

KCS 11 40 20 : 2019

# Subsurface Drainage

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KC CODE



국토교통부



# Foreword

- This standard was organized and integrated as the code by comparing and reviewing duplicate or contradictory content within the existing construction standards (design standards, standard specifications) due to the transition of the construction standards code system.
- This standard is established by integrating and organizing the parts that are related to reinforced concrete culverts in each standard based on the existing Road Construction Standard Specifications. The history of the standards are as follows:

Construction Standard	Main Content	Enacted or Revised (Year.Month)
Road Construction Standard Specifications	<ul style="list-style-type: none"><li>• Established by the Korean Society of Civil Engineers commissioned by the Ministry of Construction</li></ul>	Enacted (1967.12)
Road Construction Standard Specifications	<ul style="list-style-type: none"><li>• The specifications were improved and revised to become general specifications of overall road work by reviewing the related existing specifications and guidelines that were used and being developed.</li></ul>	Revised (1985.12)
Road Construction Standard Specifications	<ul style="list-style-type: none"><li>• The specifications were improved and revised to be better specifications by advancing and complying with the currently used specifications and guidelines, along with the introduction of new theories</li></ul>	Revised (1990.05)
Road Construction Standard Specifications	<ul style="list-style-type: none"><li>• The specifications were revised to enhance the international competitiveness and to promote quality improvements of road works by reorganizing the system to cope with the openness of the construction market as a result of the launch of the World Trade Organization (WTO)..</li></ul>	Revised (1996.07)
Road Construction Standard Specifications	<ul style="list-style-type: none"><li>• The specifications were re-organized to establish a system of national standards and to reflect the revision of contents and other standards, such as the Korean Industrial Standard (KS) and the Standard Specification of Concrete according to the Construction Standard Organization Guideline, and to improved and revise standards to address the problems.</li></ul>	Revised (2003.11)

Construction Standard	Main Content	Enacted or Revised (Year.Month)
Road Construction Standard Specifications	<ul style="list-style-type: none"> <li>The specifications were revised to improve the problems produced during the road construction and to induce reliable constructions through consistency with other standards such as the KS, Standard Specification of Concretes , and Standard Specifications of Tunnels, ensuring the prevention of shoddy and faulty construction thorough quality control.</li> </ul>	Revised (2009.03)
Road Construction Standard Specifications	<ul style="list-style-type: none"> <li>The specifications were revised to reflect the recommendations from the Central Construction Technology Deliberation Committee and changed the standard specifications, specialized specifications, and design drawings.</li> </ul>	Revised (2015.09)
Road Construction Standard Specifications	<ul style="list-style-type: none"> <li>Partial, revision including overview, forest and tree protection materials, and general construction works.</li> </ul>	Revised (2016.05)
KCS 11 40 20 : 2016	<ul style="list-style-type: none"> <li>Integrated and organized to accommodate the code system due to the transition to the code system of construction standards.</li> </ul>	Enacted (2016.06)
KCS 11 40 20 : 2018	<ul style="list-style-type: none"> <li>Modified to satisfy the Korean Industrial Standards and Construction Standards.</li> </ul>	Revised (2018.07)
KCS 11 40 20 : 2019	<ul style="list-style-type: none"> <li>Modified to satisfy the Korean Industrial Standards and Construction Standards.</li> </ul>	Revised (2019.11)

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## 1. Generals

### 1.1 Scope of Application

(1) This standard specifies overall items concerning subsurface drainage facilities.

### 1.2 Reference standards

#### 1.2.1 Related laws

No contents.

