Korean Construction Standard

KCS 11 20 25 : 2019

Refilling and Back Filling

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국토교통부

Foreword

- To address needs caused by changes in the construction standard code system, the overlaps and conflicts between existing construction standards (design standard, standard specification) were compared and reviewed and then integrated into the newly enacted Construction Standard Code.
- This code was revised and enacted as a standard by integrating the parts of Road Work Standard Specification and Civil Engineering Standard General Specification related to refilling and back filling in the Architecture Construction Work Standard Specification, the Sewer Construction Work Standard Specification, the Architectural Electric Facility Construction Works Standard Specification, the Utility Tunnel Standard Specification, and the Urban Railway (Subway) Construction Work Standard Specification. Major matters related to the enactment and revision of this code are as follows:

Construction Standard	Major Contents	Enactment· Revision (Month, Year)
Road Work Standard Specification	• Enacted by the Ministry of Construction by entrusting it to the Korean Society of Civil Engineering	Enactment (1967.12)
Road Work Standard Specification	• All specifications and guidelines used were reviewed for correlations, and revised and improved to prepare a specification for general road works.	Revision (1985.12)
Road Work Standard Specification	• Compensated and revised to prepare a more detailed specification by introducing new theories to all specifications and guidelines being used.	Revision (1990.5)
Road Work Standard Specification	• Revised to improve road work quality and increase international competitiveness by modifying the systems in response to the opening of the construction market that followed the initiation of the WTO system.	Revision (1996.7)
Road Work Standard Specification	• Reconstructed and compensated according to construction standard maintenance guidelines to reflect the revision of other standards including Korean Industrial Standards (KS) and Concrete Standard Specification, and to establish the system as a national standard.	Revision (2003.11)
Road Work Standard Specification	• Revised to address problems found in road work procedures; to harmonize with other standards, including Korean Industrial Standards (KS), Concrete Standard Specification, and Tunnel Standard Specification; to prevent faulty construction works; and to induce solid construction works through thorough quality control.	Revision (2009.3)

Construction Standard	Major Contents	Enactment·Revision (Month, Year)
Road Work Standard Specification	• Revised to change the sequence of standard specification, specialized specification, and design drawings, and to reflect the opinions of the Central Committee.	Revision (2015.9)
Road Work Standard Specification	• Partially revised in the area of general matters, tree protection materials, general construction works, etc.	Revision (2016.5)
Civil Engineering Construction Standard General Specification	• Enacted as a Civil Engineering Construction Standard General Specification	Enactment (1962)
Civil Engineering Construction Standard General Specification	• Revised as a Civil Engineering Construction Standard General Specification	Revision (1967)
Civil Engineering Construction Standard General Specification	• Revised on the basis of the drafts submitted by individual subcommittees of the Korean Society of Civil Engineers in accordance with the continuous progress in construction technologies, including the scaling-up and diversification of construction works and the development of new engineering methods and materials.	Revision (1977)
Civil Engineering Construction Standard General Specification	• Revised to prepare a general specification for the entire scope of civil engineering by reviewing the correlations between all the specifications and guidelines under application.	Revision (1985.12)
Civil Engineering Construction Standard General Specification	• Revised to arrange the individual specifications for each engineering process, to add the specifications on grouting, spraying, and waterproofing as well as those for advanced engineering methods, equipment, and materials, and to harmonize with various other standards and regulations, including various specifications that have already been revised.	Revision (1992.12)
Civil Engineering Construction Standard General Specification	• Revised to be partially modified and compensated by arranging for each of the subdivided engineering processes, and to modify the name to the Civil Engineering Construction Standard General Specification.	Revision (1996.3)
Civil Engineering Construction Standard General Specification	• Revised to be partially modified and compensated by arranging for each of the subdivided engineering processes for each handling to respond to the changes in the construction work operation management and the construction work standards.	Revision (2004)
Civil Engineering Construction Standard General Specification	• Revised by adding, compensating and modifying the information in accordance with the updated construction engineering works. Revised particularly by reflecting the details of new technologies, new engineering methods, and new materials, and by modifying the units to those of the SI system.	Revision (2005.2)
Civil Engineering Construction Standard General Specification	• Revised by specifying that low-flowability cementation agents and soil-cement are used for back filling to prevent road sinking, ground loss, and sink holes in cases where the surrounding ground is sand or dredged soil.	Partial Revision (2015.8)
KCS 11 20 25 : 2016	• Integrated and maintained as code according to changes in the construction standard code system.	Enactment (2016.6)
KCS 11 20 25 : 2016	• Revised to accord with Korean Standard and Construction Specification.	Revision (2018.7)

