097.13 DPWH 09-01-2007



REPUBLIC OF THE PHILIPPINES DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS OFFICE OF THE SECRETARY MANILA

SEP 0 4 2007

DEPARTMENT ORDER) No. 50) Series of 2007, 9, 01 27) X-X-X-X-X-X-X-X-X-X

SUBJECT:

DPWH Standard Specifications For Mechanically-Stabilized Earth (MSE) retaining walls, Item 515

In line with the mandate of the Department to provide effective standard specifications to be used in the implementation of various infrastructure projects and in view of the need of setting standard specifications for mechanically-stabilized earth retaining walls, the attached **DPWH Standard Specifications for Mechanically-Stabilized Earth (MSE) retaining walls, Item 515,** are hereby prescribed, for the guidance and compliance of all concerned.

These specifications shall form part of the revised edition of the DPWH Standard Specifications (Volume II – Highways, Bridges and Airports).

This Order shall take effect immediately.

HERMOGE JR. Secretary



DEPARTMENT ORDER NO. <u>50</u> SERIES OF 2007 ANNEX PAGE 1 OF 11

DPWH STANDARD SPECIFICATION FOR ITEM 515 – MECHANICALLY-STABILIZED EARTH (MSE) RETAINING WALLS

515.1 Description

This item shall consist of furnishing materials and placement of Mechanically-Stabilized Earth (MSE) retaining walls constructed in accordance with these specifications and in reasonably close conformity to the lines, grades, design and dimensions shown on the Plans.

The Mechanically-Stabilized Earth (MSE) retaining wall shall consist of a nonstructural leveling pad, facing panels, and soil reinforcement elements mechanically connected to each facing panel. Soil reinforcement shall have sufficient length, strength, and frictional resistance as required by the design.

515.2 Material Requirements

515.2.1 Concrete Leveling Pad

Concrete leveling pad shall be Class A as specified in Item 405, Structural Concrete, unless otherwise specified or required by the Engineer.

515.2.2 Geotextile

Geotextile shall be as specified in Item 715,Geotextiles, unless otherwise specified or required by the Engineer.

515.2.3 Mechanically-Stabilized Earth (MSE) retaining wall material

Mechanically-Stabilized Earth (MSE) retaining wall materials shall conform to the following, unless otherwise specified in the Contract.

515.2.3.1 Concrete face panels

Concrete shall conform to Item 405, Structural Concrete, unless otherwise specified or required by the Engineer.

Reinforcing steel bars shall be as specified in Item 404, Reinforcing Steel, unless otherwise specified or required by the Engineer.

Concrete shall have a minimum compressive strength of 30 MPa at 28 days.

Concrete panels shall be fully supported until the concrete has reached a minimum compressive strength of 7 MPa. The concrete panels shall be shipped and installed after the concrete has reached a minimum compressive strength of 24 MPa.

DEPARTMENT ORDER NO. 5⁰ SERIES OF 2007 ANNEX PAGE 2 OF 11

Concrete facing panels shall have a minimum thickness of 140 mm and a minimum concrete cover on reinforcing steel of 37.5 mm.

The panels shall be cast face down in level forms supported on a flat working surface. Guides shall be used to locate and support attachment devices set in the back face of the panel. The concrete in each panel unit shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corners of the forms and to prevent the formation of stone pockets or cleavage planes. Clear form oil or release agent shall be used throughout the casting operation.

The rear face of the panel shall be screed to eliminate open pockets of aggregate and surface distortions in excess of 6 millimeters. The panels shall be casted on a flat area. Galvanized connecting devices or fasteners shall not be attached to the face panel steel reinforcement.

The production lot number, date of manufacture and the piece mark shall be clearly inscribed on an unexposed face of each panel the.

All units shall be handled, stored, and shipped in such a manner as to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels in storage shall be supported on firm wooden blocking to protect the panel connection devices and the exposed exterior finish.

Concrete panels shall be manufactured within the following tolerances:

- (a) Panel dimensions. Position of panel connection devices shall be within 25 millimeters. All other dimensions within 5 millimeters.
- (b) Panel squareness. Squareness, as determined by the difference between the 2 diagonals, shall not exceed 13 millimeters.
- (c) Panel surface finish. Surface defects on smooth formed surfaces 1.5 meters or more in length shall not exceed 3 millimeters. Surface defects on texturedfinished surfaces 1.5 meters or more in length shall not exceed 8 millimeters.

