

KCS 11 20 15 : 2019

Excavation works

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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 trenching in the Architectural Construction Standard Specification, Sewer Pipeline Construction Standard Specification, Architectural Electrical Facility Construction Standard Specification, Utility Tunnel Standard Specification, Urban Railway (Subway) Construction Standard Specification, Water Pipe Standard Specification, and River Construction Standard Specification.

Construction Standard	Main 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	Main Contents	Enactment · Revision (Month, Year)
Road Work Standard Specification	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Partially revised in the area of general matters, tree protection materials, general construction works, etc. 	Revision (2016.5)
Civil Engineering Construction Standard General Specification	<ul style="list-style-type: none"> Enacted as a Civil Engineering Construction Standard General Specification 	Enactment (1962)
Civil Engineering Construction Standard General Specification	<ul style="list-style-type: none"> Revised as a Civil Engineering Construction Standard General Specification 	Revision (1967)
Civil Engineering Construction Standard General Specification	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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 15 : 2016	<ul style="list-style-type: none"> Integrated and maintained as code according to changes in the construction standard code system. 	Enactment (2016.6)

ConstructionStandard	MainContents	Enactment· Revision (Month, Year)
KCS 11 20 15 : 2016	<ul style="list-style-type: none"> Revised to accord with Korean Standard and Construction Specification. 	Revision (2018.7)
KCS 11 20 15 : 2019	<ul style="list-style-type: none"> Revised by adding the approval of construction supervisor in a change of foundation size and plan height after measuring and excavation in sandy foundation excavation, and by quoting earth retaining works as KCS 21 30 00, by erasing the unnecessary examples. 	Revision (2019.12)





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1. General

1.1 Scope of Application

- (1) This code is applied to excavation works or ditch dredging for the construction of bridges, culverts, retaining walls, other structures, pipeline trenches, subway tunnels, underground structures, and facilities; transferring of various surface and underground obstacles; and water draining works for removing groundwater and rainwater from a construction site during the installation of structures and pipes.
- (2) For details that are not mentioned in this code but are specified in the relevant items of another code, the other standard should be observed. If this standard conflicts with the details separately specified in contract documents, the contract documents should be preferentially applied.

1.2 Reference Standard

1.2.1 Relevant Laws and Regulations

Not applicable.

1.2.2 Relevant Standards

- KCS 10 10 10 Public Administrative Requirements
- KCS 11 40 20 Underground Water Draining
- KCS 11 40 35 Water Draining During Construction Works
- KCS 21 30 00 Temporary Earth Retaining Work
- KCS 21 40 00 Cofferdam, Construction Work Road, Provisional Road, and Detour
- KCS 51 10 15 River Earthwork
- KS F 2310 Plate Bearing Test Method for Roads
- KS F 2311 Soil Density Test Method according to Sand Replacement Method
- KS F 2444 Soil Bearing Capacity Test Method Against Static Load on Footing Foundation
- KS F 8024 Retaining Wall

1.3 Definitions of Terms

Not applicable.

1.4 Deliverables

- (1) The contractor should prepare a construction work plan according to the construction plan with reference to KCS 10 10 10, and submit it to the construction supervisor.
- (2) For bridges and culvert structures, a foundation work report should be additionally submitted.

2. Materials

2.1 Equipment

- (1) Machines and facilities used for excavation having appropriate functions should be selected by considering the type of earth-flow (earth retaining works), presence of lining, arrangement of earth-flow support works (earth retaining works), geological features, groundwater conditions, excavation depth, transportation distance, and muck treatment method. The machines and facilities should be arranged in an organized manner for utilization.

3. Construction

3.1 Verification of Construction Conditions

3.1.1 Verification of Construction Conditions for Excavation works

- (1) A safe construction method should be employed for excavation by sufficiently considering the soil type and underground facilities through a preliminary investigation to prevent collapse of the ground or the destruction of underground facilities.
- (2) A thorough preliminary investigation should be performed before the excavation works. If there is a significant difference between the design soil type and the actual site soil type, the construction method (temporary facility construction works, etc.) should be changed in consultation with the construction supervisor in order to carry out the excavation works safely.

3.1.2 Verification of Construction Conditions for Obstacle Transfer Works

- (1) In cases where the construction works are performed at places that are in close

proximity to or disturbed by underground facilities, surface structures and their foundation, houses, and aerial wires, a protection plan should be prepared by reviewing the countermeasures to prevent the damage or displacement of those facilities.

