KCS 11 80 25 : 2019

Masonry (Block Masonry) Retaining Wall

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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 General Civil Engineering Construction Work Standard Specification, Waterwork Standard Specification, and Sewer Work Standard Specification. Major matters related to the enactment and revision of these standards are as follows.

Construction Standards	Major Contents	Enactment · Revision (Month, Year)
Construction Work Slope Design Standards	• Construction Work Slope Surface Design Standards enacted.	Enactment (May 2006)
Construction Work Slope Design Standards	• Construction Work Slope Surface Design Standards revised.	Revision (Dec 2011)
KCS 11 80 25 : 2016	• Integrated and maintained as a code according to changes in the construction standard code system.	Enactment (June 2016)
KCS 11 80 25 : 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 masonry and concrete block masonry retaining walls.

1.2 Reference Standards

1.2.1 Related Regulations

Not applicable.

1.2.2 Related Standards

- KS D 3504 Steel bars for concrete reinforcement
- KS F 2530 Stone materials
- KS F 2538 Specification for preformed expansion joint fillers for concrete paving and structural construction
- KS F 4002 Hollow concrete blocks
- KS L 5105 Testing method for compressive strength of hydraulic cement mortar
- KS L 5201 Portland cement
- KS L 9501 Industrial lime
- KS M 3401 Unplasticized poly(vinyl chloride) (PVC-U) pipes for water supply
- KS M 3404 Unplasticized poly(vinyl chloride) (PVC-U) pipes for general service
- KS F 2426 Standard test method for compressive strength of mortar grouting

1.3 Definitions

Not applicable.

1.4 Deliverables

1.4.1 Data Submission Requirements and Procedures

(1) The data submission and procedures shall satisfy the corresponding requirements.

1.4.2 Detailed Construction Work Drawings

(1) Detailed construction work drawings shall be submitted regarding block division, number of points of mortar and grout filling, and positions and methods of masonry joints and anchoring.

1.4.3 Product Data

(1) Product data from the manufacturers regarding special blocks, including change of color, shall be submitted.

1.4.4 Product Sample

(1) An actual-size sample of the special block shall be submitted and approved.

1.4.5 Letter of Confirmation

(1) A letter of confirmation written by the manufacturer shall be submitted, wherein the letter states that the concrete blocks satisfy the requirements of the specification as well as the strength requirements of the specification.

(2) The letter of confirmation shall be signed by the manufacturer, and shall include details such as the name of the manufacturer, the construction site, the quantity of blocks subject to the date when the letter of confirmation was issued.

1.4.6 General Requirements

(1) Unless otherwise specified in the current standards, concrete block masonry shall be in accordance with the contract drawings and the detailed construction work drawings.

(2) Allowable construction errors for concrete block masonry shall be established to limit the eccentricity of the applied load and load carrying capacity, and shall be based on structural functionality and not the outer appearance.

1.5 Transportation, Storage, Handling

1.5.1 Protective Measures

(1) Concrete pavements, walkways, curbs, base courses, and other facilities near to a construction site shall be protected with appropriate measures.

(2) Constructer shall be responsible for any damage caused by an employee or equipment, and shall provide necessary repair.

1.6 Environmental Requirements

(1) Concrete block masonry shall be constructed when the air is dry.

(2) A wet masonry shall be covered with a waterproof material and shall be firmly anchored after the work is completed or in the event of rainfall.

(3) In masonry (block masonry) work, the air temperature shall be maintained over 5℃ before, during, and for 48 hours after the masonry work. Masonry work shall not be performed if the air temperature is over 30℃.

(4) If masonry (block masonry) has to be performed unavoidably when the air temperature is below 5℃, the filling concrete and masonry joint mortar shall be protected from freezing, the materials shall be heated, and the completed parts shall be heat-insulated after obtaining approval from the construction supervisor.