Concrete face panels having any or all of the following defects shall be rejected.

- (a) Defects that indicate imperfect molding.
- (b) Defects indicating honeycombed or open texture concrete.
- (c) Cracked or severely chipped panels.
- (d) Color variation on front face of panel due to excess form oil or other reasons.

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DEPARTMENT ORDER NO. <u>P</u>SERIES OF 2007 ANNEX PAGE 3 OF 11

515.2.3.2 Wire Facing

Wire facing shall be fabricated welded wire fabric conforming to AASHTO M 55M, except that section 7.4 applies for all longitudinal and transverse wire sizes. After fabrication wire fabric shall be galvanized according to AASHTO M 111M.

515.2.3.3 Gabions

Gabions shall conform to Item 515, Gabions and Mattresses, unless otherwise specified or required by the Engineer.

515.2.3.4 Backing Mat

Backing mat shall be fabricated welded wire fabric conforming to AASHTO M 55M, except that section 7.4 applies for all longitudinal and transverse wire sizes. After fabrication wire fabric shall be galvanized according to AASHTO M 111M.

515.2.3.5 Clevis Connector

Clevis connector shall be fabricated from cold-drawn steel wire conforming to AASHTO M 32M, and weld according to AASHTO M 55M. After fabrication clevis connector shall be galvanized according to AASHTO M 111M.

515.2.3.6 Connector Bars

Connector bars shall be fabricated from cold-drawn steel wire conforming to AASHTO M 32M and shall be galvanized according to AASHTO M 111M.

515.2.3.7 Fasteners

Fasteners shall be made of 13-millimeter diameter, heavy hexhead bolts, nuts, and washers conforming to AASHTO M 164M and shall be galvanized according to AASHTO M 232.

515.2.3.8 Hardware Cloth

Hardware cloth shall be fabricated with maximum 7-millimeter square mesh openings from woven or welded galvanized steel wire fabric conforming to ASTM A 740.

515.2.3.9 Reinforcing mesh

Reinforcing mesh shall be fabricated from cold-drawn steel wire conforming to AASHTO M 32M. Wire shall be welded into the finished mesh fabric according to AASHTO M 55M. Wire shall be galvanized according to AASHTO M 111M after fabrication. Damaged galvanized coating shall be repaired before installation.

M.S.E. (RETAINING WALLS) SPEC'Z.ALDV

DEPARTMENT ORDER NO.5^D SERIES OF 2007 ANNEX PAGE 4 OF 11

515.2.3.10 Reinforcing strips

Reinforcing strips shall be fabricated from high-strength, low-alloy structural steel conforming to ASTM A 572M, grade 450, type-3. Reinforcing strips shall be galvanized according to AASHTO M 111M after fabrication.

515.2.3.11 Tie strip

Tie strip shall be fabricated from hot-rolled steel conforming to ASTM A 570M, grade 50. Tie strip shall be galvanized according to AASHTO M 111M.

515.2.4 Select Granular Backfill

Select Granular Backfill shall consist of sound, durable, granular material free from organic matter or other deleterious material (such as shale or other soft particles with poor durability).

The select granular backfill materials shall conform to Table 515.1, Grading Requirements.

Sieve Designation	Percent by Mass Passing Designated Sieve (AASHTO T 27 and T 11)	
Standard (mm)		
100	100	
0.0425	0 – 60	
0.075	0 – 15	

Table 515.1 – Grading Requirements

The shear angle of internal friction shall not be less than 34°

Compact samples for AASHTO T 236 to 95 percent of the maximum density determined according to AASHTO T 99 method C or D and corrected for oversized material according to AASHTO T 99, Note 9.

If the select granular backfill materials are subjected to five (5) cycles of the sodium sulfate soundness test by ASSHTO T 104, the weighted loss shall not exceed 15 mass percent.

The material shall have a Plasticity Index of not more than 6 as determined by AASHTO T 90.

Electrochemical requirements for Mechanically-Stabilized Earth (MSE) retaining walls with metallic reinforcements shall comply with the following requirements:

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M.S.E. (RETAINING WALLS) SPECZ.ALOV

DEPARTMENT ORDER NO. <u>D</u> SERIES OF 2007 ANNEX PAGE 5 OF 11

Test	Requirements
Resistivity, AASHTO T 288	3000 Ώ-cm min.
pH, AASHTO T 289	5.0 to 10.0
Sulfate Content, AASHTO T 290	200 ppm max.
Chloride Content, AASHTO T 291	100 ppm max.

