KCS 11 50 25 : 2019

Caisson Foundation

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국토교통부

Foreword

• In accordance with the change to the construction standards code system, the duplications and conflicts between existing construction standards (design standards, standard specifications) were compared and reviewed and then integrated into this standard as a standard code.

• This standard was established by integrating the parts of the existing highway bridge standard specification corresponding to the caisson foundation. The history of this standard and its revisions is as follows.

Construction Standard	Main Content	Enacted or Revised (Year.Month)
Highway bridge standard specification	• Established highway bridge standard specification	Enacted (1977.12)
Highway bridge standard specification	• Revised to reflect the revisions to the concrete construction standard specification	Revised (1983.12)
Highway bridge standard specification	• Revised to reflect the latest domestic & international specifications and technological advancements	Revised (1992.11)
Highway bridge standard specification	• Content divided into design and construction, and maintenance included	Enacted (1996.4)
Highway bridge standard specification	• Reorganized into a new system to resolve conflicts between different sectors	Revised (1999.8)
Highway bridge standard specification	• Added TMC steel standards and improved welding standards	Revised (2005.2)
Highway bridge standard specification	• Added new regulations for the construction of high-performance materials such as rolled steel for bridge structures and high-strength concrete, and added quality control technology for centrifugal concrete piles	Revised (2013.2)
Highway bridge standard specification	• For non-destructive inspection methods, ultrasonic inspection may be selected in addition to radiographic inspection	Partially revised (2015.6)
KCS 11 50 25 : 2016	• Integrated and maintained as code according to the changes to the construction standards code system	Enacted (2016.6)
KCS 11 50 25 : 2016	• Amended according to Korean Industry Standards and Construction Standards	Amended (2018.7)

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1. General

1.1 Scope of application

(1) This standard applies to the foundation work for pneumatic caissons and open caissons used as foundations for highway bridges.

(2) In addition to the ground work, the pneumatic caisson foundation method involves excavation under a dry condition through the use of compressed air in the workspace, and the open caisson method mainly performs wet excavation on the ground. Both of these methods consist of the same types of work, such as constructing the main body and repeating excavation and sinking.

1.2 Reference

1.2.1 Related laws and regulations

No content

1.2.2 Related standards

- KCS 11 50 05 Shallow foundation
- KCS 11 50 15 Precast pile
- KCS 14 20 00 Concrete work
- KCS 14 20 10 General concrete
- KCS 14 20 11 Reinforcement work
- KCS 14 31 05 General aspects of steel structure work
- KCS 14 31 10 Production
- KCS 14 31 20 Welding

1.3 Materials to submit

1.3.1 Construction plan

(1) Subject to KCS 11 50 15 (1.3.1).

1.3.2 Construction report

(1) Subject to KCS 11 50 15 (1.3.3).

2. Materials

2.1 Concrete materials and mixing

(1) Subject to KCS 14 20 10.

2.2 Reinforcement

(1) Subject to KCS 14 20 11.

2.3 Steel plates and welding

(1) Subject to KCS 14 31 05, KCS 14 31 10, and KCS 14 31 20.

3. Construction

3.1 General

3.1.1 Preparing for construction and reviewing data

(1) Investigate the following data to establish a caisson construction plan and carefully review the materials to ensure optimal construction.

① Construction details and site overview

② Design and construction data

③ Natural conditions: ground layer structure, groundwater, weather, flood level, depth of installation location, and current and river bed data

④ Field equipment and materials: Construction site, construction materials, transportation

⑤ Construction cost analysis data, mechanical equipment, power, electric power facility

⑥ Test caisson production and test settlement plan

3.1.2 Selecting construction equipment

(1) For the construction, excavation, and sinking of the main body, special machines are required for excavation and sinking. Therefore, review the construction conditions including the specifications of the caisson foundation, the number of constructions and arrangement, ground conditions, the construction period, the environment of the work site, and the safety of the work in order to select the construction equipment that can satisfy the dimensions and functions specified in the design documents.

3.2 Pneumatic caisson method

3.2.1 Construction equipment

(1) In addition to the ground work, excavate under dry conditions by using compressed air in the workspace during basic work such as construction, excavation, and sinking. Therefore, the main targets of this method are equipment for air supply, fitting, excavation, and communication means.