(5) In summer, awnings and windbreakers shall be installed to prevent rapid evaporation of moisture from the bottom surface treatment work and the filling concrete, and then the masonry (block masonry) work shall be performed immediately to enhance the attachment of the masonry materials to the concrete.

2. Materials

2.1 Materials

2.1.1 Masonry Material

(1) Wedge stone

① The wedge stones shall have the necessary strength and durability, shall be without any surface cracks, and shall be unaffected by weathering and freezing.

② The shape of the surface shall be circular, flat, or of a slow convex. The back face area shall be least 1/16 of the front face area, and shall have a contacting part of at least 1/10 of the length between the front and back.

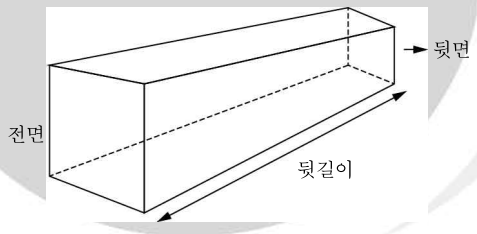

Figure 2.1-1 Basic shape of wedge stone.

(2) Crushed stone

① Crushed stones shall have the necessary strength and durability, shall be without any surface cracks, and shall be unaffected by weathering and freezing.

② The depth of the crushed stones shall be the same as the wedge stones. The length of the crushed stones is not limited.

(3) Boulders and fieldstones shall be unpolished natural stones of a relatively large size and their shape shall allow for transportation and banking.

(4) The backfilling rubble shall be rubble or pebbles that are hard and free of any deterioration, and shall include large and small stones with a diameter of 150 mm at

maximum in an appropriate particle diameter distribution.

(5) Concrete (foundation, backfilling, water sealant, top concrete)

① Concrete specifications: Compressive strength over 18 MPa at 28 days of curing, air percentage 4.5% ± 1.5%, slump 8 ㎝ ± 2.5 ㎝, and maximum coarse aggregate size as 40 mm

② Cement: Common portland cement specified in KS L 5201

③ Aggregates: Fine and coarse aggregates for concrete specified in KS F 2526

④ Water: Clean water

(6) Mortar

① The volumetric mixing ratio of portland cement to sand in the mortar shall be 1:3, and the compressive strength of the mortar shall be over 15 MPa at 28 days of curing.

② The use of a water-reducing agent to decrease the mortar mixing quantity is allowed if it is approved by the construction supervisor and the mortar strength is not decreased.

③ The quality standards of the sand are provided in KS F 2526, and the particle size shall satisfy the standards shown below.

Table 2.1-1 Particle size standards of sand used for masonry joint mortar.

Sieve opening	2.36 mm	1.18 mm	600 μm	300 μm	150 μm
Passing weight percentage (%)	100	70~100	35~80	15~45	2~10

(7) Cement

① The cement shall satisfy the specifications in KS L 5201.

② A superplasticizer may be added to the portland cement, but shallless than 12% of the total volume.

(8) Aggregates

① The fine aggregates used for the masonry mortar shall satisfy the specifications in KS F 2526.

② The aggregates for the grout shall satisfy the specifications in KS F 2526. The volumetric mixing ratio of the coarse aggregates with a maximum size of 10 mm to the fine aggregates shall be 1:1.5.

(9) Drainage pipes shall be those specified in KS M 3401 or KS M 3404 with a pipe diameter of 40 mm or those with better specifications.

2.1.2 Block Masonry Material

(1) Concrete blocks

① Concrete blocks shall be of the specified size and thickness, the combined beam blocks and edge blocks satisfying the specified shape and size, and the half-sized blocks specified or needed for a certain position.

② Hollow load-bearing concrete blocks shall satisfy the specifications in KS F 4002, and shall have a compressive strength over 16 MPa, a tensile strength over 1 MPa, a contraction ratio below 0.06%, and absorption ratio below 8%.

③ The concrete blocks shall have the standard faces and the normal color of cement. Concrete blocks which contains volcanic ash or matters which can disturb finishing paints are prohibitted.

