

KCS 11 75 20 : 2019

Rock Shed Tunnels

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KC CODE



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 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 75 20 : 2016	• Integrated and maintained as a code according to changes in the construction standard code system.	Enactment (June 2016)
KCS 11 75 20 : 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 the construction of rock shed tunnels made of RC, PC, steel, and mixed type to protect structures, such as roads and railways, and human life from rockfalls, landslides, and collapse of rock masses.

1.2 Reference Standards

- KDS 11 10 15 Earth cutting
- KCS 14 20 10 General concrete
- KS A 1513 Polystyrene foam for package cushioning
- KS D 3503 Rolled steels for general structures
- KS F 2402 Method of test for slump of concrete
- KS F 2312 Test method for soil compaction using a rammer
- KS F 2405 Standard test method for compressive strength of concrete

1.3 Transport, Storage, Handling

1.3.1 Mixing and Transport of Concrete

- (1) Concrete shall satisfy the concrete design conditions. The mixing ratio of the concrete shall be determined to have a workability that does not cause material separation and pores.
- (2) Concrete shall be placed as soon as possible after mixing. The time between mixing and the completion of the placement shall not exceed 1.5 hours for the air temperature greater than 25 °C or 2 hours for the air temperature less than 25 °C. However, when a retarder is used, the time limits may be adjusted after obtaining approval from the responsible engineer within a range not affecting the quality of the concrete.
- (3) Field mixing of concrete shall be determined with reference to the specified mixing conditions in consideration of the used materials, placement methods, and other factors.
- (4) The batch plant-mixed concrete shall be transported by a method not causing separation and loss of the materials and mixing of foreign materials. A transport vehicle equipped with an agitator shall be used for the transportation. When another transport method is applied, the appropriateness of the transport method shall be verified.

2. Materials

2.1 Materials

2.1.1 Concrete

- (1) The concrete materials shall satisfy the conditions specified in KCS 14 20 10.

2.1.2 Precast Concrete Members

- (1) The reference strength of the concrete shall be over 30 MPa in accordance with the design drawings or relevant specifications.
- (2) When high-performance and high-strength concrete is required, the pozzolan admixture shall be mixed at a ratio less than 10% of the cement weight together with an emulsifying agent.
- (3) The members shall be prepared according to the specified dimensions and shapes.

2.1.3 Steel Rock Shed Tunnel

- (1) The steel materials shall have a high ductility and a good processability in terms of bending and welding.
- (2) The reference steel material is SS400 specified in KS D 3503, and the steel materials shall be structural materials with performance equal to or higher than SS400.
- (3) The steel materials shall be prepared to have cross-sections and dimensions appropriate for the applied load and cover.
- (4) The number of connections of steel supports shall be determined by considering the placement and the constructability. The steel supports shall be prepared to have a minimum number of connections and to be firmly connected at points of structural advantage.

2.1.4 Buffer Materials

- (1) Waste tire is often used as the buffer material that relieves the impact of rockfalls on the roof of the rock shed tunnel. EPS may also be used.

2.1.5 Sand

- (1) The sand layer as a buffer material shall be loosely placed by hand.

Table 2.1-1 Quality standards for sand buffer.

Unit weight (MN/m ³)	Water content (%)	Invasion depth (mm)	Note
15.4	0.4	37	Placed by way of free falling from a height of 1.5 m
15.6	0.3	24	Leveled five times using a roller with 1.2 kN
15.7	1.1	21	Spraying 200 ℓ of water

2.1.6 Waste Tires

- (1) Light waste tires with high elasticity are used.

2.1.7 Expanded Polystyrene (EPS)

- (1) The EPS shall satisfy the standards specified in KS A 1513.

3. Construction

3.1 Work Preparation

- (1) Locations where the occurrence of rockfalls, landslides and collapse of rock masses are highly probable shall be identified by considering the geographical features.
- (2) Rock shed tunnels are classified as concrete rock shed tunnels (horseshoe-shaped, Rahmen-structured, etc.) and steel rock shed tunnels according to the materials and structures. The design shall be checked whether the design is appropriate to the site conditions.

3.2 Construction Standards

3.2.1 Cutting

- (1) Cutting works for construction of a rock shed tunnel shall satisfy the standards specified in KDS 11 10 15.

3.2.2 Foundation Ground

- (1) The foundation ground on which a rock shed tunnel is laid shall have a sufficient bearing capacity against the upper load including the load of the structure and the backfilling, and shall not cause excessive settlement.
- (2) A camber shall be placed on the bottom of the structure in expectation of differential settlement of the structure due to change in the thickness of the top cover. The size

of the camber shall be less than 1% of the total length of the structure.

3.2.3 Backfilling

- (1) Separate compaction work is not performed in the backfilling of a concrete rock shed tunnel. However, in the case of a steel rock shed tunnel, the thickness after the completion of first-layer compaction shall be less than 0.2 m. The density shall be at least 95% of the maximum dry density calculated by the C, D, or D method specified in KS F 2312 for every three layers or 50 m³.
- (2) During backfilling compaction work for a steel rock shed tunnel, the passage of heavy equipment, except compaction machine, shall be strictly restricted within 0.5 m from the steel materials and the steel walls. The side compaction machine shall be driven in parallel with the longitudinal direction of the structure. For the compaction of the upper part, the machine shall be driven perpendicularly to the longitudinal direction of the rock shed tunnel.