Note: Tests for sulfate and chloride content are not required when resistivity is greater than 5,000 Ohm centimeters.

Electrochemical requirements for Mechanically-Stabilized Earth (MSE) retaining walls with Geosynthetic reinforcements, specify that the pH shall be between 5.0 to 10.0 as determined by AASHTO T 289

515.2.5 Structural Backfill

Structural Backfill shall consist of free draining granular materials free from excess moisture, muck, frozen lumps, roots, sod, or other deleterious material.

The structural backfill materials shall conform to Table 515.2, Grading Requirements.

Sieve Designation	Percent by Mass Passing	
Standard mm	Designated Sieve (AASHTO T 27 and T 11)	
75	100	
0.075	15 max	

Table 515.2 – Grading Requirements

The material shall have a liquid limit of not more than 30 as determined by ASSHTO T 89.

515.3 Construction Requirements

515.3.1 General

Survey and verify the limits of the wall installation. Detailed working drawings such as but not limited to wall elevations, soil reinforcement length for each section of wall, applied bearing pressure, facing panel layout, and representative typical details and supporting calculations of the Mechanically-Stabilized Earth (MSE) retaining walls shall be furnished by the Contractor to the Engineer at least three (3)

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M.B.E. (RETAINING WALLS) SPEC'Z. ALDY

DEPARTMENT ORDER NO.30_____ SERIES OF 2007 ANNEX PAGE 6 OF 11

weeks prior to construction. Construction shall not start until the Engineer has reviewed and approved the design / Plans.

Mechanically-Stabilized Earth (MSE) retaining walls design shall be in accordance with DPWH - Design Guidelines Criteria and Standards (Latest Edition).

A minimum horizontal bench 1.20 meters wide shall be provided in front of walls founded on slopes.

515.3.2 Excavation

The ground shall be excavated in accordance with the dimensions, lines and grades shown on the Plans. Excavation shall be in accordance whenever applicable, with Section 103.2, Excavation.

Level and layout the foundation for a width equal to the length of reinforcing elements plus 0.5 meter. When a rocky foundation is situated anywhere along the wall, place 150 millimeters of select granular backfill materials under the reinforcing mesh or strips.

515.3.3 Foundation Preparation

Prior to wall construction, the foundation, if not on rock surface shall be compacted as directed by the Engineer. Any unsuitable foundation material, as determined by the engineer, shall be excavated and replaced with granular material, and shall be compacted in accordance with Section 515.3.5, Backfilling.

The construction requirements for concrete leveling pad shall be in accordance, whenever applicable, with Section 405.3, Structural Concrete. Allowable elevation tolerances are + 3.0 mm (1/8 inch), and - 6.0 mm (1/4 inch), from the design elevation.

515.3.4 Wall Erection

Walls shall be erected in accordance with the approved shop drawings and the manufacturer's recommendations. When required by the Engineer, an experienced field representative from the wall system manufacturer shall be present on site during erection.

The starting point for the wall erection shall be as shown on the plans or if the new wall matches an existing wall. Otherwise the wall shall begin on the leveling pad at the lowest elevation.

The concrete leveling pad shall be allowed to cure for at least 12 hours before the wall erection.

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M.S.E. (RETAINING WALLS) SPECZ ALDV

DEPARTMENT ORDERNO. 50SERIES OF 2007ANNEXPAGE 7 OF 11

515.3.4.1 Concrete-faced Walls

Where walls or wall sections intersect at an angle of 130° or less, a special vertical corner element panel shall be used. The corner element panel shall cover the joint of the panels that abut the corner, to allow for the independent movement of the abutting panels.

Standard facing panels shall have at least two levels of earth reinforcements to stabilize the panels against rotation. Top and bottom half panels shall have at least one (1) level of earth reinforcements. The wall facing shall be designed to accommodate differential settlement of one (1) meter in one hundred (100) meters. The spacing between adjacent panels shall be designed to be 19 millimeters (0.75 inches). Joints between panels shall have a ship lap configuration to protect the joint materials from vandalism. There shall be no openings through the wall facing except for utilities to pass through the wall. Slip joints to accommodate excessive differential settlement shall be included if indicated in the plans.