#### 1.2.2 Related standards

- KCS 10 10 10 Public administration requirements
- KCS 11 20 15 Excavation
- KCS 11 20 25 Refilling and backfill
- KCS 11 80 15 Wire cylinder retaining walls
- KS D 0201 Test method of hot dip galvanizing
- KS F 2322 Test method of soil's permeability
- KS M 3805 Polyvinyl chloride cut off plate
- KS F 4902 Asphalt roofing
- KS F 4409 Centrifugal perforated reinforced concrete pipes
- KS F 4403 einforced concrete pipes
- KS F 4405 Core type prestressed concrete pipes
- KS F 4911 Waterproofing sheets of synthetic polymer
- KS M ISO 527-1 Plastic – Measurement of tensile properties – Part 1: General principles
- KS M ISO 1183-3 Plastic – Density measurement of non-foaming plastic – Part 3: Gas pycnometer method
- KS M ISO 180 Plastic– Measurement of Izod impact strength
- KS M 3404 General purpose rigid polyvinylchloride pipe
- KS M 3409 Adhesives of rigid polyvinyl chloride pipe for water works service
- KS M 3802 PVC(vinyl)-based flooring materials
- KS K 0210 Test methods for quantitative analysis of fiber mixtures of textiles – Fiber mixture rate
- KS K ISO 5084 Textiles—Determination of thickness of textiles and textile products
- KS F 0514 Measuring method for weight of cloth: small specimen method
- KS K 0520 Textiles – Tensile properties of fabrics – Determination of maximum force and elongation at maximum force: using the grab method
- KS K ISO 13935-2 Textiles—Seam tensile properties of fabrics and made-up textile articles— Part 2: Determination of maximum force to seam rupture using the grab

method

- KS F 0706 Test method for weathering resistance of cloth: Accelerated weathering
- ASTM D 2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

### **1.3 Submission documents**

#### **1.3.1 Construction plan**

- (1) The contractor shall create a construction plan document after checking the site circumstances to meet the construction plan in accordance with KCS 10 10 10, and submit the construction plan document to the construction supervisor prior to the start of construction.

#### **1.3.2 Construction drawings**

- (1) The drawings required by the construction supervisor shall be created and submitted.
- (2) The dimension and layout of the pipes, high and low points of the pipe bottom, and gradient between nodes and intersection shall be specified.

#### **1.3.3 Product material**

- (1) The data of pipe products for drainage and accessories shall be submitted.
- (2) All physical properties of the materials and finished products shall comply with this standard.
- (3) The constructor shall submit the quality management plan document in relation to unique construction methods created based on certified data in Korea and other nations with regard to construction methods including all materials used in the construction, and obtain the approval of the document from the construction supervisor. Accordingly, materials and construction methods that are passed in the inspections and tests must be used.

### **1.4 Environmental requirements**

- (1) A drain facility that plays a role in the subsurface drainage function during construction and until the structure exhibits its original function, it is called a temporary drainage work, which shall be installed differently from permanent drainage work.



## 2. Materials

### 2.1 Materials

#### 2.1.1 Pipe materials and connector

- (1) The end of the pipe shall be joined with bell-and-spigot joint, groove joint, and lap joint to make the pipes to have a continuous linear shape by couplings, collars, or other connectors.
- (2) Earthen ware pipes,
  - ① For perforated earthen ware pipes, perforated drain pipes of continuous perforated drainpipe shall be used.
  - ② Joints and gaskets shall be products that are suitable to be used with perforated earthen ware pipes.
- (3) Concrete pipes
  - ① reinforced concrete pipes shall be products that comply with KS F 4403.
  - ② Core type prestressed concrete pipes shall be products that comply with KS F 4405.
  - ③ Centrifugal perforated concretes shall be products that comply with KS F 4409.
  - ④ Joints and gaskets shall be products that comply with pipe materials.
- (4) Plastic pipes
  - ① Pipes
    - A. Perforated PVC pipes shall be products that comply with KS M 3404, and the hole for all pipe dimensions shall be 10mm.
    - B. Non-perforated PVC pipes shall be products that comply with KS M 3404.
  - ② Cement adhesives that are suitable to act as the joint of PVC pipes shall be used.

#### 2.1.2 Accessories

- (1) For pipe adhesives, those of rigid polyvinyl chloride pipe that complies with KS M 3409 shall be used.
- (2) For joint cover, asphalt roofing felt that complies with KS F 4902 or 0.25 mm-thick polyethylene shall be used.
- (3) For filtration textile, permeable non-woven fabric shall be used.
- (4) For sleeves, rigid PVC pipes that are suitable for foundation walls shall be used.