Construction Standard	Major Contents	Enactment· Revision (Month, Year)
KCS 11 20 25 : 2019	• Revised by describing the back filling materials synthetically and specifying the flowing filling materials.	Revision (2019.12)

Table of Contents

1. General

1.1 Scope of Application

(1) This standard is applied to refilling works for the construction of subway tunnels, underground structures, facilities, and relevant structures; back filling around structures and on-site structures up to a specified height; filling under floor slabs or pavement; and filling works up to the ground plane in landscape areas.

(2) Refilling and back filling include the restoration of existing pavements and relevant facilities to the state before trenching. Construction works should be performed according to the requirements specified in the relevant specifications for asphalt concrete pavement, cement concrete pavement, curbs, gutters, and sidewalks.

1.2 Reference Standards

1.2.1 Relevant Laws and Regulations

Not applicable.

1.2.2 Relevant Standards

- KCS 10 30 05 Construction Surveying
- KCS 11 20 10 Earth Cutting
- KCS 11 20 15 Trenching
- KCS 11 20 20 Banking (Mounding)
- KCS 11 70 00 Slope Surface Protection
- KCS 14 20 00 Concrete Construction Works
- KCS 14 20 10 General Concrete
- KCS 44 50 05 Freezing Protection Layers, Auxiliary Base Course and Base Course Construction Works
- KS F 1005 Terms for Fibers for Ground
- KS F 2301 Method of Preparing Samples for Soil Particle Diameter Testing and Physical Testing
- KS F 2302 Method of Soil Particle Diameter Testing
- KS F 2303 Method of Soil Liquid Limit Testing
- KS F 2304 Method of Soil Plastic Limit Testing
- KS F 2306 Method of Soil Water Content Testing
- KS F 2308 Method of Soil Density Testing

- KS F 2309 Method of Soil Washing Testing
- KS F 2310 Method of Plate Bearing Testing on Roads
- KS F 2311 Method of Soil Density Testing by Sand Replacement Method
- KS F 2312 Method of Soil Compaction Testing
- KS F 2314 Method of Soil Uniaxial Compression Testing
- KS F 2320 Method of Subgrade Soil California Bearing Ratio (CBR) Testing
- KS F 2324 Engineering Method of Soil Classification
- KS F 2340 Method of Sand Equivalent Testing of Sandy Soil
- KS F 2345 Method of Relative Density Testing of Non-cohesive Soil
- KS F 2347 Method for Density of Soil Testing in Place by the Rubber-Balloon Method
- KS F 2502 Method of Sieve Analysis Testing of Coarse Aggregates and Fine Aggregates
- KS F 2503 Method of Coarse Aggregates Density and Absorption Rate Testing
- KS F 2504 Method of Fine Aggregates Density and Absorption Rate Testing
- KS F 2508 Method of Coarse Aggregates Abrasion Testing with Los Angeles Machine
- KS F 2510 Method of Testing Organic Impurities Contained in Sand for Concrete
- KS F 2511 Method of Testing Fine Particles Contained in Aggregates (Passing No. 200 Sieve (0.08 mm sieve))
- KS F 2550 Method of Aggregates Water Content Testing

1.3 Definitions of Terms

Not applicable.

2. Materials

2.1 Materials

2.1.1 Bottom-Raising Materials

(1) The sand used for the bottom-raising of the facility pipes installed in a dredged ditch should be clean and washed sand having a uniform particle diameter distribution. The particle diameter should be less than 5 mm. Finer sand may be used with the approval of the construction supervisor if it does not contain any hazardous components. However, only sand should be used in the bottom-raising

works for concrete pipes, clay pipes, and cast-iron pipes.

(2) The gravel used for bottom-raising works should be clean and water-washed gravel having a uniform particle size distribution. The gravel may be applied to a ditch requiring additional water drainage, or used for refilling on top of the upper half of pipes (above the center-line of the pipes).