(2) The surface painting material shall be a water-proof painting material that is transparent and that does not allow color fading and molding.

(3) Concrete blocks with surface fractures

① Concrete blocks with surface fractures which have the specified dimensions and thickness; and concrete blocks with surface fractures satisfying the specified dimensions and thickness and having special surface configuration.

② Concrete blocks with surface fractures of the color selected by the construction supervisor from the standard products of the manufacturer

(4) Precast beams and top and finishing blocks shall be precast concrete products of the shape specified in the design and shall satisfy the specifications in KCS 11 73 05 (2.1.2). The exposed surfaces shall be finished by sand-blasting to make the surfaces in accordant with the concrete blocks.

(5) The material standard of the mortar is the same as the mortar used for wet masonry.

(6) Grout

① Rough grout shall have a compressive strength of 14 MPa at 28 days of curing, and the volumetric ratio of the cement, fine aggregates, and coarse aggregates shall be 1:3:2.

② The grout mixed at the ratio designed by the manufacturer and handled by an approved grout pump shall have a slump of 25 cm.

③ The use of a water-reducing agent to decrease the grout mixing quantity is allowed if it is approved by the construction supervisor and the grout strength is not decreased.

④ The grout aggregates shall be the fine aggregates for concrete in accordance with KS F 2526 and shall have well-graded particle size distribution. The volumetric mixing ratio of the coarse aggregates with a maximum size of 1.0 mm to the fine aggregates shall be 1:1.5.

(7) The adhesive shall be polyvinyl acetate emulsion adhesive that attaches the mortar

bottom on the concrete slab. The adhesive shall be a manufactured product that permanently attaches the mortar bottom onto a wet or dry concrete slab, and shall have a pale color that allows to visually distinguish between the applied areas. The adhesive shall be dried within one hour when applied to concrete, and shall have flexibility and bond strength over 1 MPa when dried.

(8) The expansion joint material shall satisfy the specifications in KS F 2538.

(9) The contraction joint reinforcing material shall be a 3.76 ㎜ steel wire netting in the form of a ladder or a truss.

(10) The steel reinforcements shall satisfy the specifications of the deformed bars SD300 and SD400 specified in KS D 3504.

(11) The slaked lime shall satisfy the requirements specified in KS L 9501.

3. Construction

3.1 Verification of Construction Conditions

3.1.1 General Matters of Masonry (Block Masonry)

(1) Masonry (block masonry) work is applied if the inclination is steeper than 1:1, while stone (block) pitching work is applied if the inclination is less than that.

(2) The height limit is 7 m for a masonry (block masonry) retaining wall, 5 m for wet masonry work, and 3 m for dry masonry work.

3.1.2 Foundation Bearing Capacity

(1) The foundation bearing capacity of the masonry (block masonry) shall satisfy the standards required by the design. If the needed bearing capacity may not be obtained after trenching, the design shall be changed by implementing counteractions such as substituting the foundation or changing the foundation type.

3.1.3 Bottom Surface of Trenching

(1) If the bottom surface of trenching work is long and has different depths, the bottom surface shall be constructed as steps, and shall be inspected by the construction inspector before starting the masonry work.

3.2 Construction Standards

3.2.1 Preliminary Survey

(1) Materials that have been affected by ice or frost or that have been frozen shall not be used.
(2) The appropriateness of the bottom of the masonry work shall be checked before starting the construction work.
(3) The installation position, inclination, height, and others shall be checked by referring to the construction work drawings.

3.2.2 Work Plan

(1) In masonry work, the trenching work shall be performed only in the workable area by considering material supply conditions, labor and equipment supply plans, quantity of one-day masonry work, meteorological conditions, and timing of refilling work. The next work shall be carried out after all the trenching works have been completed.