#### 2.1.3 Backfilling materials

Backfilling materials shall comply with the following quality conditions.

- (1) Granular material (SB-1)
- (2) Maximum dimension: Below 100 mm
- (3) Percent passing through #4 sieve: 25% - 100%

- (4) Percent passing through #200 sieve: 15%
- (5) Plastic index (PI): below 6
- (6) Water immersion C.B.R of first density in the specification: 10 or higher
- (7) Sand equivalent: 15 or higher

#### 2.1.4 Drainage materials

- (1) The drainage and filter aggregates shall be permeable drainage and filter aggregates for the ditch filling and backfilling of the foundation and retaining walls, and clean and coarse gravels or crushed stones for the permeable bottom below, around, and above the subsurface drainage pipes. The grain size of drainage and filter aggregates shall satisfy the filter law considering the in-situ ground.
- (2) The asphalt-treated permeable base course shall be constructed according to the instruction of the supervisor.
- (3) The permeable drain material is a factory-produced plastic mixed panel designed to remove water pressure when applied to concrete foundations and retaining walls. It shall play a role in preventing soil from infiltrated the core by making protruding bumps or button shapes that forms drainage cores or water channels on the surface and attach the filter non-woven fabrics to the core to block the water flow. The drainage material shall be equipped with accessories for installation.
- (4) Soluble membrane sheet, which is an impermeable sheet, is a PVC material that complies with KS F 4911, and its thickness shall be more than 0.25 mm.
  - ① Adhesives shall be products of synthetic rubber that are not heated to be used for PVC or synthetic rubber membrane materials.
  - ② Tapes are Neoprene or vinyl rubber adhesive tapes that are sensitive to pressure, which are used in lap or joints of membrane sheets, shall have a width greater than 75 mm.

#### 2.1.5 Filtration materials

- (1) Granular materials
  - ① For granular materials, natural pebbles, grain refined pebbles, crushed stones, or recycled aggregates shall be employed. The size grading of granular materials shall satisfy the following conditions in principle. The size grading of granular material shall satisfy the following conditions in principle.
    - A. Conditions that filtration materials are not blocked by subgrade soils:
 
$$\frac{D_{15}(\text{Filtration material})}{D_{85}(\text{Subgrade})} < 5$$
    - B. Conditions that filtration materials have sufficient permeability compared to that of subgrade soils.
 
$$\frac{D_{15}(\text{Filtration material})}{D_{15}(\text{Subgrade})} > 5$$

C. D15 and D85 refer to grain sizes that correspond to 15% and 85% of passing percentage in the grain size accumulation curve.

② Materials around the perforated drain pipes

Conditions of the filtration materials around the perforated drain pipes of pipe-laying mole drainage:  $\frac{[D_{85}(\text{Filtration material})]}{[d]} > 2$

Here, refers to a diameter (mm) or joint gap (mm) of drainage hole in the perforated drain pipes.

(2) Geotextiles

① Geotextiles shall have optimal hole sizes that can ensure sufficient permeability and prevent the loss of soil particles as much as possible.

② The geotextiles as filtration materials shall satisfy the following conditions in principle.

A. Conditions that filtration materials are not blocked by subgrade soils:

$$\frac{[D_{10}(\text{Filtration material})]}{[D_{85}(\text{Subgrade})]} < 0.5 \sim 1.0$$

(Normal condition: 0.5, Poor condition: 1.0).

B. Conditions that filtration materials has sufficient permeability compared to that of subgrade soils:  $\frac{[K_g(\text{Filtration material})]}{[K_s(\text{Subgrade})]} > 10 \sim 100$

(Normal condition: 10, Poor condition: 100).

C. refers to the effective hole size of geotextile (set to 95% of passing grain size of the sample), and Ks and Kg refer to vertical permeability coefficients (cm/sec) of subgrade soil and geotextile respectively.

