Korean Construction Standard

KCS 11 20 20 : 2019

Banking (Mounding)

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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 banking (mounding) in the Construction Work Slope Surface Standard Specification and the River Construction Standard Specification. Major matters related to the enactment and revision of this code are as follows:

ConstructionStandard	MajorContents	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)
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)

Construction Standard	Major Contents	Enactment· Revision (Month, Year)
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 process, 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 the cases where the surrounding ground is sand or dredged soil.	Partial Revision (2015.8)
KCS 11 20 20 : 2016	• Integrated and maintained as code according to changes in the construction standard code system.	Enactment (2016.6)
KCS 11 20 20 : 2016	• Revised to accord with Korean Standard and Construction Specification.	Revision (2018.7)

Construction Standard	Major Contents	Enactment· Revision (Month, Year)
KCS 11 20 20 : 2019	• Revised by adding preliminary dewatering in the banking on soft ground and weather condition on the banking, separated application of the diameter and size in particles	Revision (2019.12)

Table of Contents

1. General

1.1 Scope of Application

(1) This standard is applied to banking for installing roadbeds or slope surfaces, compaction performed until an appropriate compaction density is obtained in roadbed and subgrade compaction works in road construction, and finishing works for trimming and arranging earth works to be a uniform shape along with the linear shapes, slopes, and cross-sectional surfaces.

(2) For details that are not mentioned in this standard but specified in the relevant items of another standard, the other standard should be observed. If this standard conflicts with details separately specified in the contract documents, the contract documents should be applied preferentially.

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 10 10 15 Quality Control
- KCS 11 20 15 Trenching
- KCS 11 20 25 Refilling and Back Filling
- KCS 11 70 00 Slope Surface Protection
- KS F 2301 Method of Preparing Samples for Soil Particle Diameter Testing and Physical Testing
- KS F 2302 Method of Soil Particle 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 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.

1.4 Deliverables

1.4.1 Data Submission Requirements and Procedures

(1) The contractor should prepare deliverables, including a construction work plan and a progress inspection report, according to the construction plan by referring to the requirements specified in KCS 10 10 10, and submit them to the construction supervisor.

1.4.2 Inspection and Test Record

(1) The contractor should submit to the construction supervisor the test reports from all the tests performed according to KCS 10 10 15, and a quality testing engineer should sign and seal on the test reports.

1.4.3 Samples

(1) The banking and back filling samples selected by the construction supervisor should be submitted.

1.4.4 Material Entry Statement

(1) A material entry statement including information about the type and number of banking materials brought into the construction site should be submitted for each transportation vehicle.

2. Materials

2.1 Materials

2.1.1 General Requirements of Banking Materials

(1) The materials to be used for banking should be inorganic soil with no hazardous materials, having a particle size that allows sufficient compaction by water sprinkling to minimize the pores.

(2) On-site materials obtained by excavation that satisfy the banking material requirements are considered as appropriate.

(3) The banking materials decided as appropriate by the construction supervisor should be stacked layer by layer in a thickness less than 200 mm after removing coarse stones and stone debris.

(4) Banking materials should include nothing hazardous materials of plants and trees, stumps, thickets, tree roots, wastes, organic soil etc.

2.1.2 Specific Requirements of Banking Materials

(1) As a normal filling material, a soil mixed with gravels, sand, silt, and clay and having an appropriate or good particle diameter may be prepared by digging, sieving, or mixing. The maximum particle diameter should be less than 100 mm, and the ratio of particles having a particle diameter less than 5 mm should be less than 60%.

(2) A normal banking material should be a normal filling material having a liquid limit equal to or less than 40% as per KS F 2303, and a plasticity index equal to or less than 15 as per KS F 2304.

(3) As a selective material banking material, a soil mixed with gravels, sand, silt, and clay and having an appropriate or good particle diameter may be prepared by digging, sieving, or mixing. The soil should have the following particle diameter:

① Particle diameter (KS F 2302)

Table 2.1-1 Particle diameter of selective material banking material.

Nominal size of sieve (mm)	Passing weight ratio (%)
25	100
10	Equal to or higher than 75
5	Equal to or higher than 20
0.08	Equal to or lower than 35

② Sand equivalent (KS F 2340) : Equal to or higher than 10

③ Plasticity index (KS F 2304) : Equal to or lower than 10

(4) A soil structure banking material should be a selected material having an appropriate or good particle diameter, and may be prepared by digging, sieving, and mixing. The material should have the following soil quality and particle diameter.

① Materials smaller than 0.425 mm

a. Liquid Limit (KS F 2303) : Equal to or lower than 25

b. Plasticity index (KS F 2304) : Equal to or lower than 6

② Particle Diameter (KS F 2302)

Table 2.1-2 Particle diameter of soil structure banking material.

Nominal size of sieve (mm)	Passing weight ratio (%)
80	100
5	Equal to or higher than 35
0.6	Equal to or higher than 20
0.08	Equal to or lower than 25

③ Sand equivalent (KS F 2340) : Equal to or higher than 20

(5) The water permeable refilling material should be cleanly washed gravel or crushed stones satisfying the following conditions:

① Particle Diameter (KS F 2302)

Table 2.1-3 Particle diameter of water permeable refilling material.