3.2.3 Batter Board Installation

(1) Since the front inclination is different from the back inclination in wet masonry work, batter boards to examine the inclination shall be installed at both the front and back faces, and shall be inspected by the construction supervisor. The leading string shall be installed to be tight in order to maintain the level.
(2) The standard spacing of batter board installation is 10 m. However, the batter boards shall be installed at the starting points, end points, and the points where the planes and cross-sections change.

3.2.4 General Matters of Masonry

(1) Masonry work shall be perpendicular at the front face, and shall not be constructed using a masonry method that reduces the strength. Stacking shall be performed from the bottom surface to a consistent heigth. Stacking shall be performed between joints if there are expansion joints. In the absence of expansion joints, stacking shall be performed consequently, and the height shall not be significantly different between different stacked areas.
(2) The stone edges of wedge stones and crushed stones layers shall be modified at each layer, and hammer trimming shall be performed if necessary. Rubble and field-stones shall be trimmed using a trimming hammer for stable attachment.
(3) The base stones shall be as large as possible and fixed to the leading frame. The stones shall be trimmed to be tightly attached to the adjacent stones. Backfilling shall be performed to fill the cracks with fine gravel.
(4) Wedge stone and crushed stone masonry shall basically be performed by way of uncoursed masonry. The gap between the contacting parts shall be within 10 mm in

dry masonry work. The stones shall be made to be in contact with each other using a hammer, and shall be supported by pebbles for backfilling. The gaps shall be filled with filling gravel.

(5) Masonry work of fieldstones, boulders, and pebbles shall all be performed by way of header bond.

(6) Masonry work shall not be performed at a temperature below zero or in water.

3.2.5 Wet Masonry

(1) Wet masonry work of crushed stones shall basically be performed as uncoursed masonry. The base stones shall be large stones, trimmed into a pentagonal shape by breaking two edges, and tightly attached to the adjacent stones.

(2) The stones for wet masonry work shall be cleansed of dust or impurities, and shall be sufficiently wetted before being used.

(3) In wet masonry work, the stone edges shall be aligned along the front surface, and the stacked stones shall be anchored using supporting stones. The stone gaps shall be filled with concrete sufficiently to the stone edges on the front surface, and then compacted.

(4) When the following concrete is placed more than six hours after the previous concrete layer placing, mortar shall be firstly placed as a thin layer on the top of the former concrete layer before placing the next concrete.

(5) Construction height of wet masonry work for one day shall not exceed 1.2 m.

(6) The top concrete shall be integrated with the backfilling concrete.

(7) The expansion joints shall be installed at a spacing of about 20 m according to the design drawings or the instructions given by the construction supervisor.

(8) Unless otherwise specified, weep holes shall be installed at a ratio of one per 2 m^2. Additional weep holes may be installed according to the decision made by the construction supervisor or an executive engineer in the field of ground.

(9) Masonry mortar for the front surface shall be applied after wetting the joint parts sufficiently.

(10) Immediately after the construction works, the surfaces of the wet masonry work and the filling concrete shall be covered with straw bags and sprayed with a sufficient amount of water to maintain the wetness for over 10 hours. No hazardous vibration or impact shall be applied until the mortar or concrete is cured.

3.2.6 Dry Masonry

(1) Dry masonry work shall basically be performed as linear embanking practice. The height of dry masonry work for one day shall not exceed 1 m.

(2) In dry masonry work, the width of the stone edges shall be adjusted by using a trimming hammer to between 50 ㎜ and 100 ㎜ for wedge stones, and between 30 ㎜ and 60 ㎜ for crushed stones. The stones shall be anchored using supporting stones, and the gaps shall be filled with backfilling stones.

(3) The front masonry joints of dry masonry work shall be alternated.

3.2.7 Block Masonry

(1) Common matters

① Concrete blocks shall be constructed according to the specified dimensions, and shall be dried before stacking.

② The use of blocks smaller than a half-sized block shall be avoided at the parts where the finished surface is exposed. The hollow space shall never be exposed to the air.