③ The quality standards of geotextiles (non-woven fabrics) are presented in Table 2.1-1.

Table 2.1-1 Quality standards of geotextiles(non-woven fabrics) for drainage

Category	Unit	Quality standards	Test method	Note
Material	-	Polyester, Polypropylene	KS K 0210	
Weatherability	%	More than 95% of tensile strength	KS K 0706 (exposed for 250 hours)	
Thickness	mm	1.8 or higher	KS K ISO 5804	
Tensile strength	kgf	45 or higher	KS K 0520 (Grab method)	
Ductility	%	50 or higher	KS K 0520 (Grab method)	
Permeability coefficient	cm/sec	$\alpha \times 10^{-1}$	KS F 2322	$\alpha$ : value from 1 to 9
Seam strength	kgf	More than tensile strength	KS K ISO 13935-2	
Weight	(gf/)	- Short fiber (300) or higher - Long fiber (200) or higher	KS K 0514	
Chemical resistance		-	KS M 3802	
Test frequency	/1 time	Every 20,000m <sup>2</sup>		

## (3) Other materials

- ① Other filtration materials may be used if the design drawings or the construction supervisor's instruction is given.

**2.1.6 Perforated drain pipe**

- (1) The perforated drain pipes used in subsurface drainage shall be products that have holes at every required spacing according to KS M 3404 or KS F 4409, It shall not allow sands to infiltrated well and allow for easy water collection at the pipe surface, or products that have the equivalent or better quality and function.
- (2) The quality standards of high-density polyethylene perforated drain pipes (PE, HDPE, THP pipes etc.) are presented in Table 2.1-1.

**Table 2.1-2 Quality standards of high-density polyethylene perforated drain pipes**

Category	Unit	Quality standards	Related test specification
Material	-	High density polystyrene (HDPE)	-
Specification	mm	D+5 (inner diameter)/100, 200, 300+5 (inner diameter)	-
Density	kN/	9.4 or higher	KS M ISO 1183-3
Tensile strength	MPa (kgf/)	25 or higher	KS M ISO 527-1
Impact strength	J/ (kgf·/)	120 or higher	KS M ISO 180
Pipe Stiffness	kPa (kgf·/)	350 or higher	ASTM D 2412
Hole size	mm	Below 5	-
Allowable strain	mm	Below 10	-

### 2.1.7 Bundle type pipe

- (1) Bundle type pipes are compression molding products of rigid reinforced vinyl (PVC). The quality standards and test methods are presented Table 2.1-3.
- (2) The products shall have good durability against expansion and resistance against acids and alk

**Table 2.1-3 Quality standards of bundle type pipes**

Category	Unit	Quality standards	Related test specification
Specification	mm	50 mm or thicker	-
Proportion	-	1.3 or higher	KS M ISO 1183-3
Tensile strength	MPa (kgf/cm <sup>2</sup> )	40 or higher (400 or higher)	KS M ISO 527-1
Elongation rate	%	120 or higher	KS M ISO 527-1
Impact strength	J/cm <sup>2</sup> (kgf-cm/cm <sup>2</sup> )	50 or higher (5 or higher)	KS M ISO 180

### 2.1.8 Wire cylinder

- (1) KCS 11 80 15 pertains to wire shape and dimension, and the sizes of filling stones used in wire cylinder drainage work.

### 2.1.9 Aggregates for culverts

- (1) The specifications shall follow the design drawings or specifications at the time of ordering.
- (2) Aggregates shall be clean, strong, and have no foreign substances.

### 2.1.10 Other materials

- (1) Other filtration materials may be used if the design drawings or the construction supervisor's instruction is given.

## 3. Construction

### 3.1 Construction standards

#### 3.1.1 General construction

- (1) Pipe-laying excavation shall be conducted with the same gradients and dimensions presented in the design drawings, and the excavated foundation bottom shall be compacted.
- (2) A perforated drain pipe is laid out in subsurface drains where the amount of gush-out water is large. Here, laying shall be done to direct the perforated portion downward, except for the last 3

m portion nearest to the non-perforated outlet. The joints of the pipes shall be completely coupled using proper connectors or bands.