2.1.2RefillingMaterials

(1) Refilling materials are the materials from trenching or earth cutting works for the construction of the foundation of a structure, and should be appropriate for the code specified in KCS 11 20 20.

(2) Refilling materials should have a low compressibility, and their strength should not be lowered by water infiltration. The materials should be easily compacted, and should not be easily affected by freezing.

(3) The refilling works for the pits and ditches excavated under a structure or a pavement layer should be performed using the specified method of structure banking. Common banking is allowed only for earth cutting in a wide area and a landscaping area as well as the refilling of a ditch.

(4) A liquid mixture prepared by mixing Portland cement, clean aggregations of a uniform particle diameter distribution, and water should be applied to cement slurry refilling.

2.1.3BackFillingMaterials

(1) Back Filling should be performed using general banking materials and structure banking materials that meet the requirements of KCS 11 20 20 (2.1.2).

(2) Concrete materials should be the lean concrete and structure concrete of which the uniaxial strength specified in the present code satisfies the corresponding requirements in KCS 14 20 10 (1.9.2).

(3) Back filling materials should have a low compressibility, and their strength should not be lowered by water penetration. The materials should be easily hardened, and should not be easily affected by freezing.

(4) Materials used for the back filling works in road construction should satisfy the quality standards given in Table 2.1-1.

Table 2.1-1 Quality standard for back filling materials

Item	Selected filling material	High quality soil	Note
	Cover[1)] (Less than 3.5 m)	Cover (Equal to or higher than 3.5 m)	
Maximum size (mm)	KCS 44 50 05 Tables 2.2-1 and 2.2-2 Materials equivalent to auxiliary base course materials	Equal to or less than 100	
5 mm sieve passing ratio		25 to 100	
0.08 mm sieve passing ratio		Equal to or less than 15	For subgrade: Equal to or less than 25 %
Plasticity index (PI)		Equal to or less than 10	
Modified CBR (%)		Equal to or higher than 10	

Note 1) The term "cover" refers to the minimum height from the top of the culvert center-line to the effective road width excluding the road shoulders.

(5) An alternative material having a quality equivalent to or higher than that of the materials described above may be used as a back filling material. The alternative material should undergo a separate review and acquire the approval of the construction supervisor.

(6) An alternative back filling material should be applied to the areas where the cover above the culvert top is high and thus is less affected by the impulsive load from operated vehicles, or the areas where the culvert installation ground is under good conditions to secure the necessary bearing capacity. In areas where the inflow of rainwater or groundwater is expected, inflow before the back filling works should be prevented by installing a dummy culvert.

2.1.4Accessories

(1) Fiber for ground: Noncorrosive nonwoven fabric

(2) Separation membrane: 0.25 mm thick polyethylene membrane material

3. Construction

3.1 Verification of Construction Work Conditions

3.1.1 Verification Items for Backfilling

(1) The inspection of the underground drainage, moisture-proofing, or water-proofing works should be verified.

(2) The installation of underground tanks to avoid damage after back filling works should be verified.

(3) The structural capacity of non-supported walls to bear the load applied by back filling should be verified.

3.2 Work Preparation

3.2.1 Preparation of Bottom Surface in Back Filling Works

(1) The original bottom should be compacted to the density required of the materials for the subsequent back filling works.

(2) For an original bottom that may not be compacted at its original position, the soft part should be removed, back fill should be performed with a banking material the same as the back filling material, and it should be compacted to a density equal to or higher than the density required of a banking material.

(3) The original bottom should be scratched to a depth of 100 mm to identify the soft parts, and the test compaction should be performed. The soft parts should be filled and compacted to a density equal to or higher than the density required of a banking material.

(4) In case that the inflow of rainwater or underground water is estimated, inflow of the running water should be drained outside the backfilling itself with installing the stone filled drain etc. before the construction of backfilling.

3.2.2 Measurement Point Piles and Construction Ground Planes

(1) To determine the construction work positions, bench marks and measurement

piles, which are needed according to the requirements specified in KCS 10 30 05, should be installed.

