

KCS 11 70 10 : 2019

Rock Bolts

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KC CODE



Foreword

- To address needs that were caused by changes in the construction standards 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 Temporary Construction Standard Specification, Tunnel Standard Specification, and Road Construction 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 70 10 : 2016	• Integrated and maintained as a code according to changes in the construction standard code system.	Enactment (June 2016)
KCS 11 70 10 : 2016	• Revised to harmonize Korean Standards with Construction Standards.	Revision (July 2018)



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1. General Matters

1.1 Scope of Application

(1) These standards are applied to construction works for reinforcing a slope surface using rock bolts.

1.2 Reference Standards

- KS D 3504 Steel bars for concrete reinforcement.
- KS F 2426 Testing method for compressive strength of mortar grouting.
- KS F 2432 Testing method for consistency of mortar grouting.
- KS L 5201 Portland cement.

1.3 Supplied Materials

Not applicable.

1.4 Definitions

Not applicable.

2. Materials

2.1 Materials

2.1.1 Rock Bolt

(1) Rock bolts may be used according to site conditions and construction conditions, such as deformed bars, steel pipes, expandable steel pipes, screw thread reinforcing bars, and screw thread steel bars. Rock bolts should be equipped with anchor plates, nuts and washers. Deformed bars should be at a grade higher than SD300 of KS D 3504, and the quality standard is shown in the table below.

Table 2.1-1 Rock bolt quality standard.

Diameter	Code	Yield strength (N/mm ²)	Tensile strength (N/mm ²)	Strain rate (%)	Note
Over D22 to D25 mm	SD300	Over 300	Over 440	Over 16	If the displacement is over 20mm, a product having a yield strength value of over 500N/mm ² should be used.

2.1.2 Cement Grout

- (1) When cement grout is used as the material for anchoring a rock bolt, the following rules from (2) to (6) shall be complied.
- (2) The cement used for grout injection shall be normally the portland cement or rapid hardening cement according to KS L 5201. When another type of cement is used, approval from the construction supervisor should be obtained.
- (3) The admixtures shall be used as specified in the design drawings. When another type of admixture is used, approval from the construction supervisor should be obtained.
- (4) The water used in grout shall not contain over 0.1% of any materials that negatively affect the tendon and rock bolt body, such as oils, acids, salts, and organic matters.
- (5) The grout shall be a material that is not reduced in volume and eroded, and that is chemically stable without organic matter. The grout shall be filled by way of gravitational force or by pressurization.
- (6) The 28-day compressive strength of the grout shall be tested in advance with the specimens obtained before tension and during construction. The standard strength should be satisfied even when a hardening accelerator has been used to decrease the curing period. The water-cement ratio (W/C) should be in accordance with the design drawings.

2.1.3 Resin Grout

- (1) When a resin grout is used as the material for anchoring a rock bolt, the following rules from (2) to (6) shall be complied.
- (2) A resin grout shall be of a polyester-based material or a higher material, and shall be provided in capsule form.
- (3) A resin grout shall not be used after the expired storage periods indicated by the manufacturer.
- (4) The resin grout shall not be affected by water, brine, acids, or weakly alkaline materials. A temperature condition above 50°C or below -30°C shall be avoided when storing and transporting the resin grout. The resin grout shall not be used if the color has been changed.
- (5) The pull-out resistance of a resin grout shall be 1.2 times greater than the strength of the rock bolt, and the adhesion shall be exerted early.
- (6) A general test shall be performed in the quality control of the site for the resin grout to confirm that the pull-out resistance is higher than the predetermined design value. However, a resin grout shall not be applied to a sandy area or a completely weathered rock area.

2.1.4 Anchor Plate

- (1) The anchor plate shall be a product capable of withstanding the designed area, thickness, and strength specified in the design drawings.
- (2) The anchor plate shall be able to adjust the angle to restrain the rock deformation and collapse, and to be adhere the rock or spray surface.

2.2 Components

Not applicable.

2.3 Equipment

2.3.1 Selection of Boring Equipment

- (1) The boring equipment shall be selected by considering the ground conditions, size, shape and length of the slope surface, excavation method, boring length, and the number of holes.
- (2) The equipment shall be capable of keeping the boring angle constant during perforation.
- (3) The equipment used for the inserting, anchoring, and tightening of rock bolts shall be adequate to the anchoring type of the rock bolts.