3.2.4 Construction of Concrete Rock Shed Tunnel

- (1) Placement of concrete shall be performed in a way that prevents the separation of materials and the formation of pores by filling uniformly.
- (2) The concrete shall be placed continuously with the specific amount of concrete corresponding to the length that does not allow cracking due to dry contraction, and a placement speed that does not cause the separation of materials shall be maintained.
- (3) Compaction shall be performed after the concrete placement using a vibrator.
- (4) When a shoot or a belt conveyor is used for concrete placement, the work shall be performed after receiving instructions from the construction supervisor.
- (5) Appropriate measures shall be employed not to deteriorate the concrete quality due to the spring water or flowing water.
- (6) The placed concrete shall be cured by maintaining the temperature and humidity required for curing.
- (7) Contractive joints shall be placed at appropriate intervals to prevent cracking caused by dry contraction of the concrete.
- (8) Construction works shall be carefully performed to minimize cracking of the concrete. The necessary measures shall be employed for sections where cracking is anticipated.
- (9) Expansion joints shall be placed if necessary due to the temperature difference between the inside and outside of the tunnel.

3.2.5 Drainage and Waterproofing

- (1) Appropriate drainage works shall be performed in order to prevent the surface water on

the top of the rock shed tunnel from flowing along the wall of the rock shed tunnel. Appropriate waterproofing materials shall be constructed on the external surfaces of the structure in contact with the soil.

- (2) Collector wells for smooth drainage shall be installed at the inlets and outlets of the rock shed tunnels in order to prevent the water from flowing into the pavement inside the tunnel during rainfall.

3.2.6 Construction of Precast Rock Shed Tunnel

- (1) The transport and installation of precast concrete members shall be performed carefully not to damage the members.
- (2) Precast concrete members shall be precisely set at their right positions for installation by using a lifting machine with a capacity larger than the weight of the concrete members.
- (3) Precast concrete members shall be placed to always maintain the right standing positions. The members shall be handled by a specified lifting device or cushion pads using a method that does not apply overload stress or damage to the members.
- (4) Precast concrete members shall be installed within the allowable construction error rate. The members shall be placed at the right positions to avoid the eccentricity effect, and shall be completely and uniformly attached to the supporting surface.
- (5) Welding and bolting for anchoring and connecting shall be performed as specified in the design drawings. Touch-up painting shall be performed on the on-site welded surfaces and abraded surfaces.
- (6) After the completion of the installation, the members shall be rightly aligned with the vertical and horizontal directions, the rectangular shape, and the lines. The angles and edges shall be parallel to the structural lines.
- (7) A noise prevention envelope shall be constructed as specified in the design drawings. The noise prevention envelope shall be compressed by more than 15% for tight attachment.
- (8) Fillers shall be installed at the right positions as specified in the design drawings.

3.2.7 Construction of Steel Rock Shed Tunnel

- (1) If the load delivered to the foundation of steel supports is large, bottom-reinforcing concrete supports that may provide sufficient bearing capacity shall be used.
- (2) If steel supports are difficult to be installed due to extrusion of the slope surface or the excavated surface, the extruding part shall be removed before the installation. For the stabilization of the cutting surface, concrete spraying shall be performed on the cutting surface before the construction of the steel rock shed tunnel.

- (3) If it is necessary to modify the constructed steel supports, it shall be performed in the unit of one set.

3.3 Site Quality Management

3.3.1 Quality Management of Concrete Rock Shed Tunnel

- (1) The thickness of the rock shed tunnel shall be controlled not to exceed the design thickness. The allowable construction error at a local point shall be the smaller one of 0.1 m and 1/3 of the design thickness.
- (2) The concrete strength shall be judged by performing strength tests at least three times. The 28-day strength shall be higher than the design strength. If the concrete strength fails to pass the first test, a re-test shall be performed at positions within 5m to the left and to the right. If the result of the re-test fails to satisfy the design strength, supplementary construction works, such as increasing the thickness, or re-construction shall be carried out.
- (3) The items shown in Table 3.3-1 shall be managed during or after the construction works.

Table 3.3-1 Items for concrete lining quality management.

Management items	Management details and tests	Testing frequency	Note
Construction accuracy; Thickness; Cracking and deformation	<ul style="list-style-type: none"> • Installation of steel reinforcements and forms at specified positions • Management of concrete lining thickness • Cracking and deformation conditions after concrete lining placement 	<ul style="list-style-type: none"> • Before construction • Before construction and immediately after construction • Frequently after construction 	
Slump test	Concrete slump value	Whenever necessary	KS F 2402
Compressive strength test	Concrete compressive strength		KS F 2405

3.3.2 Quality Management of Steel Rock Shed Tunnel

- (1) The items shown in Table 3.3-2 shall be managed during or after the construction of a steel rock shed tunnel.

Table 33-2 Items of on-site quality management for a steel rock shed tunnel

Management items	Management details and tests	Testing frequency
Shapes and dimensions	Check if the materials have been processed according to specified shapes and dimensions	Upon delivery
Deformation and damage	Check deformation and attachment of foreign materials, including rust	Before construction
Construction accuracy	Check specified positions, verticality, and height	Immediately after construction
Joint and connection conditions	Check construction conditions of joint bolts and connecting materials	Immediately after construction