Nominal size of sieve (mm)	Passing weight ratio (%)
50	100
0.3	0 ~ 100
0.15	0 ~ 80
0.08	0 ~ 40

② Abrasion rate (KS F 2508) : Equal to or lower than 50

③ Softness represented by abrasion rate : Equal to or lower than 15

④ Coal and lignite: Equal to or lower than 0.25

⑤ Clay balls: Equal to or lower than 0.25

⑥ Other hazardous materials: Equal to or lower than 2.0

2.1.3 Road Banking Material Quality Requirements

(1) Soil having a liquid limit equal to or higher than 50%, material having a dried density equal to or lower than 14.71 kN/m^3, and soil having a porosity equal to or higher than 42% and a plasticity limit equal to or higher than 25% may not be used as banking material.

(2) When a rocky muck is used as a banking material, it may be applied to the part less than 600 mm from the completed roadbed surface, and it should be well graded.

(3) The maximum particle diameter(the longest size) of softening of the rocky muck, resulting from breaking or repeated water immersion due to the mechanical properties of rocks, including weathered rock, mudstone, shale, sandstone, phyllite, and schist should be equal to or less than 300 mm.

(4) Frozen material may not be used for banking.

(5) The quality standards for banking materials are shown in Table 2.1-4.

Table 2.1-4 Banking material quality standard.

Work classification specification standard	Roadbed	Subgrade	Note
Maximum size (mm)	Equal to or lower than 300	Equal to or lower than 100	-
Modified CBR (compaction according to specification)	Equal to or higher than 2.5	Equal to or higher than 10	KS F 2320
5 mm sieve passing ratio (%)	-	25 ~ 100	KS F 2302
0.08 mm sieve passing ratio (%)	-	0 ~ 25	KS F 2302 KS F 2309
Plasticity index	-	Equal to or lower than 10	KS F 2303

① The testing items for banking materials are shown in Table 2.1-5.

Table 2.1-5 Testing items for banking materials.

Testing Items	Testing Method	Testing Frequency (Measurement Frequency)	Note
Water content	KS F 2306	At each borrow pit	On-site testing
Particle diameter	KS F 2302		On-site testing (Sieve analysis)
75 μm sieve passing ratio of soil	KS F 2309		On-site testing
Density	KS F 2308		〃
Liquid and plastic limits	KS F 2303		〃

② Banking materials should be standard materials. Soils having high absorptivity and high compressibility, including bentonite, solfataric clay, acid bentonite, and organic soils; frozen soil; frozen snow; and soil containing a large amount of humic substances, including grass and trees, should not be used.

③ When a nonstandard material is used as a banking material, it should be approved by the construction supervisor, and a mid-term and long-term management plan should be established for construction and operation works.

④ When rock blocks and stone blocks are used as a banking material, the construction method, layer thickness, and degree of compaction should be approved by the construction supervisor. The cavities should be filled with stone debris for stabilization.

2.1.4 Maximum Particle Size of Slope Surface Banking Materials

(1) When on-site recycled soil is used as a banking material

① General banking

a. A high quality soil should basically be used for banking between a depth of 0.3 m and 1 m from the finishing surface. If site conditions do not allow this, the following standards should be applied to the construction works:

(a) Particles having a diameter equal to or higher than 50 mm should not be mixed with material within 0.3 m depth from the finishing surface. The mixing ratio of the particles having a particle diameter equal to or higher than 40 mm should be equal to or less than 40%.

(b) The maximum particle diameter within 0.3 ~ 1 m depth from the finishing surface should be 150 mm (100 mm for subgrade), and the mixing ratio of the particles having a particle diameter equal to or higher than 40 mm should be equal to or less than 50%.

b. The maximum particle diameter(the longest size) at a depth equal to or more than 1 m from the finishing surface may be 300 mm if the material does not have a negative effect on the foundation of the structure and the underground utilities. However, the maximum particle diameter may be increased to 500 mm if stringent construction measures such as small particle's filling in the opening of large particles are applied. For example, a material having a smaller particle diameter may be filled around the large particles to avoid the formation of pores. Other materials should conform to the corresponding standards. The particle diameter of the rock muck is applicable for the quality control of the field as a length of major axis.

② Rocks or muck having a maximum particle diameter over 100 mm should not be applied to the banking main body within 1 m from the finishing surface of a banking slope surface. However, slope surfaces with stone pavement are an exception.

(2) External carry-in soil

External soil transported into the banking site should basically be a high quality soil. However, if inevitably necessary for economical construction works, the standard described above may be applied to the construction works after acquiring the approval of the construction supervisor.

2.1.3 Industrial Byproducts Used as Banking Materials

(1) Before an industrial byproduct is used as a banking material, a construction work plan should be submitted to and approved by the construction supervisor together with the information about the design, construction method, layer thickness, and compaction as well as the data showing the appropriateness of the material as a banking material after the material compaction and the safety of the material with regard to the effect on the environment, including the effect on groundwater pollution.

(2) Blast-furnace slags, mineral dressing residue from coal mines or mines, fly ash, and other recycled aggregates and industrial byproducts may be used as banking materials.

2.2 Equipment

2.2.1 Compaction Equipment

(1) The compaction equipment used in the entire banking area should have the specifications equal to those of the equipment used for the test works. To change the compaction equipment, the test works should be performed again and verified by the construction supervisor.

(2) In narrow areas, such as the areas near to a structure, or in places where excessive compression to a structure may cause damage, a small-sized compaction device, approved by the construction supervisor, may be used for uniform compaction.