3. Construction

3.1 Verification of Construction Conditions

Not applicable.

3.2 Work Preparation

Not applicable.

3.3 Construction Standard

3.3.1 Boring and Cleaning

- (1) The boring shall be perforated in accordance with the predetermined location, diameter, and depth perpendicular to the boring surface. However, if the master joint surface has been found, the boring shall be performed perpendicular to the master joint surface. It is recommended that the boring interval of the rock bolts should not exceed three

times the joint interval.

- (2) Before inserting the rock bolt, the borehole shall be cleaned to remove any residual materials such as rock dust.
- (3) Before inserting the rock bolt, the borehole shall be kept clean by preventing the attachment of harmful rust or other impurities.

3.3.2 Grout Injection

- (1) The grout for a rock bolt shall be fluid and adhesive with early strength, and long-term stability.
- (2) A rock bolt shall be inserted to an unrelieved ground, and grout shall be injected to achieve the predetermined anchoring force.
- (3) For a fully grouted rock bolt, the gap between the borehole and the rock bolt shall be completely filled with the grout to exert the anchoring force satisfying the design standard.

3.3.3 Rock Bolt Tightening

- (1) A rock bolt shall be tightened with sufficient force to not exceed the yield strength.
- (2) A fully grouted rock bolt shall be tightened with nuts so that the anchoring plate is tightly attached to the rock slope surface.
- (3) For a point anchored rock bolt, an anchoring part shall be solidly formed to maintain the tension strength after applying a tension. In an area where the anchoring part may be loosened or the rock bolt may be corroded over time due to the ground conditions, the gap between the rock bolt and the ground shall be filled with a cement adhesive or mortar after applying the tension.
- (4) A pre-tensioned rock bolt shall be tightened again about one week after the first tightening. Even after that, the rock bolt should be regularly checked to verify whether the required tension is applied. If the rock bolt has been loosened, it should be tightened again.
- (6) The anchor plate exposed to the air shall be treated to prevent corrosion.

3.3.4 Rock Bolt Construction in Water Areas

- (1) When grouting of a rock bolt is difficult due to water, a hardening accelerator may be used or the application of an expandable rock bolt may be considered.

3.3.5 Rock Bolt Construction in Fracture Zones

- (1) When the inside of a hole is filled with mortar in a fault fractured zone, the leakage of mortar to the fracture zone shall be investigated.

(2) If there is a large amount of mortar leakage, grouting shall be performed repeatedly.

3.4 Allowable Construction Error

Not applicable.

3.5 Repair and Reconstruction

Not applicable.

3.6 Site Quality Control

3.6.1 Pulling Test

(1) The items shown in Table 3.6-1 shall be managed during and after the construction.

Table 3.6-1 Items of rock bolt quality control in the site.

Type	Management item	Management detail and relevant test	Testing frequency	Note
Routine management	Construction precision	Check if the construction has been performed according to the predetermined location, diameter, and depth	At each boring	Measurement of rock bolt
	Filling state	Check if the grout is solidly filled between the rock bolt and the original ground	At each placement	Checking by hammer hitting
	Anchoring effect	Check the anchoring effect after construction (Tightening with a torque wrench, etc.)	At each placement	Checking by hammer hitting
	Deformation	Observe deformation of the anchor plate	Frequently	Preparation of countermeasures based on site measurement results
Periodic management	Strength	Rock bolt pulling test		
Others	fluidity	Measure mortar fluidity	Whenever necessary	KS F 2432
	Strength	Test compressive strength of mortar		KS F 2426

(2) The rock bolts used for the pulling test are randomly selected from the test area, and the anchor plates of the selected rock bolts shall be treated with plaster or mortar to be perpendicular to the rock bolt axis.

- (3) The pulling test shall be performed after an anchoring effect satisfying the design standard has been achieved and the loading rate of the pulling load shall be about 10kN/min.
- (4) The displacement shall be measured in each loading step during the pulling test to prepare a load-displacement curve. Acceptability shall be judged by verifying if the measured displacement is within the range that allows the rock bolt to show the design effect.
- (5) A preliminary pulling test shall be performed with the same type of rock bolts as those used in the pulling test to measure the pulling resistance. In the actual pulling test with the constructed rock bolts, those showing over 80% of the design pulling resistance are accepted.
- (6) If a rock bolt fails to pass the pulling test, a new rock bolt shall be constructed around it.