(2) General equipment for construction includes safety equipment, construction management equipment, work tables, transportation equipment, concrete placement equipment, power equipment, lighting and water supply facilities, excavation and sinking equipment, air supply equipment, and fitting equipment. Of this, certain equipment may be excluded or other special equipment may be added depending on the size of construction or the site conditions.

3.2.2 Plan for major temporary facilities

(1) Install the temporary facilities of the caisson according to the construction plan, and always conduct inspection and maintenance during the construction to ensure safety. In terms of the capacity and safety of the field equipment, secure a sufficient margin because the caisson method requires fast construction and is subject to significant operational risks.

(2) The structure, specifications, and materials of bridges, access roads, and platforms connected to both banks of a river shall be planned to be safe against various loads and external forces expected during the construction period, and approval shall be obtained from the construction supervisor in advance.

(3) Since sinking the caisson usually continues day and night, prepare the production, transport, and placing equipment of concrete to perform the concrete work in parallel. The quality, transport, and placement of concrete shall follow the standard specification for concrete.

(4) Power, lighting, and water supply facilities

(5) The air supply facility consists of an air compressor, an air cooling system, an air purifier, and the main pipe to receive and supply air.

(6) Cranes are usually installed as the excavation equipment, but since cranes are used for various purposes such as concrete placement, formwork removal, and transporting other materials, the excavation work should be planned carefully.

(7) For emergency and supplementary facilities, hospital locks should be installed at construction sites of pneumatic caissons with an internal pressure of more than 100 kPa, and more than 1 unit should be installed according to the size and number of caissons. The operation of the hospital locks shall be in accordance with the safety regulations of high-pressure work.

3.2.3 Caisson installation

(1) Install the caisson on ground that can fully support the weight of the main body, formwork, and staging, and safely achieve the initial sinking.

(2) Caissons can be installed by the land-based method, the island method, or the underwater method. The construction method should be selected after considering the construction conditions, water depth, and concrete weight.

3.2.4 Shoe

(1) Construct the shoe of the caisson according to the design and construction plan.

(2) The production of shoe steel fittings shall conform to that of steel bridges.

(3) Select a welding method with minimal deformation to weld shoe metal fittings in the field.

3.2.5 Staging

(1) The structure of the staging shall be sufficiently rigid to withstand the total load during the construction of the shoe and ceiling slab of the chamber.

(2) Install the staging on ground that can safely support the weight of the staging and the ceiling slab of the chamber.

(3) When dismantling the staging, review the strength of concrete to prevent any adverse effects on the structure. The compressive strength of concrete at the point of dismantling the staging and the retention period of the staging after concrete placement shall conform to the concrete standard specification.

3.2.6 Constructing the main body

(1) The construction of the main body of a caisson, such as the workspace, the body, and the connection with the sphere, is achieved through a combination of fitting and temporary work, and the whole process should be planned to ensure safe and smooth construction. When constructing the main body with reinforced concrete, the major types of construction consist of formwork assembly, processing and assembly of rebars, and placing and curing concrete, which shall be in accordance with KCS 14 20 00.

3.2.7 Fitting

(1) In the pneumatic caisson method, the process of installing the equipment required for excavation and sinking after sinking the caisson to the groundwater level is referred to as fitting, in which equipment such as locks, shafts, air supply pipes, exhaust pipes, and wiring pipes shall be installed according to the design drawing and shall be inspected for daily maintenance. In addition, the equipment shall be removed according to the construction plan.

3.2.8 Excavation and sinking

(1) Perform excavation by modifying the subsidence relationship according to the construction conditions, prevent the movement, tilting, and rotation of the caisson and avoid sudden subsidence.

(2) When cutting rocks by blasting, take safety measures and prevent damage to the caisson.

(3) Conduct sinking based on the self-weight of the caisson, the live load, and the reduction of frictional resistance. If using decompression subsidence, confirm the stability of the main body of the caisson and the evacuation of workers, and thoroughly review the impact on adjacent structures.

3.2.9 Reduction of frictional force

(1) When the resistance to subsidence while sinking the caisson is expected to be large, the most common method of reducing the frictional force between the outer wall of the main body and the ground is a 50 ~ 100 ㎜ friction cut in the caisson shoe. It is necessary to review a combination of other methods to facilitate settlement depending on the shape of the caisson, dimensions, and soil characteristics.