(3) The banking slope surface should be compacted using a compaction device approved by the construction supervisor.

(4) The compaction device applied to rock banking should be approved by the construction supervisor, and should have a compaction roller width of over 1.8 m and a static weight of over 10 t.

2.3 Material Quality Control

2.3.1 On-Site Quality Control

(1) The appropriateness of banking materials to be used for construction should be determined by performing experiments to verify whether the following requirements are satisfied:

① Water content-density curve: KS F 2312 Method of Soil Compaction Testing
② Water content: KS F 2306 Method of Soil Water Content Testing
③ Liquid limit: KS F 2303 Method of Soil Liquid Limit Testing
④ Plastic limit and plasticity index: KS F 2304 Method of Soil Plastic Limit Testing
⑤ Abrasion rate: KS F 2508 Method of Coarse Aggregates Abrasion Testing by Use of the Los Angeles Machine
⑥ Particle diameter: KS F 2302 Method of Soil Particle Diameter Testing
⑦ 0.08 mm sieve passing ratio: KS F 2302 Method of Soil Particle Diameter Testing
⑧ Organic matter content: KS F 2510 Method of Testing Organic Impurities Contained in Sand for Concrete

(2) All the test result reports on the banking materials should be submitted to the construction supervisor as specified in the specifications.

3.Construction

3.1VerificationofConstructionConditions

3.1.1CautionsinUsingBorrowPit

(1) If the amount of the available materials generated from the excavation works in the construction site is not sufficient or if the properties of the materials are inappropriate for the requirements of the banking and other construction works, the contractor should find a borrow pit in order to obtain sufficient and appropriate materials.

(2) A specified borrow pit should be cleaned and straightened, and the ground should be adjusted and thus a rainpool to be nonexistent.

(3) In case of road construction, the location and size should be specified on the design drawings(fround plan) and mass curve. And these things, described on the specification of work, that the relations with prevention of civil complaints, the permission possibility of landowners and related local government, the prior consultation subjects, precautions for construction, the minimization method of the natural environmental damages etc. should be investigated as it is on the site. The results should be submitted to the construction supervisor and construction should be proceeded according to the approvals.

(4) Excavation and transportation works in a borrow pit should be performed by paying attention to the following cautions:

① The area and facilities outside of the boundary should not be damaged.

② To prepare for the possibility of rainfall during the construction works, a drainage plan should be established, including catch drains and grit chambers.

③ Facilities for blast protection and slip prevention should be installed according to the surrounding circumstances.

④ If rainfall during the construction works may affect the water content of the soil, a diversion channel should be installed to prevent an increase in the water content.

⑤ The mixing of soil and blast rocks in the earth cutting process should be avoided so as not to change the soil quality.

⑥ Cutting work should be performed in order to form uniform cross-sections and stable slope surfaces for harmony with the surrounding topographic features and the stability of the slope surfaces.

⑦ A vehicle wheel washing facility should be installed at the entrance way.

⑧ After completing the utilization of a borrow pit or a quarry, the contractor should neatly arrange not only the borrow pit but also the surrounding facilities occupied during the construction. If necessary, a water draining facility should be installed after obtaining the approval of the construction supervisor.

⑨ The contractor should fulfill the restoration and landscaping duties as directed by the authority permitting the development of the borrow pit or quarry, as well as the duties of stabilizing the slope surface formed by the borrow pit earth cutting and repairing and arranging the roads used as transport paths in order to eliminate any causes for ex post conflict. A certificate showing the fulfillment of these duties should be issued, and a copy of the certificate should be submitted to the construction supervisor.

3.1.2 CautionsinCompaction

(1) For uniform and efficient compaction, the contractor should perform surface compaction using a grader. Compaction should be performed after adjusting the soil water content to the allowable range of optimal water content for the indoor compaction test.

(2) Before initiating compaction, the contractor should submit a construction work plan that includes the type and number of devices to be used for compaction works and the combination of the devices according to the process plan, and acquire the approval of the construction supervisor.

(3) Compaction work should be discontinued if the water content cannot be adjusted due to rain or other factors, or in winter when the materials are frozen.

3.2WorkPreparation

3.2.1PreliminarySurvey

(1) The site conditions should be checked to determine whether they are appropriate for the initiation of the construction.

(2) Consistency between the design drawings and the site conditions should be checked. If the elevation of the measurement bench mark and the slope surface inclination on the design drawings are not consistent with the actual conditions, the contractor should immediately report to the construction supervisor and follow his or her directions.

(3) Before the initiation of the construction works, the topographic features, soil quality, meteorological conditions, and correlation with other construction works should be reviewed. The contractor should investigate the effect of any significant change in the topography according to the design on the inside and outside of the construction site, the degree of flooding from the surrounding topographic features to the construction site, and the stability of the slope surfaces. If a problem is found, the contractor should prepare a countermeasure to the problem, and request a change of the plan.

3.2.2WorkPreparation

(1) Preliminary dewatering

① Before the construction works, any still water on the original ground should be drained. During the construction works, diversion channels and grit chambers should be installed in order to maintain good water drainage in the banking area. Actions should be taken to prevent the immersion of the facilities under the banking slope surfaces or the obstruction of existing water drainage facilities due to the loss of soil by torrential rain.

② For Preliminary dewatering, the contractor should trench a banking bottom surface in the early stage and fill the surface with water permeable materials, including unscreened gravel. The dimensions and area of the places to be drained should be marked on the construction drawings and reported to the construction supervisor to acquire approval before the construction works.