(2) Measurement to inspect the quantities should be performed according to the requirements specified in KCS 10 30 05 in the presence of the construction supervisor, and should include the following items:

① Initial measurement to check the original ground surface

② Final measurement after the completion of trenching, refilling, banking, and other works

③ In cases where earth cutting is classified as rock cutting for the inspection of quantities, the measurement of the rock bed surface determined by the construction supervisor

(3) Settlement marking bars and other marks should be installed at the positions and heights determined by the construction supervisor.

① The settlement marking bars should be of the materials and dimensions set according to the conditions specified in the design drawings. The bars and cross beams should be painted white, and a measure scale should be drawn in black on the level above each of the marking bars to measure the movement of soil.

② The bars should be vertically inserted into the holes drilled in advance on the bottom surface, and the holes should be refilled with a lean concrete mixture to firmly install the bars. The bars should be installed at the positions specified in the design drawings or as directed by the construction supervisor. The bars should be installed as lines or linear segments. Linear segments should be aligned by using more than three vertical bars. A horizontal beam should be aligned with a visual reference plane for detecting the movement of soil. The horizontal beams do not need to be placed at a specific height, but should be aligned along a specific perspective plane. Adjacent or crossing linear segments may share a bar.

③ Unless being placed on a banking slope surface or a step, the marking bars should be installed before the adjacent banking works. However, banking works for a height less than 1.5 m may be performed before the installation of the bars after acquiring the approval of the construction supervisor, if needed to prevent disturbance by machines operated near to the bars.

④ The contractor has the responsibility to maintain and protect the bars from damage, and should notify the construction supervisor if a movement is detected. Bars that are damaged or incorrectly aligned due to the carelessness of the

contractor should be re-installed or re-aligned at the contractor's expense according to the directions given by the construction supervisor.

⑤ If the movement of the banking bench mark bars has been detected, the construction supervisor should discontinue the construction works until corrective actions are taken.

3.2.3 Underground Facility Treatment

(1) Before initiating trenching works, the positions and depth (bottom height) of all existing underground facilities should be verified at the construction site. Manual trenching should be performed within 1.0 m from a facility.

(2) Abandoned sewer, pipes, and facilities found during the trenching works should be removed, and the end parts should be sealed.

(3) If a facility under operation that is not specified in the contract drawings is found, it should be immediately reported to the construction supervisor and the facility manager.

3.2.4 Removal of Underground Facilities

(1) Underground facilities and obstacles within the range specified in the design drawings should be removed.

(2) If an underground facility that interferes with the construction works and is not specified in the design drawings is found during the trenching works, it should be immediately reported to the construction supervisor for correction.

3.3 Construction Standard

3.3.1 Main Details of Refilling Works

(1) Before the initial road refilling works, various test reports about the construction plan and road restoration should be submitted.

(2) The refilling material should be sand or sandy soil having good quality and low compressibility. Blast stones mixed with the refilling material should have a maximum diameter of 100 mm.

(3) Sand or sandy soil of a good quality should be refilled between the external surfaces of a structure and earth retaining plates.

(4) Refilling works should immediately follow the completion of structure waterproofing

works and waterproofing protection works.

(5) If the construction supervisor is concerned regarding the settlement of the ground surface, a test mounding may be performed, and then refilling works may be performed according to the test result.

3.3.2 Refilling, Mounding(Banking), and Leveling

(1) The time at which refilling works are performed after the completion of underground frame construction works should be determined to avoid damage to the structure by considering the soil input method, compaction method, and concrete strength.

(2) Before the refilling works, the mold forms attached to the structure should be completely removed.

(3) The refilling soil material should satisfy the current code. If not specified in the present code, sandy soil or excavated soil may be sieved to remove unclassified stones and any foreign materials that may disturb compaction to be used in the refilling works after acquiring the approval of the construction supervisor.

(4) The refilling materials should be sand, stone flour, and sandy soil of a good quality. Blast stones should have a maximum diameter of 100 mm.

(5) Excavated materials considered as appropriate refilling materials may be selected and used with the approval of the construction supervisor.

(6) Refilling works on the external surfaces of a structure should be performed with sandy soil of a good quality to avoid damage to the waterproof layers. Each layer should be well compacted. If compaction is difficult to perform, sand should be recharged to perform water-based compaction.