515.3.4.1.1 Installation

Precast facing panels shall be erected by means of lifting devices connected to the upper edge of the panel. Precast facing panels shall be aligned within 19 millimeters vertically and horizontally when measured with a 3-meter straightedge.

Joint openings shall be 19±6 millimeters wide. Joint material shall be installed according to the drawings. All joints at the backside of the panels shall be covered with a 300-millimeter wide strip of geotextile. Geotextile splices shall be overlapped with a minimum of 100 millimeters.

The panels in position shall be supported with temporary wedges or bracing during backfilling operations. The final position of the wall shall have a maximum overall vertical tolerance (top to bottom) of 13 millimeters per 3 meters of wall height.

515.3.4.2 Wire-faced Walls.

Place backing mats and 6-millimeter hardware cloth in successive horizontal lifts as backfill placement proceeds. Connect, tighten, and anchor soil reinforcement elements to the wall facing units before placing backfill. An individual lift shall have a maximum vertical tolerance and an overall wall (top to bottom) vertical tolerance of 25 millimeters per 3 meters of wall height. Reinforcement elements shall be placed within 25 millimeters vertically above the corresponding connection elevation at the wall face. Reinforcing elements shall not be placed below the corresponding connection elevations. Designed batter of the wall shall not deviate by more than 25 millimeters per 3 meters of wall height. Deviation of more than 50 millimeters shall not be allowed at any point in the wall from a 3-meter straightedge placed horizontally on the theoretical plane of the design face.

DEPARTMENT ORDER NO. 50 SERIES OF 2007 ANNEX PAGE 8 OF 11

The minimum wall embedment shall be 300 mm unless otherwise shown on the plans or established by the engineer.

515.3.4.3 Gabion-faced Walls

The construction requirements of gabions shall be in accordance whenever applicable, with Section 511.3, Gabions and Mattresses.

The first lift of backfill shall be placed before filling the gabion baskets. Reinforcement mesh shall be layed horizontally on compacted fill and normal to the face of the wall. The gabion facing unit shall be connected to the reinforcement mesh with spiral binders or tie wire at 100-millimeter nominal spacing with alternating single and double locked loops. Reinforcement mesh taut shall be pulled and anchored before placing additional backfill.

515.3.5 Backfilling

The stabilized volume shall be backfilled with select granular backfill. The maximum compacted thickness of any layer shall not exceed 150 mm. All subsequent layers shall be spread and compacted in a similar manner.

The backfill materials shall be compacted until a uniform density of not less than 95 mass percent of the maximum dry density determined by AASHTO T 99 Method C is attained, at a moisture content determined by Engineer to be suitable for such density. Acceptance of compaction may be based on adherence to an approved roller pattern developed as set forth in Item 106, Compaction Equipment and Density Control Strips.

During the progress of the Work, the Engineer shall make density tests of compacted material in accordance with AASHTO T 310 or other approved field density tests. If, by such tests, the Engineer determines that the specified density and moisture conditions have not been attained, the Contractor shall perform additional work as may be necessary to attain the specified conditions.

At least one group of three (3) in-situ density tests shall be carried out for each 500 m of each layer of compacted fill.

Backfilling shall be even on all sides of the structure, and each layer shall be extended to the limits of the excavation or to natural ground.

Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the facing panels. Any wall materials which become damaged or disturbed during backfill placement shall either be removed and replaced at the Contractor's expense or corrected, as directed by the Engineer.

Backfill shall not be placed against concrete less than 7-days-old or until 80 percent of the design strength is achieved.

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M.S.E. (RETAINING WALLS) SPECZ.ALDV

DEPARTMENT ORDER NO. 50 SERIES OF 2007 ANNEX PAGE 9 OF 11

Ensure that no voids exist below the reinforcing mesh or strips. An acceptable lightweight mechanical or vibratory compactor shall be used within one (1) meter of the wall face. The specified lift thickness shall be adjusted as warranted by the type of equipment actually used and as approved by the Engineer, but no soil density tests need be taken within this area. Where the stabilized volume supports spread footings for bridges or other structural loads, the top 1.5 meters shall be compacted to at least 100 percent of the maximum density.

Facing or reinforcing elements shall not be damaged or disturbed during backfilling. Equipment shall not be operated directly on top of the reinforcing mesh or strips. The Contractor shall correct damaged, misaligned, or distorted wall elements.

