steel Bar and Concrete Combined Special-Shaped Column Structure Mechanics Performance and Engineering Application [J]. Journal of Tianjin University, 2012 (6).

[7] Jingxuan Wang. Research on Mechanical Behavior of Composite Frame with Concrete-filled Steel Tubular Columns after Exposure to Overall Stage of Fire [J]. Journal of Disaster Prevention and Mitigation Engineering, 2011(10).