(7) If refilling is performed with sand, sufficient water-based compaction should be carried out. If refilling is performed with general soil, compaction should be performed in layers of about 300 mm to the compaction density specified in the present compaction density standard or required by the construction specification.

(8) Approved materials should be applied to the refilling of the top 1 m parts and side walls of a structure. Thin-layer compaction should be performed using a compacting machine (plate compactor or baby roller) to obtain over 95% of the standard compaction density(in the maximum dry density using D or E method).

The compaction thickness should be determined by an on-site test depending on the refilling materials and compacting machines used.

(9) In mechanical refilling and compaction works, the refilling materials should be placed to an appropriate thickness and compacted using a vibration roller to obtain over 95% of the standard compaction density. The compaction thickness should be determined by an on-site test depending on the refilling materials and compacting machines used.

(10) Mounding works on a soft ground should be performed after implementing appropriate ground improvement works selected based on the advice provided by a geotechnical engineering expert.

(11) The refilling materials and compaction methods for the areas under the bottom concrete should conform to the construction specification.

(12) The mounding materials should conform to the construction specification. If not specified in the construction specification, soil prepared by removing unclassified stones and any foreign materials that may disturb compaction may be used after acquiring the approval of the construction supervisor.

(13) The earth leveling surfaces should be leveled to be flat and clean and compacted to a degree that allows walking.

(14) After the completion works on the sides of a structure, the refilling works on the top of the structure should be uniformly spread and paved, and compacted using an rolling compactor. In an area where a rolling and compacting machine is difficult to use, another compacting method, such as water-based compacting, should be applied after acquiring the approval of the construction supervisor.

(15) In the removal of the struts on the top of the structure, the surrounding soil should not be moved. The refilling works, voltage, and the time and method of the removal should be approved by the construction supervisor by submitting a relevant plan in advance.

(16) Areas in close proximity to underground utilities, scaffolds, and struts should be refilled with soil of a high quality to avoid the application of differential pressure and impact.

(17) To avoid causing damage to the utilities, in the refilling works on the top of

underground utilities, the refilling materials should not be put into the areas directly from a transportation vehicle.

(18) In the refilling works on the top of a structure, manual refilling should be performed within 1 m from the structure to avoid the loss or damage of the waterproof layers by the soil.

(19) In the refilling works, the electrical construction method should be determined according to the type and weight of the electric compactor and the work procedures after performing a test mounding, considering the safety of the structure.

(20) In side wall refilling works, since the compaction work is incomplete in the areas where the gap between the earth-flow wall and the external wall of the structure is less than 85 cm, the refilling should be performed with sand or stone flour, and water-based compaction should be carried out to prevent settlement.

(21) Unless the compacting work materials for an area around an obstacle are otherwise specified by the management entity, sand refilling should be performed around the obstacle in principle.

(22) Refilling works at a position above which a structure is to be installed should be performed with a sufficient amount of filling concrete, as specified in the design drawings.

(23) The filling concrete should be protected so as not to be lost due to groundwater.

(24) Unclassified stone and boulder compaction

① Gap filling and face leveling should be performed with gap-filling gravels (including crushed stones).

② Unclassified stones and boulders should be placed as a layer. Large gaps should be removed by adding gap-filling gravels. The layer should be compacted using a rammer or a soil compactor until the bottom may not be scattered.

(25) Gravel compaction

① Gravel refers to a gravel or crushed stone having a size less than 45 mm.

② The crushed stone should not include grass, roots, wood, and other organic materials, and should be a mixture of less than 5% soil and clay, about 30% sand, and an appropriate ratio of gravel having a particle diameter between 2

mm and 50 mm.

③ The bottom surface should be paved with a predetermined amount of gravel and compacted using a rammer or a soil compactor until the bottom may not be scattered.

(26) Bottom (floor) concrete compaction

① The materials should conform to the corresponding details in KCS 14 20 00.

② The design standard strength of the bottom (floor) concrete should be over 150 kgf/cm^2 (14.7 MPa).

③ The surface of the lean concrete should remain horizontal at a predetermined height and should be finished to be flat.