③ In case that the surface of foundation ground is soft ground at the high water content, the banking should be done after lowering the water content by the drain excavation. However, the banking should be performed after the completion of the ground improvement for all of the zone that soft ground treatment method is designed.

(2) Leading frame installation

A leading frame must be installed on the banking slope surface to finish the banking surface correctly. Leading frames should be installed at the points where the lateral lines are bent or the inclination is changed. After piling supporting piles at the end of the slope, a leading plate longer than 1 m should be accurately fixed according to the slope surface inclination.

3.3 Construction Standard

3.3.1 General Requirements of Soil Banking

(1) The general requirements of soil banking includes water content adjustment and compaction of banking material and it uses in the banking of a river bank within 1 m from the finished base surface or bottom surface. in The pure banking materials excavated from a borrow pit can be included

(2) A soil test laboratory at the construction site, owned or employed by the contractor, should perform the tests after acquiring the approval of the construction supervisor. If required by the construction supervisor, the test results should be submitted.

(3) Scouring should always be prevented at the construction site. A temporary bank should be prepared and trenched to a low height to induce natural drainage.

(4) The surface should be extended to allow the traffic and passage of construction machines to aid in achieving uniform compaction. Exposed soil layers having a high water content should be protected from an excessively high wheel load.

(5) Recycling of surface soil

① The surface soil within the boundary lines specified in the design drawings should be recovered and recycled. The recovered surface soil should be temporarily piled at a position in the construction site approved by the construction supervisor, and protected from contamination by foreign materials. Appropriate actions should be taken to drain water and prevent scouring.

② The surface soil for temporary banking should be placed in a zone designated

in the contract drawings.

3.3.2 General Matters related to Banking Works

(1) Banking works should be initiated after completing the installation of leading frames, preparatory water draining, clearing and grubbing and topsoil removal, and removal of structures and obstacles.

(2) Concave areas, including rivers, water ways, holes formed by clearing and grubbing and topsoil removal, and areas of faulty material removal should be refilled up to a height equal to the surrounding ground and compacted until the required density is obtained before the placing of the first banking layer.

(3) If the foundation bearing capacity of the banking ground is significantly insufficient or if soft ground treatment is required due to settlement exceeding the allowable standard value, a separate review should be carried out to acquire the approval of the construction supervisor before the initiation of the construction works.

(4) In the banking works on unstable grounds, such as in the water or on a lowland, soft ground improvement works should be performed before the banking works for the area designed by the soft ground treatment method according to the standard specified in the design drawings. For shallow lowlands that are not designed according to the soft ground treatment method, appropriate materials should be substituted up to the highest water level in the lowland or rocky muck containing granular materials or large and small particles together should be used to prevent loss and long-term settlement of the ground, to avoid capillary rise, and to stabilize the ground.

(5) On the original ground for banking works, the soil should be scraped up to a depth of at least 150 mm, and compacted until an appropriate compaction density is obtained. However, in the areas having a very high water content, such as submerged lands and lowlands, a separate ground improvement method should be approved and implemented. If the site conditions are favorable, this work may be omitted with the approval of the construction supervisor.

(6) Banking should not be performed on frozen ground. However, if the frozen depth is less than 75 mm, the banking work may be performed after completely removing the frozen layer and receiving the approval of the construction supervisor.

(7) In case of road construction, Superelevation should be provided on horizontal

curves according to the design drawings.

(8) The banking works should not be performed in the harmful weather conditions to the construction in progress or completed construction. The banking works should not be resumed until the condition of field and soil becomes to be proper to the compaction works in case that the construction was stopped due to rain.

3.3.3Benching

(1) In banking works performed on a ground where the slope surface inclination is steeper than 1:4, benching should be carried out on the surface of the original ground to promote tight adhesion on the banking part and the original ground and to prevent the deformation and movement of the ground.

(2) Benching should also be performed in the banking works connected to an existing road for the expansion of the existing road.

(3) In banking works performed on a slope surface, a water drainage layer or a catch drain should be installed to prevent water infiltration between the banking part and the foundation ground, which may cause movement. In areas where spring water exists in the foundation ground or where no spring water is found during the construction works but is expected in a rainy season, a water draining layer should be installed at the banking part connected with the original ground.

(4) Benching should be implemented according to the height and width specified in the design drawings, which may be adjusted to the topography of the construction site in consultation with the construction supervisor.

3.3.4TreatmentofWetlandandSoftGround

(1) In banking works on swamps, paddy fields, and other wetlands, ditches should be trenched lengthwise and breadthwise for sufficient water draining. The scale and difficulty of construction works, the characteristics of the construction methods, and the scope of the soft ground should be comprehensively reviewed. If the soft ground is considered unable to bear the banking load sufficiently, an additional ground improvement should be selected and implemented after acquiring approval for the design change.

3.3.5 Transverse Banking · Cutting Connection (Cutting on One Side with Banking on the Other Side)

(1) If banking is performed on one side and earth cutting on the other side of the same transverse surface, differential settlement may occur due to the difference of the soil bearing capacity of the two sides. Therefore, benching should be performed according to 3.3.3 at the transverse connecting part, and a relaxation interval should be installed at an inclination of about 1:4 from the banking roadbed finishing surface to the subgrade finishing surface on the inside of the connection with the earth cutting area.