- (2) In establishing specific methods for implementing the protective measures, the methods should conform to the agreement about the protective measures for each of the underground facilities, if there is one. In the absence of such an agreement, specific methods should be established after reviewing the necessary measures through close cooperation with the individual facility managers and the property owners in advance.
- (3) Before initiating the construction works, data should be prepared (drawing, photos, construction workers, and opinions of local residents, etc.) to show the current status of various extruding obstacles on the ground surface, including the steel towers for high-voltage electric power transmission, telephone poles and electric power poles, electric wires, electric power manholes, water pipes and sewer manholes, and city gas manholes, and then an on-site survey should be performed. Any obstacle existing in the construction work area should be transferred in consultation with and in the presence of the construction supervisor and the obstacle management institutions.
- (4) In particular, an appropriate protective measure should be established in advance by sufficiently considering the work spaces for cranes, dump trucks, and other heavy equipment (for piling works) used during the construction works.

3.1.3 Verification of Construction Conditions for Water Draining Work

- (1) Water discharging through water draining works should be performed in consultation with the construction supervisor and the water discharging manager, and any change of the ground due to the lowering of the groundwater level should be carefully observed.
- (2) The water discharging lines should be approved by the facility manager, and a layout of the water-discharging outlets should be prepared, if necessary.
- (3) Plans should be prepared with regard to pumps, settling tanks, and noise prevention, and methods for measuring the groundwater level and ground displacement should be established.

- (4) In cases where ground settlement and displacement may be caused by the lowering of the groundwater level, preventive construction methods should be established, including grouting.

3.2 Work Prevention

- (1) The contractor should prepare a construction work plan before the construction works by considering the design drawings, specifications, structure construction methods, and various site conditions (earth retaining walls, ground, road traffic, underground utilities, and gas duct structures, etc.), and then submit it to the construction supervisor to acquire the approval.
- (2) The construction work plan should include information about the excavation sequence, excavation method, measurement plan, water treatment method, equipment and instruments to be used, and materials and human resources input plans according to the scale of the excavation works, the entire process, ground conditions, earth-flow retaining works, and the construction work environment.
- (3) The excavation method included in the construction work plan should be determined according to the site conditions, including the ground conditions, and the following items should be noted in particular:
- ① Method of excavation under lining
 - ② Measures for protecting underground utilities
 - ③ Minimization of road traffic disturbance
 - ④ Minimization of pollution from construction works
 - ⑤ Plans for spoil areas
- (4) Details that are not included in the design should be quickly reported to the construction supervisor, and the design should be adjusted through appropriate procedures.
- (5) Post of measuring point and formation level should be performed according to KCS 11 20 25 (3.2.2).

3.3 Construction Work Standard

3.3.1 General Matters of Construction Work

- (1) The contractor should pursue every avenue available to maintain the planned excavation slope surface and prevent disturbance to the onsite work implementation

and safety from the leakage of groundwater and the external run-off of rainwater.

- (2) The contractor should review the details related to the excavation works, including the inclination of the trenching slope surface, the construction of earth-flow retaining walls (earth retaining walls), and the protection of adjacent structures, and a detailed construction plan should be prepared accordingly.
- (3) Excavation works for structure foundations should be appropriate for the width, inclination, and depth specified in the design drawings. In cases of overbreak in the structures such as bridges and retaining walls in the absence of measurement by the construction supervisor, concrete back filling should be performed up to the planned height of the foundation bottom, or the foundation penetration depth should be adjusted after reviewing the structure for the construction works. However, in excavation works for structures that do not have a significant effect on the ground supporting force, such as gutters and collector wells, sandy soil of a good quality may be back filled to the planned height of the foundation bottom and compacted, and the supporting force should be verified before the construction works. All additional expenses for this procedure should be paid by the contractor.
- (4) Excavation should basically be initiated after the transfer of roadside trees, telephone poles, and artifact.
- (5) The contractor is responsible for the removal and treatment of all obstacles having a negative effect on the quality of the construction works, including existing structure and tree roots, and should consider the obstacles when preparing the detailed construction work drawing.
- (6) An accurate status drawing should be submitted for the road structures that should be removed before the construction works (paving blocks, curbs, protective stone materials, road signs, etc.).
- (7) When separate reinforcing measures are needed for the construction works or for other purposes with regard to the ground, underground utilities, gas ducts, supporting works, earth retaining walls, and protective works, a detailed plan should be submitted to and approved by the construction supervisor.
- (8) In the excavation works for roads, the contractor should prepare protective measures to protect the existing underground utilities. In particular, excavation works should be precisely performed in the presence of gas pipes and water pipes,

and the follow-up processes should be carried out after visually checking the underground utilities.