③ At parts where the finishing surface is not exposed, concrete bricks or mortar may be used to fill the spaces that do not allow the stacking of whole-sized blocks or half-sized blocks.

(2) Work quality

① Block masonry work shall be performed by a skilled and experienced masonry worker.

② The wall shall be vertical and linearlly straight. The stacking layers shall be horizontal, and the width of all the masonry joints shall be uniform. The specified mortar shall be used. The vertical masonry joints shall be vertically aligned on all the exposed walls.

③ The concrete blocks shall be solid and have no cracks or surface defects. The blocks shall be carefully handled to avoid rupture or damage. When using a special shaped block, it shall not be a cutted shallblock.

④ When a steel beam or a joist is included in the frame inside block masonry work, the space shall be filled with mortar. The space around a steel material shall be finished by properly placing mortar and making it as a plane integrated to the block surface.

(3) Block cutting

① Blocks shall be accurately cut using a powered stone saw.

② The cutting surface shall be polished to be smooth and uniform.

(4) Bottom fill-up and masonry joint finishing

① The mortar shall be mixed for at least three minutes by adding water to a batch mixer.

② The mortar shall be used within 60 minutes after mixing if the external air

temperature is over 25℃, and within 90 minutes after mixing if the external air temperature is below 25℃.

③ Before block masonry work, the concrete foundation or the top surfaces of the floor masonry joints shall be roughly trimmed and cleaned so that the aggregates may be exposed.

(5) Drainage grooves

① In various pipeline works, subsequent work shall not be initiated before obtaining approval from the construction supervisor.

② The grooves and concave spaces shall be made vertical, and the internal masonry joints shall be made flat. There shall be no obstacles in the inside.

③ When the pipeline works are completed, the detached mortar and debris shall be removed.

(6) Anchored material and buried material

① In block masonry work, various anchored materials, attached materials, and buried materials shall be accurately installed at the right positions. Duplication of works in tearing and repairing shall be prevented in consultation with other preceding works.

② All the holes through which an anchored material or a buried material is inserted shall be filled with grout.

③ In cases where blocks are stacked in contact with concrete or a metallic material, the masonry joints between individual layers shall be filled with mortar.

(7) Masonry joint finishing

① Masonry joints shall be tightly filled with mortar.

② Exposed masonry joints shall be densely trimmed to be concave. The mortar shall be smoothly trimmed by using a masonry joint finishing tool when the mortar is cured in order to avoid hand prints.

③ Unless otherwise specified in the construction specification, the thickness of the masonry joints in the horizontal and vertical directions shall be 10 mm.

④ The masonry joints near a steel frame of an opening part shall be raked out at a depth of 20 mm in order to insert the filler.

(8) Joining construction

① Before starting or resuming joining work, loose mortar and foreign materials shall be removed from the existing facility, and the joining surfaces shall be completely cleaned.

(9) Precast beam and top and finishing blocks

① The precast members shall be installed at the positions specified in the design drawings.

(10) Steel reinforcement

① Steel reinforcements shall be installed as specified in the design drawings.

② Vertical steel reinforcements shall be installed before stacking the walls, and shall be anchored at the right positions using standard steel reinforcement supports.

③ If the connecting steel bars of the foundation are not parallel to the vertically algined hollow spaces of blocks, the inclination shall not exceed 6:1. All the hollow spaces where the foundation steel bars are inserted shall be filled with grout.

(11) Grouting

① Grouting requirements

A. The hollow spaces of the concrete blocks shall be filled with grout at the positions specified in the design drawings. The hollow spaces of the concrete blocks with the inserted steel reinforcements, anchored materials, or buried materials shall be filled with grout.

B. The space around steel frames and other buried materials shall be filled with grout or mortar.

C. The steel reinforcements anchored at the right positions shall be inspected and approved before placing grout.

D. Detached mortar and protruding mortar shall be removed from the grout space. The mortar detached from the boards and steel reinforcements shall be removed before placing grout.