(2) If spring water is found at the earth cutting part of the connection, the adhesion of the banking part may fail. Therefore, a water drainage layer or a catch drain should be installed according to the design drawings.

(3) Rock muck banking should not be performed at the connection of the boundary areas.

3.3.6 Longitudinal Banking · Cutting Connection (Boundary of Banking and Cutting)

(1) Similar to the transverse connection, differential settlement may occur at longitudinal connections. Therefore, earth cutting should be performed from the end of the cutting area to the lower surface of the subgrade in the banking area to connect to the lower surface of the subgrade at a gradual inclination. The connecting interval length is determined by the design drawings. The earth cutting area should be refilled with the same material as the subgrade in the banking area, and compacted to the specified compactness.

(2) Surface water and infiltrating water may be concentrated to the longitudinal connections, and the adhesion between the foundation ground and the banking area may fail. Therefore, benching should be performed according to the design drawings.

(3) Rock muck banking should not be performed at the longitudinal connections.

3.3.7 Banking Construction Works

(1) Banking material should be placed in a thickness specified in the design drawing. Compaction should be performed through a predetermined method before placing the next layer.

(2) Materials with different properties, such as cohesive soil and sandy soil, supplied

from different sources, should be placed to form the layers one by one. However, if the construction supervisor finds it advantageous, the materials may be mixed for banking.

(3) In banking works performed on soft grounds that cannot bear the load of trucks or other transportation vehicles, such as lowlands, the first layer should be sufficiently thick to bear the load of the transportation vehicles. However, the maximum thickness of the first layer should be determined in consultation with the construction supervisor.

(4) In banking works that may give impact to or damage to a structure, the soil and stones should not be dropped from a high position.

3.3.8BankingSlopeSurface

(1) In the construction of banking slope surfaces, the inclination, benching, slope surface protection works, compaction methods, and drainage treatment should be reviewed.

(2) When banking works are performed on a highly vulnerable area with regard to the slope surface stability, measurement management should be carried out to support safety management during the construction and the maintenance after the completion.

(3) To increase the stability of the banking slope surfaces, filter layers and underground drainages may be installed according to the directions given by the construction supervisor.

(4) The banking slope surface stability should be reviewed by comprehensively considering the surrounding construction results and disaster cases as well as the soil conditions, construction method, construction scale, and foundation ground conditions.

(5) The seismic stability of banking slope surfaces should be reviewed by considering the sliding destruction of the slope surface and the flowing destruction by the liquefaction of the ground.

(6) Construction works near to banking slope surfaces

① Construction works near to a banking slope surface should be performed with sufficient compaction to connect with the main banking body.

② If banking of a banking slope surface unavoidably has to be performed with rock muck, stone paving should be performed in principle.

3.3.9 Foundation Ground of Banking Area

(1) A ground survey should be performed to verify the presence of factors that may affect the banking stability, such as soft ground, cliff, and collapsing areas. If necessary, an appropriate countermeasure should be established according to the directions given by the construction supervisor.

(2) If the inclination of the foundation ground is steeper than 1:4, actions should be taken according to the banking standard for slope grounds.

(3) In the event of a cavity in the foundation ground, such as an abandoned mine, appropriate actions should be taken according to the directions given by the construction supervisor after undergoing consultation with relevant authorities and a review by an experienced engineer approved by the construction supervisor.

3.3.10 Banking on Slope Ground

(1) Water draining plans should be established when there is high water-content soft ground or spring water in the surface layer of the foundation ground.

(2) In banking works on slopes ground, benching should be performed on the original ground surface to promote adhesion between the original ground and the banking works and to prevent the deformation and sliding of the ground.

(3) Banking with rock muck on the slope ground is allowed only when approved by the construction supervisor.

(4) In case of partial cutting and partial banking, differential settlement should be avoided considering the adhesion between the foundation ground and banking, the difference in bearing capacity, surface water or infiltrating water, and insufficient compaction.

(5) Benching on the original ground surface should be performed according to the angle, water draining method, and transverse slope approved by the construction supervisor.

3.3.11 Unfolding

(1) To make the banking thickness as specified in Table 3.3-1 after the completion of

compaction of the first layer, unfolding should be performed and compaction should follow. The thickness of the first-layer unfolding thickness should be determined by a test work.

Table 3.3-1 First-layer thickness after compaction.

Item	Roadbed	Subgrade	Note
First-layer thickness after compaction (mm)	300	200	-

(2) The devices used for banking should be approved by the construction supervisor before the initiation of the construction works.

(3) In banking works, the soil should be leveled and spread widely to enable easy compaction.

(4) In banking works, arbitrary unfolding of different types of materials on the first layer should be avoided. unfolding of a mixture of different materials should be performed, as per 3.3.19.

3.3.12DrainageinBankingArea

(1) In a banking area, water draining plans should be established to prevent an increase in the groundwater level.

(2) Plans to prevent an increase in the groundwater level should be determined by considering all types of infiltrating water on the foundation ground, including spring water and rainwater.

(3) In addition to the preparation of the water draining plans, if the possibility of a groundwater level rise is high, banking materials with a high water draining capability should be used.

(4) Water draining plans for a banking work area should be established after sufficiently investigating the ground conditions and meteorological conditions.

(5) If the water content of the foundation ground is high, preparatory water draining should be performed to lower the water content.