- (3) The ends in the upstream side of all pipes shall be capped with a stopper to prevent the inflow of soil.
- (4) If there is water in the banking slope, a protective facility shall be provided after the installation of culvert.
- (5) If there is underground water in the slope surface, the bearing capacity is reduced due to the rise of pore water pressure or mud pumping occurred in the surface. Thus, subsurface drains shall be installed, and subsurface drains shall have a 0.15m drain layer from the subsurface drain pipes such as bundled concrete pipes and perforated drain pipes where filtration materials such as non-woven fabrics are attached.
- (6) For rock masses where the cut surface becomes a roadbed, a drain layer is unnecessary. However, for soft or vulnerable rocks where slacking or swelling is likely to occur, a drain layer shall be considered. If geotextiles are used, the drain ability and durability shall be fully taken into consideration.

### 3.1.2 Pipe-laying mole drainage

- (1) Pipe-laying excavation shall be conducted in accordance with the same gradients and dimensions presented in the design drawings, and the excavated foundation bottom shall be compacted.
- (2) Laying a perforated drain pipe shall be done to direct the perforated portion downward except for the last 3 m portion near the non-perforated outlet. The joints of the pipes shall be completely coupled using proper connectors or bands.
- (3) The perforated drain pipe shall be laid to have the bell-shape end located in the upstream side, It shall be wrapped with proper materials for water to be introduced or shall be a closed joint type, as specified.
- (4) Once the inspection on the perforated drain pipe laying is complete, granular materials shall be refilled up to the specified dimension. Here, care should be taken not to move the cover of the closed joint portion or perforated drain pipes.
- (5) For longitudinal mole drainage, perforated drain pipes are installed, and non-woven fabrics are not installed in the rock section (ripping rock, blasting rock).
- (6) When the water of mole drainage is received by a collecting well and processed in the longitudinal drainage pipe, care should be taken to locate the installation of collecting well for the prevention of water collected in the collecting well from backflowing.
- (7) If there is water in the banking slope, a protective facility of the slope shall be provided after the installation of the mole drainage.
- (8) A perforated drain pipe is not placed in the mole drainage installed in the lateral direction, and the mole drainage shall be installed at 60° angle from the center line of the road.

- (9) The building of mole drainage in the road must be complete prior to the start of pavement construction to prevent rainwater from being introduced to the inside of pavement layer.
- (10) If there is water in the cut section, mole drainage in the longitudinal and lateral directions shall provide a protective measure against slope loss after the installation.

### 3.1.3 Outlet

- (1) The outlet of subsurface drains shall be excavated using the length and width instructed by the construction supervisor or in the design drawings. It shall be installed inside the ditch using a proper method to firmly fasten the end of the pipe.
- (2) Refilling shall be done using the approved materials after the inspection on the pipe laying is completed by the construction supervisor.

### 3.1.4 Installation of bottom-mounted drain pipes

- (1) The bottom-mounted drain pipes shall be constructed as specified in the drawings, and the perforated drain pipe shall be wrapped by filter aggregates, and bottom-mounted drain pipes shall be covered by filter non-woven fabrics as specified. In the PVC pipes, vertical pipes and drip valve shall be placed including the specified accessories for installation.

### 3.1.5 Installation of permeable drain sheet

- (1) Pre-fabricated permeable drain sheets or mats shall be installed on the underground concrete walls as specified, and filter non-woven fabrics shall be wrapped around the outside of the panel.
- (2) Lap joint of the panel shall be overlapped in the water flow direction.
- (3) In the footing, drain sheets shall be connected to the subsurface drainage pipes, and the joint method shall be instructed by the construction supervisor.

