Korean Construction Specification

KCS 11 75 05 : 2019

Rockfall Prevention Net

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국토교통부

Foreword

- To address needs that were caused by changes in the construction standard code system, the overlaps and conflicts between existing construction standards (design standards, standard specification) were compared and reviewed and then integrated into a new document that can be maintained as a standard code.

- These standards were revised and enacted as standards by integrating the Construction Work Slope Surface Standard Specification and the corresponding parts of the Road Work Standard Specification. Major matters related to the enactment and revision of these standards are as follows:

Construction Standard	Major Contents	Enactment · Revision (Month, Year)
Construction Work Slope Surface Standard Specification	• Construction Work Slope Surface Design Standards enacted.	Enactment (May 2006)
Construction Work Slope Surface Standard Specification	• Construction Work Slope Surface Design Standards revised.	Revision (Dec 2011)
KCS 11 75 05 : 2016	• Integrated and maintained as a code according to changes in the construction standard code system.	Enactment (June 2016)
KCS 11 75 05 : 2016	• Revised to harmonize Korean Standards with Construction Standards.	Revision (July 2018)

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1. General Matters

1.1 Scope Application

(1) These standards are applied to the construction of installing rockfall prevention nets for preventing the falling of rocks from rock cutting slope.

1.2 Reference Standards

- KS D 3514 Wire ropes
- KS D 3503 Rolled steels for general structure
- KS D 3504 Steel bars for concrete reinforcement
- KS D 7018 Chain link wire netting
- KS D 7036 Polyvinyl chloride coated color steel wires
- KS B 1012 Hexagon nut and hexagon thin nuts
- ISO 4017B Bolt
- KS D 3552 Low carbon steel wires

1.3 Supplied Materials

Not applicable.

1.4 Definitions

Not applicable.

2. Materials

2.1 Materials

2.1.1 Wire Rope

(1) Wire rope shall satisfy KS D 3514. The rope shall have a diameter of over 16 mm, and the stranding block of the strand shall be the normal z-type for six strands (over $\phi 16 \times 6 \times 24$)

(2) The wire rope applied to the rockfall prevention net shall be Type G and Type A according to the classification based on the fracture load. Type G rope shall tolerate at least 117 kN if the rope diameter is 16 mm, and at least 183 kN if the rope diameter is 20 mm. Type A rope shall tolerate at least 126 kN if the rope diameter is 16 mm, and at least 197 kN if the rope diameter is 20 mm. The stranding diameter shall be 0.88 mm. The amount of zinc attachment shall be at least 85 gf/㎡ for Type G and 70 gf/㎡ for Type A.

2.1.2 Anchor Bolts and Nuts

(1) The anchor bolt shall satisfy ISO 4017B, and the nut KS B 1012.

(2) The material of the assembly block may be steel. The steel shall be SS400 among the types provided in KS D 3503. The tensile force between the assembly block and the wire rope shall be at least 24.44 kN (2,500 kgf).

2.1.3 Wire Net

(1) The wire net shall satisfy KS D 7036 and KS D 7018.

(2) The diameter of the core wire of the net shall be 3.2 mm to 4 mm, the diameter of the zinc-plated and PVC-coated core wire shall be 4 mm to 5 mm, and the mesh size shall be at least 50 mm × 50 mm.

(3) With reference to the SWMV-GS2 type, which is generally used in Korea, the amount of the zinc attachment shall be at least 30 gf/㎡ for a core wire diameter of 3.2 mm and at least 35 gf/㎡ for a core wire diameter of 4.0 mm.

(4) The PVC coated net shall be a wire net product coated with soft PVC (0.3 mm) satisfying KS D 3552 and shall satisfy V-G1 of KS D 7018.

2.1.4 Binding Wire

(1) The material for a binding wire shall have a strength equal to or higher than that of wire net.

2.1.5 Resin

(1) The resin that is used as a filler or head of rock anchor bolts shall have a bond strength that may sufficiently tolerate the rockfall load after being cured.

2.1.6 Pillar

(1) When an H-beam is used as a pillar, the SS400 type shall be used among the types provided in KS D 3503. The material shall have a tensile strength of 400 to 510 MPa, a yield strength of at least 245 MPa, and an elongation percentage of at least 17%.