(6) In the presence of a water permeable layer or a spring water layer in the original ground, underground drainage works or filtering layers should be installed.

(7) Materials satisfying the relevant standard should be used to install a filtering layer.

3.3.13 Water Draining During Construction Works

(1) During banking works, the contractor should take note of any water draining to avoid the accumulation of still water. Drainage treatment should be performed to avoid the inflow of external surface water and spring water to the inside of the banking area.

(2) When daily works are completed or discontinued, the banking compaction surface should be compacted at a transverse inclination of over 4% to avoid surface water stagnation and facilitate water draining.

(3) If the works have to be resumed immediately after a rainfall, the work surface should be covered before a rainfall with a waterproof material, such as polyethylene, to prevent rainwater infiltration.

(4) The spring water or surface rainwater in the earth cutting area may cause scouring or collapse of the banking slope surfaces. Therefore, a diversion channel should be installed at the edges of the banking area, and a temporary link canal should be prepared with straw bags, gunny sacks, and plastic sheets at the points where the surface water may be appropriately drained or where a link canal is to be installed in the banking area as specified in the design drawings.

3.3.14 High Banking

(1) High banking refers to banking over 15 m or the height specified by the construction supervisor.

(2) In high banking works, care should be taken with respect to the settlement of foundation ground, banking slope surface stability, selection of materials, and determination of water draining plans.

(3) The high banking work structure should be determined after considering the construction accomplishments, topography, geological features, spring water conditions, bearing capacity and shape of the foundation ground, mounding materials (banking materials), and issues related to emergency restoration.

(4) The high banking slope surface stability should be reviewed, and countermeasures should be prepared according to the review result.

(5) In high banking works, a system should be prepared to monitor the change of the material conditions and the groundwater level.

(6) If necessary, KCS 11 70 00 should be applied to high banking slope surfaces.

3.3.15 Passage of Construction Equipment

(1) Transportation equipment or pavement equipment should be allowed to move over the entire area of the banking work surface to obtain the compaction effect.

3.3.16 Banking Near to Structures

(1) Banking works on the back faces of structure abutments and both side faces of passages and water way boxes should be carried out according to KCS 11 20 15 and KCS 11 50 25.

3.3.17 Rock Banking

(1) In rock banking works, the available portion of the crushed aggregates within the entire amount of the rocks should be considered, and the remaining part may be used for rock banking.

(2) Rock banking may be applied to a depth below 600 mm from the roadbed finishing surface. The maximum size of rock balls should not exceed 600 mm.

(3) In rock banking, an appropriate material that may fill the pores should be selected, placed, and compacted.

(4) When rock banking is to be performed with another material on the construction part, compaction should be performed from the center of the constructed surface to the edges at an inclination of about 1:12 for smooth drainage.

(5) The thickness after the completion of compaction of the first rock banking layer should be less than 600 mm.

(6) In a banking area constructed only with rocks, large rock fragments should be uniformly distributed, and large and small fragments should be mixed well enough to sufficiently fill the pores.

(7) In the banking works with rock muck, the banking slope surface should be covered with a soil of a high quality in a thickness over 1m, with the exception of the part for stoneworks, to allow plant growth, and should be compacted.

(8) Rock banking should not be applied to the positions for piling, one-side cutting and

one-side banking parts, cutting-banking boundaries, and future building areas.

(9) Rock banking should not be applied to areas within 600 mm from the top of culverts, longitudinal and transverse sewer pipes and structures.

(10) If rock banking is performed on the roadbed finishing surface, the guard rail installation area should be subject to a thorough inspection of the roadbed surfaces, considering the installation of the pillars.

(11) In rock banking works, the rock banking materials should be uniformly placed, and rock balls larger than the standard should be crushed down to a size satisfying the standard. Large vibration compaction equipment is used for compaction to increase the compacting and rock crushing effects.

(12) In rock banking works, the compaction test should be performed according to KS F 2310 (Plate Bearing Testing). The bearing capacity coefficient (K30) should be equal to or higher than 196.1 MN/m^3 at a settlement of 1.25 mm. The loading plate used for the plate bearing test should have a diameter greater than the maximum size of the banking materials used in the banking work site. The bearing capacity coefficient should be normalized with respect to the standard loading plate size of 300 mm.

(13) Following the approval of the construction supervisor, the rock banking materials should be continuously paved in order to be flat. The particle-size distribution of the materials should be as uniform as possible, and the segregation of the materials should be minimized.

3.3.18FrozenSoil

(1) If the materials have been frozen or if the constructed surface has been frozen, the frozen parts should be removed before performing the banking works. If the constructed surface is covered with snow, banking works should not be performed before the snow has melted away.

3.3.19MixedMaterials

(1) Materials of different properties, such as clay, white clay, and sandy soil, supplied from different sources should be placed over the entire width of the road to form the layers one by one. However, if the construction supervisor finds it

advantageous, the materials may be mixed for banking.

3.3.20 Stability of Banking Work Areas

(1) The contractor is responsible for the stability of all the banking work parts. Except in the event of a natural disaster, any destruction or deformation of the banking works should be restored at the contractor's expense.

(2) When an inappropriate banking material has been placed, the material should be removed and an appropriate material should be placed again at the contractor's expense.