- (9) In the foundation excavation works for a structure, the contractor should prepare a construction work drawing after investigating the layer composition and groundwater state on the bottom and the trenching sides. A construction work report should be prepared and submitted for comparison with the design conditions.
- (10) Following the completion of the foundation excavation works, the contractor should report the result to the construction supervisor. The foundation works may be performed after the construction supervisor inspects the trenching depth, the geological characteristics of the foundation ground, and the arrangement of the foundation trenching surfaces.
- (11) In cases where the conditions of the soil type specified in the design drawing are different from the conditions of the soil type exposed by the excavation works and thus need to be modified, the contractor should report the result of the ground survey and analysis as well as the countermeasures to the construction supervisor. After acquiring the approval from the construction supervisor, the size and height of the foundation may be modified.
- (12) The contractor should perform the excavation works to secure the position, width, and depth specified in the approved drawing.
- (13) The excavation works should be carried out using an approved method. If the approved plan is inappropriate for the site conditions, the construction supervisor may require modification, and the contractor should accept the modification.
- (14) The contractor may temporarily pile up the excavated soil at a place separated from the top edge of the excavation slope surface at a distance determined by considering the excavation depth, excavated ground, soil conditions, groundwater level, and surrounding site conditions. Necessary actions should be taken to prevent the collapse of excavated slope surfaces, and soil erosion and leakage by rainwater.
- (15) When excavation works, including drilling, piling, and excavation, are performed on land near to a city gas pipeline, the works should be initiated after reporting to the Excavation One-Call System (www.eocs.or.kr) and receiving the notification for the initiation of the construction works.

- (16) Soil excavation should be performed by carefully considering the excavation field, width, height, and slope inclination in each excavation session depending on the soil type to avoid the relaxation of the surrounding ground as much as possible. Excavation works on highly impermeable ground, sandy ground or soft ground should be carried out by considering not only the drainage in the work site and the auxiliary method but also the possibility of slope surface collapse and the maintenance of earth-flow retaining walls.
- (17) If a joint has been severely developed on the rock, the excavation should be performed by applying an auxiliary method in preparation for a large-scale sliding.
- (18) Soil digging should be performed to make the floor surface even. Soil digging for underground pipes should be performed while accurately maintaining the inclination and compacting the bottom surface uniformly after the digging work.
- (19) Water draining should be performed to remove all the inflowing groundwater and rainwater from the construction site by using water pumps. Property damage caused by the failure to perform the appropriate water draining should be the responsibility of the contractor, who should perform the construction works again or recover the property.

3.3.2 General Matters of Excavation Machine

- (1) Open-cut excavation may be performed by manual excavation or mechanical excavation. Mechanical excavation is performed using heavy equipment such as shovel and breaker, while minimizing the ground relaxation and maintaining the stability of the slope surfaces.
- (2) Mechanical excavation should not involve blasting or manual excavation, and is applied to rocky or sandy ground with severe joints.

3.3.3 Operation of Excavation Machine

- (1) Excavation should be performed by paying attention to the change of the ground, while observing the ground conditions.
- (2) The machine operator should operate the machine carefully so as not to harm other construction site workers while rotating and moving forward and backward.
- (3) Signaling methods should be determined by the machine operator together with

other construction site workers to ensure smooth communication.

- (4) In mechanical excavation, the excavation pattern should be followed, and the bottom surface should be protected to avoid it being weakened by mechanical operation.

3.3.4 Foundation Excavation works Plan

- (1) If the final surface of structure foundation excavation works consists of sandy soil or weathered rock, the contractor should minimize the disturbance of the excavation bottom ground surface. Placement of binding concrete should be prepared and planned in advance in order to perform it after receiving the inspection from the construction supervisor following the excavation.
- (2) The contractor should prepare a plan to implement the road earth cutting works, soil banking works, and water draining waters in an organized manner.
- (3) If the earth works precede the water draining works and thus the construction roads serve as a bank that intervenes in the water flow through the water ways, the construction supervisor may direct the contractor to construct a water way appropriate for the construction site conditions across the area where the drainage structure is to be placed.
- (4) Any types of loss of the earth works that result from a failure to follow the directions given by the construction supervisor should be restored by the contractor at the contractor's own expense.