### 3.1.6 Culvert construction

- (1) Aggregate laying for culverts
  - ① The perforated drain pipes shall not be moved when aggregates are laid.
  - ② The perforated drain pipes shall not be damaged during aggregate laying or sand laying.
  - ③ Much care should be taken during the construction not to mix the surrounding earth and sand while laying aggregates and sands.
- (2) Construction of perforated drain pipes
  - ① When main and branch lines of perforated drain pipes are installed, the ends of all pipes shall be capped with stoppers to prevent the inflow of soils.
  - ② All connecting portions of the geotextiles wrapped around the perforated drain pipes shall be at least 0.1m overlapped, and shall be tied with straps every 0.3m.

- ③ The processing at the top shall be done as early as possible after the geotextile laying is complete, and geotextiles that have not processed for more than seven days shall be taken out and processed.
  - ④ The gradient of the installation of the perforated drain pipes shall be 0.5% or steeper, and shall be laid straight except in unavoidable cases.
  - ⑤ Once the inspection on the perforated drain pipe laying is complete, granular materials shall be refilled. Here, care should be taken not to move the cover of the closed joint portion or perforated drain pipes.
- (3) General culvert construction
- ① When culvert water is received by a collecting well and processed in the horizontal drain work, care should be taken to locate the installation of collecting well for the prevention of water collected in the collecting well from backflowing into the culvert.
  - ② The culvert installation refers to burial of a perforated plate to exclude rainwater and underground water around the structures on the and upper side of the clear well. It includes all construction work required to install culverts such as earth work, the laying of perforated drain pipes, gravel, and mats. If it has to be changed unavoidably due to the site circumstance, it shall be approved by the construction supervisor.
  - ③ The culvert ditch shall be excavated according to the width and depth instructed in the design drawings.
  - ④ The granular materials shall be filled in the excavated ditch up to the depth indicated in the drawings.
  - ⑤ The extension joints shall be installed at the bottom plate, walls, and ceilings at 10m to 20 m spacing according to the culvert length, and they shall be equipped with waterstop functions and materials determined in KS M 3805 shall be used. The test frequency shall be conducted more than once per delivery of the extension joint.
  - ⑥ Backfilling shall be compacted until the required density is acquired, and the loose part in the rear slope that is contacts the backfilling shall be removed prior to the start of backfilling construction, thereby preventing the mix with backfilling materials.
  - ⑦ The form oil is coated in the form of the culvert so that dents or uneven scratches shall be avoided in the concrete surface during the removal of forms.

### 3.1.7 Construction of subsurface drains

- (1) The subsurface drain shall be excavated to have a length and width instructed by the design drawings or the construction supervisor and it shall be installed inside the ditch using a proper method to firmly fasten the end of the pipe.
- (2) Refilling shall be done using the approved materials after inspection on pipe laying is complete by the construction supervisor.
- (3) Section 3.1.6 (2) in this standard is referred to for general items about the construction of



perforated drain pipes for subsurface drain work.

### 3.1.8 Construction of subsurface drainage pipes

- (1) The ditch of the subsurface drainage pipes shall be excavated as specified in the drawings, and if no specifications are available, the width shall be 300mm greater than the outer diameter of the pipe, and 50 mm below the pipe from the inner bottom surface shall be excavated.
- (2) The impervious membrane sheet shall be laid on the compacted bottom surface, and the lap joint shall be more than 100 mm in width and 150 mm in length. All lap joints shall be sealed with adhesives and tape continuously. Rupture or bursting during the lap joint work shall be repaired.
- (3) The pipes shall be laid in accordance with the survey line and level. If the pipe is a bell-and-spigot type, the bell portion shall be in line with the furrow recessed into the ditch, and placed in the upstream direction of flow.
- (4) The space underneath the pipe's bottom surface shall be filled with one layer of aggregate for drainage as specified in the drawings. The perforated drain pipes shall be installed to direct the drains downward, and the end of the pipe shall be connected using a joint. In the joint, the sleeve coupling supplied by the pipe manufacturer shall be installed or can be done using other methods approved by the construction supervisor. For pipe assembly, suitable equipment shall be used.
- (5) Stones, bricks, or broken concretes or asphalt shall not be used to settle the pipe's middle portion, and large stones or large and hard objects that are in contact with the pipes shall be removed.
- (6) The ditch excavated to place the subsurface drain pipes shall be filled and compacted with drain or filter aggregate as specified to fill the void and prevent settlement. The drain pipes shall not be damaged.