3.3.21 Protection of Banking Area (Subgrade)

(1) After the completion of banking works, the subgrade parts inspected and approved by the construction supervisor should be protected from damage and kept in good condition. However, when necessary due to a special reason, equipment or materials may be stacked or stored on the completed subgrade surfaces with the approval of the construction supervisor.

(2) If a completed subgrade surface has been damaged due to ignorance of the protection duties, the damage or deformation should be restored at the contractor's expense.

3.3.22 Scope of Compaction

(1) In banking works, the scope of compaction includes the driveways, road shoulders, and slope surface. Compaction should be performed uniformly until the compactness specified in 3.3.23 is reached.

(2) The subgrade in the cutting work area, transverse banking-cutting connections (one-side cutting and one-side banking parts), longitudinal banking-cutting connections (cutting-banking boundaries) should also be compacted uniformly until the compactness specified in 3.3.23 is reached.

3.3.23 Standard of Compaction

(1) Roadbed

The thickness of the banking roadbed parts after the completion of the first-layer compaction should be equal to or less than 300 mm. Each layer should be uniformly compacted until the density exceeds 90% of the maximum dry density

specified in Method A or Method B of KS F 2312. When a plate loading test is performed, the compaction should be performed as per Table 3.3-2.

(2) Subgrade

The thickness of the banking subgrade parts after the completion of the first-layer compaction should be equal to or less than 200 mm. Each layer should be uniformly compacted until the density reaches over 95% of the maximum dry density specified in Method C, Method D or Method E of KS F 2312. When a plate loading test is performed, the compaction should be performed according to Table 3.3-2.

Table 3.3-2 Standard of compaction

Item			roadbed		Subgrade	Note
			Rock banking	General banking		
Thickness after first-layer compaction (mm)			600	300	200	
Compactness (%)			-	Over 90	Over 95	KS F 2311 KS F 2312 ASSHTO. T 224-86
Compacting method			-	A, B	C, D, E	KS F 2312
Plate loading test	Asphalt pavement	Settlement (mm)	1.25	2.5	2.5	KS F 2310
		Bearing capacity coefficient {K30 : MN/m^3(kgf/cm^3)}	196.1(20)	147.1(15)	196.1(20)	
	Cement pavement	Settlement (mm)	1.25	1.25	1.25	KS F 2310
		Bearing capacity coefficient {K30 : MN/m^3(kgf/cm^3)}	196.1(20)	98.1(10)	147.1(15)	

3.3.24CompactionWorks

(1) Construction water content

① Soil compaction managed according to the standard density should be performed within the water content management range obtained from a compaction test.

② If the banking material is clay of a high water content, the soil should be frequently dried during the construction works to lower the water content.

(2) Compaction on the banking slope

The surface layers of banking slope should be uniformly compacted using a large compacting machine together with the main banking body through the following methods:

① In the slope surface compaction works performed manually or by using a small machine, the main banking body is constructed, and then compaction is performed using small compacting machines, such as vibration rammers, vibration plates, and vibration rollers, while adding soil to the slope surfaces.

② In the presence of a margin in the banking area width or an access road, compaction work may be performed in a width larger than the banking width, and then excavation and shaping may be performed later. Banking should be performed in a width larger than the banking width to fix the banking ends that are not sufficiently compacted.

(3) Finishing of rocky soil slope surfaces

In the finishing works for rocky soil slope surfaces, the rocks should be moved to stable positions and rammed sufficiently to prevent the rock from rolling down.

3.3.25 Protection of Structure During Compaction Works

(1) Banking works near to a structure should be performed with sufficient compaction so as not to cause damage or impose uneven pressure on the structure.

(2) Application of an excessive pressure to a structure where one-sided banking is performed should be avoided.

(3) For a culvert type structure requiring two-sided banking, the banking height of both sides should be kept the same.

(4) Banking works near to a structure should be performed by avoiding damage to the structure. After obtaining the approval of the construction supervisor, compaction should be performed using a small compacting machine.

(5) Each of the banking layers should be compacted so as to have an equal bearing capacity. If an electric compactor cannot be used due to the small area, compacting machines such as rammers and compactor should be used for compaction.

3.3.26 Finishing of Banking Works

(1) All the banking work surfaces should be neatly arranged in a manner consistent with the lines and slopes specified in the design drawings or as directed by the construction supervisor. The materials under the construction ground plane should not be relaxed. In addition, the slope shoulders of slope surfaces or both ends of slopes should be rounded.

(2) Rock fragments that are cracked by a blast and are still attached to the parent rock should be completely removed to avoid the damage or decrease of the functions of the finished surfaces or gutters.

(3) Green zones near to a building or general green zones should be inclined at an inclination of 1% to 2% toward a road or a drainage to prevent standing water after rainfall.

(4) The completed areas should be neatly arranged for inspection by the construction supervisor.

3.3.27 Preparation of Subgrade Surfaces

(1) The contractor should prepare the subgrade surface according to the design drawings, making the height and width equal to the transverse surface. The compactness of the individual finished layers should satisfy the quality standard before undergoing the inspection by the construction supervisor.

(2) The subgrade surface should be in parallel with the finished road surface. The height of the subgrade surface should not be more than 30 mm different from the planned height at any measurement points. The concave and convex should not be over 10 mm if inspected with a 3 m straight ruler.

(3) If the road surface is damaged by rainfall, has passed a winter, and has been left for more than 3 months after the final examination of the subgrade finishing surfaces and before the paving with an auxiliary ground plane material, the finishing compaction and inspection of the subgrade surfaces should be carried out again.