(2) When a steel material is used as a pillar, the SS300 type shall be used among the types provided in KS D 3504. The material shall have a tensile strength of 441 to 598 MPa and a yield strength of at least 294 MPa.

2.2 Components

Not applicable.

2.3 Equipment

Not applicable.

2.4 Accessary Materials

Not applicable.

2.5 Mixing

Not applicable.

2.6 Assembly

Not applicable.

2.7 Finishing

Not applicable.

2.8 Allowable Assembly Error

Not applicable.

2.9 Material Quality Management

(1) When a rockfall prevention net is formed by using materials that are not used for a general rockfall prevention net, the used materials of each component shall have sufficient strength and allowable strain values in order to ensure sufficient performance of the rockfall prevention net. Individual materials shall be defined in accordance with the standards.

3. Construction

3.1 Verification of Construction Conditions

3.1.1 Items for Review Before Construction

(1) Verification of absorbable energy

Before construction, the rockfall energy shall be investigated in accordance with the scale of the rockfall (weight and shape of rockfall, falling height, inclination of slope surface, rock quality, conditions of slope surface, etc.) in order to install a rockfall prevention net that may safely absorb the rockfall energy. If the necessary absorbable energy is too high to prevent the rockfall using a standard type of rockfall prevention net, a high-energy absorption rockfall prevention net with a buffering block that may absorb

additional energy may be installed. When a rockfall prevention net of new specifications or a new shape is to be designed or installed, the maximum energy that may be absorbed by the new rockfall prevention net shall be evaluated.

(2) Material product data

① Product data and installation instructions provided by the manufacturer

② Statement of delivery and quality test report showing the materials and specifications of the used materials

(3) Detailed drawings for construction

① Floor plans and construction development drawings specifing the installation location, etc. of the rockfall prevention net

② Detailed drawings for pillar installation

(4) To ensure the quality of a rockfall prevention net, the contractor shall use the construction products whose suppliers have been approved in advance for each accessary material. If necessary, the contractor shall perform a test to verify the performance and submit the test report.

3.2 Work Preparation

Not applicable.

3.3 Construction Standards

3.3.1 General Matters of Construction

(1) When installing a rockfall prevention net, trees shall be cut down from the top of the slope to 1 or 2 m. The loose stones or highly relaxed rock bed on the cutting surface shall be firstly removed. Then, the rockfall prevention net shall be tightly attached to the rock bed and firmly installed.

(2) In the presence of a rockfall prevention fence at the bottom of the cutting surface, the level of the bottom of the rockfall prevention net shall be adjusted for installation. The level of the bottom of the rockfall prevention net shall be equal to the height of the rockfall prevention fence. In the absence of a rockfall prevention fence, the rockfall prevention net shall be separated from the ground surface by about 1 m.

(3) If the ground at the top of the rockfall prevention net consists of a soft rock, rockfall prevention net shall be fixed by using anchoring pins with a diameter of at least D25 and a length of at least 1.5 m at a point 2 m away from the end of the cutting work or at a point 5 m away from the end of the cutting work on a soft ground of soil or weathered rock. The filling material to the anchoring pin must be filled using a forceful method.

(4) A non-pocket type rockfall prevention net shall be fixed by applying anchoring pins to the cutting slope by using an anchoring apparatus at each intersection point. If anchoring pins may not function properly due to the poor rock quality or the presence of a fractured zone at the point of the cutting surface for the anchoring pin construction, the position of the anchoring pin shall be moved within about 1 m or the length of the anchoring pin shall be increased.

(5) The top and the left and right sides of a non-pocket type rockfall prevention net shall be fixed onto the cutting surface by using the main anchoring pins. As described above, the anchoring pins shall have a diameter of at least D25 and a length of at least 1.5 m.

(6) The left and right sides of a pocket-type rockfall prevention net shall be fixed by applying onto the cutting surface the main anchoring pins with a diameter of at least D25 and a length of at least 1.5 m. The connecting parts of the pocket rockfall prevention net, or at least one point within a certain area (less than about 60 m^2), shall be fixed by applying auxiliary anchoring pins with a diameter of at least D16 and a length of at least 0.5 m onto the cutting surface. In cases where the cutting surface is long and thus rockfall prevention nets are connected with each other, at least 0.5 m shall be overlapped, and the nets shall be connected across the entire length from the top to the bottom of the cutting surface by using a binding wire. Auxiliary anchoring pins shall be used to attach the nets onto the cutting surface.