3.3.5 Trenching and Ditch Dredging

- (1) Trenching should be performed according to what is specified in the contract drawings and required by the underground structures or facilities. If necessary, floor posts, water draining facilities, and earth retaining walls should be installed according to the requirements specified in KCS 11 40 35, KCS 21 30 00, KCS 21 40 00, and 3.3.21.
- (2) Trenching should be performed according to the boundaries and ground floors specified on the contracting drawings.
- (3) The ditch digging for pipes and culverts should be performed through open-cutting. The tunnel excavation and jacking should be performed as approved by the

construction supervisor. Manual digging should be performed at pipe junctions.

- (4) In paved areas, the pavement should be sectioned with a saw along a straight line in the width specified by the drawings. After back filling and compacting, the pavement should be restored to the conditions at the time of initiating the construction works. If specified in the design drawing or approved by the relevant authority or construction supervisor, the back filling works for the ditch dredging under the pavement may be performed by performing cement slurry back filling or by using fluidized soil or soil cement.
- (5) Ditch dredging should be performed in the width specified for all the measurement points under the plane 600 mm above the top of the pipe. Ditch dredging above the plane may be performed in a width greater than the specified width under the approval of the construction supervisor. If the width has not been specified, the width should be in a range between 150 mm and 450 mm from the external sides. If ditch dredging has been performed over the allowed dimensions, a stronger pipe should be installed or the pipe should be surrounded with concrete, following the approval of the construction supervisor.
- (6) After the ditch dredging, the bottom surface should be a solid and firm soil surface or the original floor bed, and the surface should be clean and free of any relaxed materials, debris and foreign materials. If the bottom surface after trenching or ditch dredging works is soft or unstable, the materials should be removed to a sufficient depth and replaced by sand or gravels. The substituted materials should be compacted to a density over 90% of the maximum dry density.
- (7) In the presence of water in the ditch, water draining should be performed as specified in 3.3.21, KCS 11 40 35, and KCS 21 40 00. After water draining, the bottom should be stabilized by filling with sand or gravels.
- (8) A hole to which a coggling of the pipe is to be inserted should be drilled to a size necessary to bury the connecting part.

3.3.6 Rock Foundation Excavation works

- (1) The contractor should perform the excavation works down to the bottom surface of the ground specified in the design drawing, and remove all the unstable parts of the rock or solid foundation ground.
- (2) If the inclination of the trenching surface is over 1:4, the slope should be

constructed in the form of steps, sawtooth or bumps.

- (3) Blasting works during the foundation excavation works should be performed in a manner that may minimize the disturbance of the surrounding areas and the foundation ground.
- (4) If a large geologic structural line, including a fault, is included within the planned height of the excavation works, fault treatment and reinforcement works should be carried out in consultation with the construction supervisor according to the type of the target structures.

3.3.7 Sandy Foundation Excavation works

- (1) The supporting force and settlement in the sandy foundation excavation works area should satisfy the allowable supporting force and allowable settlement specified in the design drawings. The allowable settlement of the foundation ground should be investigated using the test method described in KS F 2444.
- (2) In cases where the soil type of the sandy foundation ground is different from the one specified in the design drawings or in the areas where a ground may be a soft ground, a drilling survey or other kind of survey should be performed to verify the layer distribution status, the allowable supporting force, and the appropriateness as a foundation type, and the result should be approved by the construction supervisor.
- (3) After the excavation works on a sandy foundation ground, the groundwater or other inflowing water should be prevented, or drained to another place to prevent the relaxation, deformation, and softening of the ground.
- (4) The foundation trenching bottom surface should be protected from being frozen. When freezing occurs, actions should be taken to maintain a soil bearing capacity equal to or higher than the natural ground by removing the frozen soil or substituting materials of a good quality in consultation with the construction supervisor.
- (5) In case of road construction, the completion of foundation excavation should be noticed to the construction supervisor. Foundation construction should be progressed according to the measuring result of the excavation depth, stratum property, arrangement condition of excavation face etc. by the construction supervisor.
- (6) If there are difference between the conditions of design drawing and the excavated ground and there are the necessity of design change, ground survey and it's results

analysis should be reported to the construction supervisor and the size and/or planned height of foundation can be changed by the construction supervisor.

3.3.8 Pile Foundation Excavation works

- (1) Before the piling works, the contractor should perform the excavation works down to the bottom surface of the foundation specified in the design drawings. If uplift or settlement of the foundation bottom surface occurs due to the piling works, additional excavation works should be performed, or back filling should be performed with an appropriate material.