(4) If a stone filled drain has to be installed on the subgrade surface, the inspection of the subgrade finishing surface by the construction supervisor should be performed in the same manner as for the completely finished subgrade surfaces.

3.3.28 Proof Rolling

(1) The contractor should perform proof rolling with a tire roller or a 15 t-dump truck with full loading to allow the construction supervisor to inspect the entire finished subgrade surface.

(2) The dual wheel weight of the tire roller used in the proof rolling should be over 5 tons, and the ground contact pressure of the tires should be over 0.55 MPa.

(3)The deformation by proof rolling may be measured through the deformation testing method based on the Benkelman beam.

(4) In the proof rolling result, the subgrade surface deformation should not be over 5 mm.

(5) The contractor should allow a tire roller or a dump truck to run on the subgrade surface, and any visible deformation should be marked. In a position where there is insufficient compaction, the compaction work should be performed again. For a position with high water content, the water content should be adjusted, and then the compaction work should be performed again. For a position with poor material, a material of a good quality should be substituted, and the construction works should be performed again.

3.3.29 Slope Surface Leveling

(1) All the slope surfaces in the banking area, earth cutting areas, access roads, gutters, water ways, borrow pits, and spoil areas should be finished in accordance with the lines and inclinations specified in the design drawings.

(2) In laying turf or planting trees on the slope surface, stone balls or other waste materials having a maximum particle diameter of 60 mm should be removed.

3.3.30 Protection of Finished Surfaces

(1) The various drainage facilities installed in connection with the earth work areas should allow effective water draining and maintain their own functions.

(2) Materials should not be stacked on the finished subgrade surfaces. Stone debris or foreign materials should be completely removed. However, equipments or materials might be stacked or stored on the finished subgrade surfaces if the construction supervisor approves due to the special reasons.

(3) If materials are stacked on the finished subgrade surfaces after the inspection with the approval of the construction supervisor, the inspection should be performed again after removing the materials. The inspection of the final finished surfaces where materials need to be stacked should be performed after the materials completely removed, if possible.

(4) When the subgrade surfaces are unstable due to meteorological conditions, passage of vehicles and machines should be forbidden.

3.4 Allowable Construction Error

(1) The height of the finished surfaces should be within ± 12 mm from the specified height.

(2) The finished river bank slope surfaces should be within ± 150 mm from the specified slope lines, and should not invade the roadbed or subgrade.

(3) The water content of the banking materials should be within ± 2% during the placement works of the water content approved by the construction supervisor.

(4) The allowable construction error for slope surfaces should be within ± 30 mm from the construction ground plane.

(5) After compaction is completed on each banking layer, the next layer may be placed after the construction supervisor confirms through an inspection that the material quality and compactness satisfy the standard.

(6) If the on-site density test result shows that the density is not appropriate, the layer should be compacted repeatedly until the required density is obtained.

3.5 On-Site Quality Control

3.5.1 Quality Control

(1) An appropriate quality control plan should be prepared according to the requirements specified in KCS 10 10 15. The leveling of the foundation and bottom floor and the placement and compacting of the banking materials should be performed under the supervision of a soil and foundation engineer employed by the contractor and approved by the construction supervisor.

3.5.2TestConstructionWorks

(1) Before the compaction works, the contractor should submit a test construction work plan covering the compacting equipment, compacting method, and construction work management system. The compaction test should be performed in the presence of the construction supervisor.

(2) The compaction works included in the test construction work should be performed in the banking areas for roads or railways. The standard area is 400 m^3, but may be adjusted with the approval of the construction supervisor depending on the amount of banking works.

(3) If the soil quality found during the test construction works is significantly different from the actual site soil quality, re-test work may be additionally performed.

(4) Through the test construction works, the contractor should determine the soil leveling thickness, the compaction water content range, the number of times of compaction performed using each machine, and the compaction work management system, which should be confirmed by the construction supervisor and applied to the actual compaction work management.

3.5.3CompactionTest

(1) The contractor should receive confirmation from the construction supervisor regarding whether the material quality and compactness in each banking stage are in accordance with 3.3.23 before moving on to the works of the next stage.

(2) In cases where the banking is performed by impact compaction and thus the accurate water content-density curve and the maximum dry density may not be obtained, or where the density of a soil that is non-cohesive and that allows good water drainage should be determined, KS F 2345 should be applied. In these cases, confirmation from the construction supervisor is also required.

(3) In the testing of actual site compactness and water content, a radioactive isotope (RI)-based measurement instrument may be used. In such a case, the comparative test data measured at the actual site should be submitted to the construction supervisor along with the legal documents about the human resources and facilities in accordance with the Atomic Energy Act and the Radiation Exposure Management Work Regulations to acquire the confirmation of the construction supervisor before using the instrument.

(4) If the compactness is difficult to measure through the method specified in Table 3.3-2 due to the site conditions, a dynamic cone penetration test (DCPT) or a light falling weight deflectometer (LRWD) method may be applied to test the compactness of the subgrade. The test methods and judgment standard are found in the Integrated Road Pavement Guidelines (Ministry of Land, Infrastructure, and Transport).

(5) The method of testing the water content, required in the compactness test, is shown in KS F 2306. If a rapid water content test, an infrared moisture meter or an RI-based measurement instrument is used, the correction values of each of the testing methods should be confirmed by the construction supervisor.