E. The grout shall be leveled and mixed using a rod, or compacted by vibration at the right positions.

F. The hollow spaces shall be filled with grout. The placement of the grout shall be stopped at the depth of 50 mm from the top of the blocks in order to make grooves at the masonry joints of the individual layers.

② Grout construction work

A. The grout shall be placed using a method approved by the construction supervisor.

B. The grout may be placed by either a low pressure-lift method or a high pressure-lift method. When the high pressure-lift method is employed for grouting, such shall be noticed to the construction supervisor at least 48 hours before the grouting, and the work shall be performed under continuous inspection.

③ In low pressure-lift grouting of hollow block masonry work, the grouting may be performed up to the height of the structure or at a lift smaller than 1.2 m.

④ High pressure-lift grouting

A. In hollow block masonry work, cleaning holes shall be placed on the bottom surface of all the hollow parts to which vertical steel reinforcements have been

inserted. The cleaning holes shall not be obstructed until the cleaning state is inspected and approved by the construction supervisor.

B. A form shall be installed at an edge or an end of an opening to support or anchor the grout in order to tolerate the injecting pressure.

C. The mortar protruding out of the grout space or detached from the steel reinforcements shall be washed off using a hose with a high-pressure jet.

D. The grout shall be placed with at least one hour of waiting time between individual stages, and the height of the construction work shall not exceed 1.2 m. The grouting circulation shall not be stopped until the entire height of the walls or block masonry works is completely filled.

(12) After the completion of the work, the block masonry surfaces shall be carefully inspected. Broken or defected blocks shall be cut off and replaced with new ones. Defected mortar masonry joints shall be raked out and placed again.

(13) Curing

① The top of block masonry work and grout placement work shall be wet-cured for at least seven days.

② The stacked wall surfaces shall be sprayed with water, but shall not be wetted until the water may flow on the surfaces.

(14) Refilling

① The back surfaces of masonry work and block masonry work shall be refilled in accordance with the stacking work progress, and then refilled with soil for each layer. Refilling work shall not be performed at once by way of high banking work.

② In the refilling work, the refilling materials shall not be mixed with the backfilling materials.

③ The refilling work shall be carefully performed in order to avoid damage to the structure due to the movement of a machine or the eccentric load.

3.3 Site Quality Management

3.3.1 Masonry Quality Management

(1) The items and methods of the quality tests for the materials used in masonry works are shown below.

Table 3.3-1 Items of quality testing of masonry materials.

Subject	Testing item	Testing method	Testing frequency	Notes
Wedge stones Crushed stones	Specific gravity test Absorption ratio test Compressive strength test	KS F 2530	1) For each aggregate source 2) At each change of materials	

3.3.2 Concrete Block Masonry Quality Management

(1) Slump test

A slump test shall be performed during grouting work in accordance with the corresponding specifications.

(2) Concrete blocks

Tests on the compressive strength, water content, and tensile strength shall be performed by sampling three blocks per 200 ㎡ of a wall surface.

(3) Mortar

A compressive strength test shall be performed according to KS L 5105. Four specimens shall be prepared per 100 ㎡ of a wall surface, and one shall be tested at Day 7 of curing, while the remaining three shall be tested at Day 28 of curing.

(4) Grout

A compressive strength test shall be performed according to KS F 2426. Three rectangular specimens shall be tested per 100 ㎡ of a wall surface.

3.4 Site Arrangement

3.4.1 Cleaning

(1) After the installation and masonry joint placement are completed, the blocks shall be completely cleaned. Mortar deposits, dirt, or other impurities on the mortar of the block surfaces shall be completely eliminated.

(2) After grouting for block masonry work is completed, laitance appearing on the blocks and mortars masonry joints as well as the dirt shall be washed off with water.

3.5 Management of Completed Work

3.5.1 Inspection of Structure

(1) The completed concrete block construction work shall be inspected to see if the allowable dimension errors, appearance, and strength provided in the current specification are satisfied.