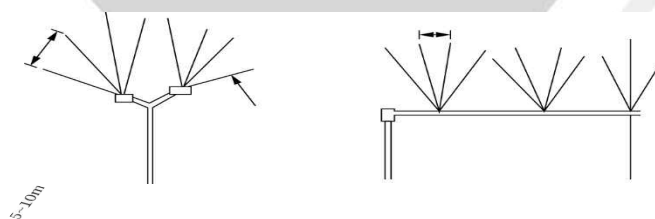
### 3.1.9 Construction of foundation drainage facility

- (1) The pipe shall be laid in line with the gradient specified in the detailed construction drawings, and the variation shall be within 3mm for a 3m-long pipe.
- (2) The pipe's end shall be butted loosely and put the center in the joint. Then, 300 mm-wide joint cover shall be attached around the pipe.
- (3) The filtration textile shall cover the filter aggregates that are evenly placed horizontally prior to refilling work.
- (4) The aggregates shall be filled and compacted into 100 mm thick layers.
- (5) The compaction shall follow KCS 11 20 15 and KCS 11 20 25, and no displacement or damage shall be done to the pipes during compaction.
- (6) The end of the perforated drain pipes shall be connected to the non-perforated drain pipes and then to the outlet.

### 3.1.10 Horizontal drain work

- (1) The horizontal drain work is applied to exclude underground water at the surface where the underground water level is relatively high or when the reduction in the underground water level is not expected due to subsurface drains.
- (2) The site investigation aims to determine the location of installation of horizontal drain work is conducted immediately after rainfall or during the rainy season to identify the location of water generation accurately, so that a 50 mm or larger inner diameter of perforated drain pipes or bundle type pipes are installed at the place where water is generated in consultation with the construction supervisor and the trend of changes in water generation is observed.
- (3) The site supervision and the construction supervisor may increase or decrease the amount of horizontal drain works depending on the water generation or the amount during cut slope work.
- (4) Generally, the applicability of horizontal drain work is degraded in slopes where slope stability is a problem, or an underground water problem does not occur. In contrast, the applicability is significant in regions where ground slip occurs, such as in landslide or collapses.
- (5) The construction length of horizontal drain work will be short as 2m to 5m if only water generation problems occur whereas it will be installed as deeper as 10m across when located in an expected slip surface in the upper part of the slope in sections where collapses are expected.
- (6) Generally, horizontal drain work is installed at regular spacing in regions where water flows out, but it may be more effective to install the drain work radially in some regions where water flows out.

**Figure 3.1-1 Layout of horizontal drain work**



- (7) The drain work transported to the site shall be stored in a place where foreign matter is not introduced to the inside of bundle pipes and perforated drain pipes while avoiding direct sunlight after wrapping it one turn of non-woven fabrics.
- (8) The damage of perforated drain pipes or bundled pipes and the inflow of foreign matter shall be prevented by wrapping the perforated drain pipes or bundled pipes with more than two turns of non-woven fabrics and tying it with steel wire or vinyl straps.
- (9) When installing the perforated drain pipes or bundled pipes, They are inserted carefully from the

borehole opening not to damage the bundled pipes.