3.3.9 Structure Excavation works

- (1) To verify the ground conditions or to slowly lower the groundwater level, excavation should be performed using a center-first method, if possible.
- (2) The ground surface at the edge of the excavation works should be reversely inclined to avoid the inflow of surface water to the trench.
- (3) If the final surface of structure foundation excavation works consists of sandy soil or weathered rock, the contractor should minimize the disturbance to the excavation bottom ground surface. Placement of lean concrete should be prepared and planned in advance to perform it after receiving an inspection from the construction supervisor following the excavation.

3.3.10 Pipeline Excavation works

- (1) Unless otherwise specified in the design drawings or directed by the construction supervisor, the excavation works for installing pipes should be performed using the open-cut method.
- (2) With regard to the details specified in the approved design drawing or the directions given by the construction supervisor, if overbreak occurs over the planned excavation line, the contractor should be responsible for the overbreak, which should be restored at the contractor's own expense.
- (3) The excavation works for pipe connection should be performed at the lower part of the pipe connection part accurately and according to the details specified in the design drawings.
- (4) After the completion of the excavation bottom treatment, the construction work lines

should be the same as the planned pipe installation lines.

- (5) Safety facilities for preventing safety accidents, including safety signs, warning lights, and shielding screens, should be installed until back filling works are completed.

3.3.11ExcavationworksinLawn

- (1) When a pipeline is installed in a lawn, the turf should be carefully lifted up and preserved so that it may be restored after the completion of the pipeline installation.
- (2) The lawns should be restored within 72 hours.

3.3.12ExcavationworksinAreasNearTrees

- (1) The contractor should protect nearby trees that do not need to be removed. Trees with roots of a diameter over 50 mm should not be cut down during the excavation works without the approval of the construction supervisor.
- (2) The contractor may not transplant the trees in nearby areas without the approval of the construction supervisor.

3.3.13EarthRetainingWorks

- (1) The relevant facts with the earth retaining works should be performed according to KCS 21 30 00.
- (2) Cut-off Walls
 - ① The contractor should install cut-off walls when facing an aquifer in the excavation works. The cut-off walls should be installed over 1 m deeper than the foundation bottom, and appropriate actions should be taken to prevent water leakage.
 - ② The dimensions inside the cut-off walls should allow the sufficient width needed for the installation of mold forms and for measurement.
 - ③ The contractor should careful to avoid weakening of the foundation due to the rapid rising of the water level, damage of uncured concrete, and scouring resulting from the cut-off works.
 - ④ It should be ensured that wood materials, including the supporting wood bars, do not remain in the concrete of the lower structure.
 - ⑤ A temporary Cut-off works should be performed according to KCS 21 40 00.

- (3) For the installation of struts, excavation works should be performed rapidly and accurately in each step to prevent the deformation of the steel piles due to buckling.
- (4) The earth retaining walls should be carefully applied at the discontinuous parts due to underground utilities or the ones between different adjacent earth retaining work methods by sufficiently considering the continuity (strength and cut-off) with the adjacent earth retaining walls in accordance with the progress of the excavation works.
- (5) Other details of earth retaining wall works are found in KCS 21 30 00.

3.3.14ExcavationandWaterDraining

(1) General Matters of Excavation

- ① The inside and outside of the pits should be frequently examined during the excavation. If an abnormality is found at the earth retaining walls, furring strips, struts, excavation surfaces, and subgrades, reinforcement should be carried out immediately.
- ② Slope surface protection works and earth retaining works should be performed for excavation slope surface according to the need.
- ③ A reinforcement measure should be taken quickly if groundwater from the back face of the earth retaining walls, water leakage from the sewer or water pipes, or rainwater inflow from the road surface is found.
- ④ Excavation works in an area near to an underground utility should be performed manually from a distance of about 1 m so as not to damage the utility.
- ⑤ The positions of the underground utilities should be checked by referring to the design drawings before the initiation of the excavation works. In addition, the positions should be reconfirmed with special care during the excavation works.

(2) General Matters related to Excavation Works

- ① Earth work excavation plans should be prepared in a balanced way with the temporary facility construction works and the structure construction works. The earth work excavation should be performed through a multi-stage compartment excavation by dividing the area lengthwise and breadthwise.
- ② The excavation plan should be established by making one longitudinal compartment of about 30 m.
- ③ The excavation works should be performed in stages by considering the water

drainage of the groundwater inflow. A separate countermeasure should be prepared for areas with a high amount of spring water.