(7) After examining the joints of the rock bed, the drilling depth and interval for anchor bolts shall be determined, and the anchor bolts shall be inserted to the drilled holes. Then, the resin for the head and the filling shall be injected. The subsequent works shall be performed after curing the injected resin for over 24 hours. The residual dust in the drilled holes shall be removed by blowing air in order to not hinder the attachment between the anchor bolts and the resin.

(8) After injecting the resin for the head and the filling, the anchor bolts shall be constructed to be integrated to the rock bed. Then, the assembly blocks and the wire rope shall be installed.

(9) The position and area of the rockfall prevention net installation shall be determined by consulting with the construction supervisor in advance in consideration of the site conditions.

(10) The rockfall energy shall be investigated in accordance with the scale of the rockfall (weight and shape of rockfall, falling height, inclination of slope surface, rock quality, conditions of slope surface, etc.) in order to install a rockfall prevention net with a structure that may safely absorb the rockfall energy.

(11) Safety education shall be provided and appropriate safety measures shall be taken

before the construction work is carried out.

3.3.2 Anchoring Pin

(1) Anchoring pins are classified as main anchoring pins and auxiliary anchoring pins. Main anchoring pins are used to anchor the top of the wire rope to the rock bed, and auxiliary anchoring pins are installed at the assembly blocks at the rope intersection points or at nearby points.

(2) The construction of anchoring pins are carried out by drilling holes with a diameter of about D35, which is greater than the diameter of the anchoring pins, inserting the anchoring pins, and injecting the filling material (usually mortar or epoxy). When mortar is used as the filling material, the cement:sand:water mixing ratio is 1:1:1.

(3) Main anchoring pins shall have a diameter of at least D25 and a length of 1.5 m, and auxiliary anchoring pins shall have a diameter of at least D16 and a length of 0.5 m. The anchoring pins applied at the top and the left and right sides of a cutting surface shall be inclined by about 15° from the right angle to the surface in the direction opposite to the force working on the wire rope.

3.3.3 Pillar

(1) When Pillars are installed at the inlet of the rockfall at the top of a pocket-type rockfall prevention net, the longitudinal rope shall be fixed to the top of the cutting surface, hanging the rope to the bottom. The pillars shall be chosen according to the scale of the expected rockfall. If the size of the rockfall is large, H-beams of the size of H150×75×5×7 mm having a height of at least 1.5 m shall be used. If the size of the rockfall is small, steel bars with a diameter of at least 25 mm and a length of at least 2 m shall be buried into the ground of the cutting surface to the depth of 1 m to be anchored. The bars shall be separated by more than 1 m on the ground surface.

(2) Pillars are connected with the rope hanging towards the bottom and the rope fixed with the reinforcing bars with a diameter of at least D22 and a length of at least 1.5 m at the points 2 to 3 m backward in order to support the rope structure in the cases of collision between the rockfall and the longitudinal rope. On the contrary, in the areas where a rockfall inlet is not necessary, the rockfall prevention net is attached to the cutting surface by using anchoring pins on the top of the ground surface. Auxiliary anchoring pins may be used for that purpose.

3.3.4 Binding Wire

(1) A binding wire is applied for binding at the points of net-net overlapping or net-wire rope overlapping. A binding wire of a material with a strength equal to or higher than

that of the net shall be bound at each mesh continuously at a length of at least 0.6 m so that the wire may not become loose. The length of the net-net overlapping shall be at least 0.5 m. The centers of the overlapped area shall be connected over the entire length from the top to the bottom.

(2) The points of net-wire rope overlapping shall be bound continuously at a length of at least 0.6 m at the middle points between an assembly block and another in the case of a non-pocket type rockfall prevention net. In the case of a pocket-type rockfall prevention net, individual meshes shall be uniformly bound in 20% of the span length along the wire ropes in both transverse and longitudinal directions.

3.3.5 Assembly Block

(1) Epoxy or other materials shall be injected into an assembly block to tighten up wire rope in the case of a pocket-type rockfall prevention net. A non-pocket type rockfall prevention net shall be anchored using an assembly block and an anchoring pin, and the tensile force between the assembly block and the wire rope shall be at least 24.44 kN.