- (10) To prevent the movement of perforated drain pipes or bundled pipes and protect them after installation is complete, a 0.5m or longer PVC pipe is inserted into the hole opening, and leakage between borehole and the PVC shall be minimized.
- (11) The used materials and structure shall be corrosion resistant and without rust.
- (12) For sections where a large amount of water is generated along a surface of discontinuity developed inside the rock mass, boring in consideration of the angle of the water along the surface of discontinuity may result in more effective drainage.
- (13) The boring shall be done by using rotation impact-type equipment that uses air in principle, and the most suitable equipment for the site circumstance shall be selected.
- (14) The installation angle of horizontal drain work is set from 5° to 100° considering the constructability, but if the water outflow angle is clearly identified, it can be adjusted according to the water outflow angle.
- (15) The boring length of the drain work is 0.1m deeper than the length of the drain pipe.
- (16) The boring diameter shall be 10mm larger than the diameter of the horizontal drain work.
- (17) Since blockage may occur due to the surface protection work as the surface exposure of the horizontal drain work is not constant, 5 cm or longer from the mounting surface shall be ensured for the surface exposure length of the horizontal drain work.
- (18) The protective cover is installed over the exposed drain work prior to the start of construction of surface protection, and the cover is removed after the completion of construction completion of the surface protection.
- (19) A permeable cover is installed for animals not to enter the drain pipes after construction completion.
- (20) For slopes where the loss of surface protection or scour is expected due to a large amount of water outflow, facilities that induce the surface protection to the lower or berm drainage facility shall be installed to prevent loss, or facilities that protect the surface such as wire cylinders or pitching shall be installed.
- (21) The protective measure to prevent freezing burst of PVC connecting pipes shall be established in sections where water outflow is strong in winter.
- (22) Other related standards may be referred to if the items related to horizontal drain work are not specified in this standard.

### **3.1.11 Construction of vertical drain work (collecting well)**

- (1) The inlet and outlet of the drain pipes at the time of installation of collecting well shall maintain the accurate gradient in line with the design level indicated in the drawings.
- (2) The drain pan shall be installed after verifying whether the location, structure, dimension, and connecting portion with the drain pipe are suitable to the drawings.

- (3) The cover and support frame shall be installed firmly without shaking along the design cross-section.
- (4) The contractor shall install steel grating by ensuring lateral horizontal degree of the steel grating, match between 계목부 of support frame and 계목부 of grating, leveling of the 계목부, evenness of grade and the road surface shall be maintained. In addition, noise generation in steel grating or damage to concrete in the support frame shall not occur due to the poor construction quality.
- (5) A connecting ring shall be installed at the collecting well and steel grating is used for theft prevention.
- (6) Steel grating, which will be used for cover material, shall be tested in accordance with KS D 0201.
- (7) For collecting wells, a ground whose geographical feature is concave shall be selected for installation.
- (8) For collecting wells installed at an area where the berm drain, and longitudinal drain are crossed in the slope, closed type covers are used, or collecting wells are constructed on higher ground to prevent water flow due to steep gradients from the longitudinal drain.

### 3.1.12 Construction of wire cylinder

- (1) Since wires are likely to be cut at regions where stones such as boulders roll down, the use of wire cylinder shall be decided carefully.
- (2) The wire cylinder shall be filled enough not to have any sizable spaces of surface wire.
- (3) The fill materials shall be large and small stones that are mixed properly to have a constant cross-section of wire cylinder, and voids shall be minimized.
- (4) If there is unavoidable spacing due a curved section construction, additional construction of short length wire cylinder shall be done as the difference in curbed length between upper and lower sections shall minimize the spacing of wire cylinder. The section whose gap is more than 50mm shall be filled with fill material for wire cylinder.
- (5) For the overview about wire cylinder construction, KCS 11 80 15 is referred to.

### 3.2 Quality management at the site

- (1) The contractor shall inspect and verify the construction status beforehand according to the inspection and verification document of construction status. Then, the inspection and verification document shall be submitted after obtaining a signature from the site agent. The contractor shall also have the approval of the construction supervisor after verifying whether the construction quality fits the standards in the presence of the construction supervisor.
- (2) The contractor shall take corrective action such as re-construction according to the instruction of the construction supervisor if the construction quality fails during inspection.
- (3) The contractor shall arrange the site cleanly after the completion of subsurface drain pipe

installation and aggregate laying, and residual materials, pieces of the perforated drain pipes, remaining non-woven fabrics, and other foreign substances shall be shipped out under the responsibility of the contractor.