- ④ The excavation works should basically be performed by mechanical excavation. If blasting is required due to the exposure of rocks, a blasting plan should be established. The blasting method should be determined according to the test blasting result.
- ⑤ A portion of the excavated soil should be recycled for back filling later. Of the excavated soil, the soil appropriate for back filling and roadbed formation should be separated from the surplus soil and temporarily stored. A storage plan should be determined through mutual consultation with the contractors working in other construction zones.
- ⑥ The soil should be transported by using dump trucks equipped with devices for preventing the leakage and flying of stacked soil. Leaked soil should be immediately removed and cleaned.
- ⑦ An automated vehicle-washing facility should be installed at the entrance to the construction site to maintain the cleanness of the dump trucks carrying the excavated soil.

3.3.15 Excavation Works Related to River Construction Works

- (1) The excavation works related to river construction works should be performed according to KCS 51 10 15.

3.3.16 Cautions regarding Construction

- (1) The excavation width should not be smaller than the one specified in the design drawings.
 - ① The excavation width should at a minimum be the one specified in the design drawings. However, if the excavation width has to be changed due to the site conditions, including problems involving the equipment entry and construction works, it may be changed in consultation with the construction supervisor.
 - ② The width specified in the design should be maintained as much as possible, as any unnecessary increase of the excavation width may affect the earth pressure and its distribution.
- (2) The range of pavement removal should be minimized in road excavation, and works should be performed in a time slot when traffic jams may be minimized.

- ① The cutting of the pavement surface during the trenching in a road area should be performed using an asphalt cutter, and the cutting lines should be drawn before the cutting work.
- ② The working time should be reduced by carefully considering the work sequence and work time slot, and the work should be carried out in consideration of the need to prevent safety accidents, ensure quality, and avoid civil complaints due to noise.
 - a. For night and holiday works, the ranges of the working time, working positions, and the change of the construction expenses should be specified in advance in the design stage. A construction work plan should be submitted before the initiation of the works through consultation with the authority implementing the construction project.
 - b. The generation of civil complaints related to changes in traffic signs and traffic control depending on the work implementation should be minimized. The construction work methods should be reported in advance to the relevant authorities (National Police Agency, etc.), and traffic plans should be prepared to facilitate the traffic through preliminary public relations activities (internet, brochures, public relation broadcasting, etc.).
- (3) Excavation should be performed to the depth specified in the design drawings, and the stagnation of rainwater or spring water should be avoided during the works. Existing structures near to the work site should be sufficiently protected.
 - ① Plans should be established with regard to whether the work will be conducted by manual excavation, mechanical excavation, or both; the selection of excavation machines; the number of workers; the number of machines to be used; and the working time slot.
 - ② The following details should be noted during the excavation works:
 - a. Overbreak beyond the specified depth should be avoided. If overbreak occurs, back filling and compacting should be performed again to keep the bottom surface from becoming softer than the original ground.
 - b. Water draining facilities should be installed to avoid stagnation of water during the excavation works.
 - c. Excavation works in close proximity to existing fixed structures, such as houses or walls, may relax the foundations of the structures or lower the supporting force of the nearby grounds through the discharge of spring water or groundwater. Therefore, plans for minimizing the damage to the nearby

- structures should be established.
- d. Protection plans should be established not only for fixed facilities but also for vehicles and residents.
 - e. Excavated soil or other materials should be piled up in a position that does not affect the stability of the excavation slope surface. The materials should be kept from falling into the excavation surface or entering into the area by collapse. In addition, application of an excessive pressure around the excavation work position should be avoided.
 - f. A temporary bridge with a handrail should be installed in the pipeline excavation area to allow the workers or equipment to cross over the area.
- (4) Linear trenching should be performed in the presence of an underground utility.
- ① Lateral linear trenching should be performed in the perpendicular direction to the obstacle line in an interval of 40 to 50 m. If the obstacle line is clearly known, the lateral linear trenching interval may be increased in consultation with the construction supervisor.
 - ② In the presence of an underground utility, a preliminary manual excavation should be performed to prevent damage to the underground utility that may be caused by mechanical excavation.
 - ③ Longitudinal linear trenching should be performed in an area where a linear obstacle arrangement in parallel with the excavation line is expected.
- (5) When trenching is performed without earth retaining work, the inclination should be constant.
- ① In natural slope surface trenching, the slope surface inclination should be kept at the one specified in the design drawings, and the inclination should not be vertical.
 - ② If vertical excavation is performed for road excavation works, the excavation surface inside the road may easily collapse, making the back filling difficult and causing the destruction of the road, including road sinking. Therefore, the cutting inclination should be determined for the excavation works according to the soil type.
- (6) The work site should be carefully patrolled during the excavation works to check the conditions of the earth-flow retaining walls (earth retaining walls), excavation surfaces, and earth-flow back surfaces in order to secure safety inside and outside the pits.