(27) In case of excavation and refilling in the paved road, flowing filling materials such as cement slurry, fluidized treatment soil, soil cement etc. can be used by the approval of the construction supervisor. Then, the standards of quality and construction on the flowing filling materials follow the construction specification of it.

3.3.3 BackFillingConstructionWorkStandard

(1) After the completion of the construction works for a structure, the contractor should perform back filling works from the foundation bottom surface of the structure to the road bottom surface to secure the specified quality. A separate management drawing should be recorded and kept for the back filling areas.

(2) The back filling works should be performed using a material that is not frozen in the specified areas in accordance with specified contours and heights after checking the conditions of the foundation ground.

(3) In the back filling areas where a vibration roller is used, a large vibration compaction roller having a weight over 10 tons may be used in a distance of about 1 m from the structure. The vibration energy should be increased to increase the compaction efficiency. In the areas where it is difficult to use a large compacting machine, a small compacting machine, such as a small rammer, may be used with the approval of the construction supervisor until the specified density is obtained.

(4) In a slack area of the back slope surfaces connected with the back filling works, back filling should be performed strongly by using a vibration roller to make the compaction density of the area the same as that of the back filling areas.

(5) Back filling works for a culvert should be performed to make the height of both sides of the back filling area the same as each other to prevent the application of differential pressure. If the back filling works may not be performed on both sides simultaneously due to site conditions, the maximum height difference between the two sides should be less than 1.0 m after acquiring the approval of the construction supervisor.

(6) In the vibration compaction works in the structure back filling areas with rock mucks banking, excessive vibration should be carefully avoided to prevent any damages to the structure.

(7) If back filling works unavoidably have to be performed when the concrete has not yet been cured in accordance with the regulations, the back filling works should be performed after acquiring the approval of the construction supervisor and after the strength of the concrete exceeds 80% of the concrete design standard strength or the concrete is cured for 14 days or longer in order to avoid cracks or damage to the structure related to vibration and impulse. In addition, the same standard should be applied to a concrete structure for which one side is back filled to be higher than the other side, or to a stonework structure.

(8) Back filling should be performed systematically to allow a sufficient time for natural settlement. Back filling should not be carried out on a bottom surface that is highly permeable, wet, frozen or soft.

(9) The aggregate banking surface should be covered with an unwoven fabric before a soil material is banked.

(10) The result of the back filling materials test should be submitted to and approved by the construction supervisor before the back filling works.

(11) The aggregate banking materials should be placed in a continuous layer having a compacted thickness of 150 mm, and compacted until compactness over 90% is obtained.

(12) The general banking materials should be placed in a continuous layer having a compacted thickness of 200 mm, and compacted until compactness over 90% is obtained.

(13) Placement of the materials should be performed in a manner that does not interfere with or damage other construction works.

3.4 On-Site Quality Control

3.4.1 Quality Control

An appropriate quality control plan should be prepared and implemented according to the requirements specified in KCS 10 10 15.

3.4.2 Self-Inspection and Test by Contractor

(1) Density test should be performed at the frequency specified in KS F 2311 and according to the contractor's quality control plan to verify that the specified requirements have been met. If no frequency is specified, the following frequency should be observed:

① Wide horizontal area: Once per 100 m^2 of refilling or back filling works

② Limited area and river bank works: Once per three layers of refilling or back filling works

(2) The laboratory compaction test should be performed in accordance with KS F 2312. The on-site test on original bottom surfaces or compacted refilling works should be performed in accordance with KS F 2311.

(3) The water content test should be performed in accordance with KS F 2306, and the test frequency is the same as specified for the density test.

3.4.3 Inspection by Construction Supervisor

(1) The construction supervisor should perform appropriate in-site and laboratory tests to assess the materials stability, optimal water content, and compactness. If the specified requirements are not satisfied, the materials should be removed or compacting should be performed again until the requirements are met.

(2) The sequential implementation of the works should be approved by the construction supervisor. If the implementation is considered as unsatisfactory or if construction works are conducted without the supervisor's approval, the works should be repaired using a method approved by the construction supervisor.

(3) Soil samples should be taken at a position designated by the construction supervisor through a method specified by the construction supervisor.

(4) The construction supervisor may perform the plate bearing test and the cone penetration test on the compacted surfaces.