3.2.10 Evaluation of bearing capacity and deformation characteristics

(1) When the pneumatic caisson reaches a certain depth, perform a plate loading test using the ceiling slab of the workspace to check the bearing capacity of the ground and the coefficient of subgrade reaction. For the loading test method, perform the quick maintained-load test using the multi-cycle method considering the environment of the caisson workspace. From a geotechnical perspective, the evaluation may be performed using the borehole loading test in addition to the plate loading test.

3.2.11 Sealing concrete placement

(1) For the construction of sealing concrete, trim and level the protrusions on the bottom of the caisson, then remove any loose soil or muck and clean the inside of the workspace, and fill the chamber using concrete of adequate workability for the work while controlling the internal atmospheric pressure.

3.2.12 Upper slab

(1) Construct the upper slab of the caisson to ensure that the applied load is transferred to the main body of the caisson.

3.2.13 Temporary retaining wall and cut-off wall

(1) The temporary retaining wall and cut-off wall shall meet the required water resistance

performance and have a rigid structure that is not altered or damaged by external forces such as earth and water pressure while sinking the caisson.

(2) If the temporary structures affect the safety of the main structure or the surrounding environment after completing the structure, remove the temporary structures.

3.2.14 Construction record

(1) Prepare by referring to KCS 11 50 05 (3.4).

(2) Record the construction status by stage during the construction period by taking photos or videos to store as evidence or reference in the future.

(3) After completing the construction of the caisson foundation, measure the location, inclination, and dimensions of the installed state and prepare an as-built drawing that indicates the production and installation of ironwork such as the arrangement of rebars. In addition, keep working drawings for each stage of construction and working drawings of various temporary facilities as records.

(4) Classify and maintain quality control plans and performance results or reports for each type of work.

3.3 Open caisson method

3.3.1 Method application

(1) Open caissons may be sunk by pumping soil from the inside from soft clay, silt, sand, and gravel layers, but this method is inappropriate for strata containing boulders. In addition, if the support rock is inclined or irregular, the caisson may be tilted after reaching the rock, so particular attention should be paid to sinking when applying the open caisson method.

3.3.2 Plan for major temporary facilities

(1) Subject to 3.2.2 of this standard.

3.3.3 Caisson installation

(1) Unlike the pneumatic caisson, rapid subsidence or inclination may occur in the open case method because there is no positive pressure due to the working pressure when the caisson starts to sink. For this reason, preventive measures should be taken to prevent these issues.

3.3.4 Shoe

(1) Construct the shoe of the caisson according to the design and construction plan.

3.3.5 Constructing the main body

(1) Construct the main body of the caisson to satisfy the required dimensions and functions by considering the construction conditions.

3.3.6 Excavation and sinking

(1) Perform excavation by modifying the subsidence relationship according to the construction conditions, and prevent the movement, tilting, and rotation of the caisson and avoid sudden subsidence.

(2) When cutting rocks by blasting, take safety measures and prevent damage to the caisson.

3.3.7 Reduction of frictional force

(1) Subject to 3.2.9 of this standard.

3.3.8 Foundation ground inspection

(1) The expected foundation ground should be a solid soil layer or a bedrock layer. Therefore, perform bearing capacity and scour tests if it is a soil layer. If it is a bedrock layer, confirm the stability of the foundation ground through the following methods.

① Inspecting the rock properties by visual observation

② Measuring the rock strength by sampling

③ Indirect inspection by photography

④ Inspecting the foundation floor by other methods

3.3.9 Bottom slab

(1) After sinking the caisson, remove the soil attached inside the shoe or the fore-end of the partition by using a discharger, and prevent the mixing of debris between the floor concrete.

(2) Except when performing a land excavation, check the water level inside the caisson and place underwater concrete.

(3) In principle, a tremie or concrete pump should be used to place concrete. Underwater concrete must be placed continuously. To prevent leakage of cement paste, the fore-end of the pipe should always be kept inside the concrete. Always measure the amount of concrete and the placement height during the process.

(4) After placing the floor slab concrete, the stagnant water inside the caisson must be drained to construct a reinforced concrete slab on top of the floor slab. In severe cases, the results may deviate from the purpose of the foundation, such as fractures in the floor slab caused by the positive pressure of groundwater or cracks in the main body of the caisson, so take precautions when draining the stagnant water inside the caisson.

3.3.10 Upper slab

(1) Subject to 3.2.12 of this standard.

3.3.11 Temporary retaining wall and cut-off wall

(1) Subject to 3.2.13 of this standard.

3.3.12 Construction records

(1) Subject to 3.2.14 of this standard.