- (7) For safe work implementation in the excavation pits, safety and hygiene facilities should be installed, including the necessary lighting, passage entrances (including exits), scaffolds footboards, fire extinguishers, leakage current breakers, and ventilation facilities.

3.3.17 Excavated Soil Transportation and Restoration

(1) Excavated soil transportation

- ① The contractor may temporarily pile up the excavated soil at a place more than 80 cm separated from the top edge of the excavation slope surface. Necessary actions should be taken to prevent the collapse of excavated slope surfaces, and soil erosion and leakage by rainwater.
- ② An excavated soil transportation plan that details transportation paths, transported places, and transported amount should be prepared and submitted.
- ③ The places to which the excavated soil is transported may be changed and designated so that some of the soil may be used for other purposes.
- ④ A soil transportation manager should be appointed, and may investigate the vehicle repair state, transportation paths, and drivers' work trips to establish the repair, checkup, and management plans for transportation vehicles.
- ⑤ For temporary heaping of transported soil, a relevant plan that includes information about the place, method, and protective facilities should be submitted.
- ⑥ The materials generated by the excavation should be appropriately treated in consultation with the owner or manager.
- ⑦ Appropriate actions should be taken to prevent dust and soil from leaving the site by adhering to the wheels of the working vehicles during the excavation. Cleaners and signaling persons should always be placed around the excavation soil loading site to thoroughly manage the cleaning and signaling works depending on the vehicle traffic.

(2) Treatment of disassembled materials

- ① Disassembled materials generated by the excavation works from manholes, road structures, and road accessories should be screened by the construction supervisor to be arranged either by storing or piling in a designated place.
- ② Underground materials generated by the excavation works should be treated according to the directions given by the construction supervisor.

(3) Road structures, road accessories, manhole heads, underground utilities, and aerial

wires should be restored to their original state after the completion of construction.

3.3.18 Underground Utility Management

- (1) In sewer pipeline construction works, if the overlap of a natural flow pipeline with existing underground utilities makes it difficult to install a pipeline, an obstacle transfer plan should be established. An appropriate plan regarding the possibility of obstacle transfer and the method of transferring the obstacle should be established in consultation with the relevant authorities.
- (2) Before initiating the construction works, data should be prepared (drawings, construction history, etc.) to show the current status of various underground utilities, including the underground high-tension power lines, electric wires, electric power cables, water pipes and sewer pipelines, and city gas pipelines, and then an on-site survey should be performed. Any obstacle existing in the construction work area should be transferred in consultation with and in the presence of the construction supervisor and the obstacle management institutions.
- (3) For excavation works performed in the urban area, the positions of the underground utilities should be investigated by means of drawings and advice from the manager, and linear trenching or other types of works may be performed.
- (4) Before the linear excavation works, the approximate positions of the underground utilities should be verified in consultation with the relevant departments and marked with red paint on the road pavement to prevent damage to the underground utilities by the linear excavation works as much as possible. Since the underground utility detector may not detect nonmetallic utilities and deeply buried utilities, manual excavation should be performed to a sufficient depth in the linear excavation to check for the presence of an underground utility.
- (5) Exposure of an underground utility by the excavation should be confirmed by the relevant authorities, owner, and manager in order to take protective actions, including the installation of braces or earth retaining walls through mutual cooperation.
- (6) Underground utility transfer, change of position, and substitution should be carried out in consultation with the relevant authorities.
- (7) The underground utilities should be monitored at least once a day, by checking the tension of the wire ropes and the safety of the placement structures, particularly at the connecting parts.

- (8) When the excavation works are performed near to an underground utility, it is highly probable that the surrounding ground may be settled due to the lowering of the groundwater level. Protective measures should be prepared for the reinforcement of curved pipes and the prevention of water leakage from walls, after sufficient consultation with the authorities related to underground utilities.
- (9) The use of machines and devices dealing with fire, including welding machines and cutting machines, should be forbidden at positions near to the underground utilities, including utilities vulnerable to fire or pipelines transporting inflammable materials. In unavoidable cases, these machines and devices may be used in consultation with the owner of the utilities after verifying the presence of combustible gases using a detector and taking necessary actions for the safety of the underground utilities by using a heat blocking device.
- (10) Even in cases where an underground utility has been discovered during linear excavation works, another obstacle may exist under the discovered obstacle. Therefore, manual excavation should be performed to a sufficient depth in the linear excavation works to check for the presence of another obstacle.
- (11) In excavation works under a pipeline, the connecting parts of a cast-iron pipe that require special fitting should be suspended after hand excavation.
- (12) All facilities of sewerage, water supply, gas, electricity etc. which were captured or found before or during the demolition works should be protected however they are specified or not in the design drawings.

3.3.19 Obstacle Treatment

- (1) Driving of H-piles should always be performed after sufficient deep trench excavation and verification of underground utilities in order to protect those damage, assuming that another obstacle may exist too at the lower of the found underground utility even in a newly developed area.
- (2) Sufficient protection countermeasures should be performed to prevent the leakage of water pipes on the back face of excavation.
- (3) Protection countermeasures for preventing deformation of water pipe should be performed.
- (4) Sufficient protection countermeasures should be performed to prevent the leakage of sewers on the back face of excavation.

- (5) Sufficient protection countermeasures should be performed to prevent the leakage of sewer culvert on the excavated area. And considering the total normal load of the sewer culvert, the bottom of the culvert should be uniformly and sufficiently supported using rectangular timbers etc.(assuming that the bottom slab of the sewer culvert is not protected well).
- (6) Reliable and stable construction should be performed to prevent leakage at the sewer culvert connection (the existing culvert and the steel plate culvert).

3.3.20 Underground Utility Protective Measure Planning

- (1) In the preliminary survey for the preparation of the construction plan, the positions, dimensions, structure, and aging of the underground utilities should be investigated in order to prepare measures for the protection of the safety of the underground utilities.
- (2) When the construction works are performed at a position near to an underground utility, the contractor should consult with the owner of the utility and the relevant authorities, and make decisions about the safety measures needed, methods of protecting the utility, verification, emergency contact, and safety measure implementation for each stage of the construction works according to the relevant laws and regulations.
- (3) When pile driving or drilling is needed for construction works on a road, the presence of underground utilities should be verified down to the depth at which underground utilities may exist, and the underground utilities should be exposed through manual excavation.
- (4) If an aged underground utility is found or an important underground utility is found near to the excavation site during the construction works, the contractor should consult with the relevant authorities about the safety measures needed, methods of protecting the utility, verification, and emergency countermeasures and contact method. In particular, for a risky or important underground utility, a person responsible for measurement should be appointed to install automating warning devices and perform frequent examination.
- (5) In cases where an exposed underground facility is damaged, the contractor should contact the ordering body or the owner of the utility, and completely repair under the supervision of the owner.

- (6) When excavation works are performed in close proximity to an underground utility, the contractor should always be careful about the settlement of the surrounding ground, and take necessary safety measures for the utility in the presence of the owner.

3.3.21 Water Drain Works

- (1) Water drain works should be performed through a method that may sufficiently drain water, considering the risk of groundwater leakage, geological conditions, and pump-up head.
- (2) A water drain work plan should be established that considers the type of the water drain work, draining capacity, installation position and number of pumps, capacity of pumps and other materials, and facility arrangement.
- (3) The water drain works should be selected by considering the permeability of the ground. An on-site water permeability test should be performed at the survey of the pipeline foundation.
- (4) A riskiness of the structures should be eliminated by the excessive hydrostatic pressure with maintaining low water level. However, water level should be properly maintained not to make an immoderate effect on the surrounding structures and ecological environments.

3.4 On-Site Quality Control

- (1) If a new soil type is found during the excavation works, it should be immediately reported to the construction supervisor, and the cutting works may be resumed after receiving the approval of the construction supervisor.
- (2) Structure excavation works should be performed carefully so as not to affect the stability of the slope's surface. The changes of the geological features and spring water status during the construction works should be observed, recorded, and then reported to the construction supervisor.
- (3) Any unexpected ground conditions found during the cutting works should be reported to the construction supervisor, and the works should be discontinued until the direction to resume the works is given.
- (4) The contractor should prevent the ground displacement and the falling of relaxed

soil onto the trenching bottom surface, and maintain the stability of the ground during the construction works.

- (5) The excavated bottom surface and the soil on or underneath the foundation should be protected from freezing damage.