Backfill and compact behind the stabilized volume with structural backfill in the same methodology done on select granular backfill. At the end of the day's operation, the last lift of backfill shall be sloped away from the wall face to direct surface runoff away from the wall. Temporary drainage shall be constructed to divert any surface runoff from adjacent areas to enter the wall construction area.

515.3.6 Placement of Reinforcements

Prior to placing the first layer of reinforcements (strips, mats or grids), backfill shall be placed and compacted in accordance with Section 515.3.5, Backfilling.

Bending of reinforcements in the horizontal plane that results in a kink in their alignment shall not be allowed. Gradual bending in the vertical direction that does not kink the reinforcements is allowable.

Connection of reinforcements to piles or bending of reinforcements around piles shall not be allowed. Cutting of reinforcement longitudinal bars shall not be allowed to avoid conflicts with piles or utility obstructions. A structural connection (yoke) from the wall panel to the reinforcement shall be used whenever it is necessary to avoid cutting or excessive skewing of reinforcements due to pile or utility conflicts.

Soil reinforcements shall be placed normal to the face of the wall, unless otherwise shown on the plans or as directed by the Engineer. If skewing of the soil reinforcements is required due to obstructions in the reinforced fill, rotatable connections shall be used and the maximum skew angle shall not exceed 15 degrees from the normal position unless specifically addressed in design calculations that justify that the skewed reinforcements are adequate.

515.4 Method of Measurement

The area to be paid for under this item shall be the number of square meters (m²) of Mechanically-Stabilized Earth (MSE) retaining walls furnished, placed and

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M.S.E. (RETAINING WALLS) SPECZ ALDY

DEPARTMENT ORDER NO. <u>50</u> SERIES OF 2007 ANNEX PAGE 10 OF 11

accepted. The area shall be measured on the facial area of the walls installed. The wall surface area shall include the surface area of nominal panel joint openings and wall penetrations such as pipes and other utilities. The payment will include mechanically-stabilized earth walls, backing mat, clevis connector, connector bars, fasteners, hardware cloth, reinforcing mesh, tie strips and other such materials contained with in or attached to the mechanically-stabilized earth walls.

515.4.1 Other items

The quantities of other Contract items which enter into the completed and accepted structure will be measured for payment in the manner prescribed for the several items involved.

515.4.2 Select Granular Backfill / Structural Backfill

Select Granular Backfill / Structural Backfill material, when specified in the Contract as a pay item shall be measured in place by the cubic meter, completed and accepted. Cross-sectional measurements shall not exceed the net dimensions shown on the Plans or as directed by the Engineer.

515.4.3 Excavation

Excavation for Mechanically-Stabilized Earth (MSE) retaining walls shall be measured and paid for as provided in Item 103, Structure Excavation.

515.4.4 Concrete

Concrete leveling pad / concrete panels for mechanically-stabilized earth (MSE) retaining walls shall be measured and paid for as provided in Item 405, Structural Concrete.

515.4.5 Gabions

Gabions for Mechanically-Stabilized Earth (MSE) retaining walls shall be measured and paid for as provided in Item 511, Gabions and Mattresses.

515.5 Basis of Payment

The accepted quantities, measured as prescribed in Section 515.4 shall be paid for at the contract unit price for each particular item listed below that is included in the bill of quantities which price and payment shall be full compensation for furnishing and placing all materials, including the use of equipment and tools, labor and incidentals necessary to complete the work.

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DEPARTMENT ORDER NO. 30 SERIES OF 2007 ANNEX PAGE 11 OF 11

Payment will be made under:

Pay Item No.	Description	Unit of Measurement
515 (1)	Mechanically-Stabilized Earth (MSE) retaining walls	Sq.m.
515 (2)	Select Granular Backfill	Cu.m.
515 (3)	Structural Backfill	Cu.m

REFERENCES:

- 1. DPWH STANDARD SPECIFICATION FOR HIGHWAYS, BRIDGES AND AIRPORTS, VOLUME II (2004)
- 2. STANDARD SPECIFICATIONS FOR CONSTRUCTION OF ROADS AND BRIDGES ON FEDERAL HIGHWAY PROJECTS (FP-03 METRIC UNITS) U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION. (PUBLICATION NO. FHWA-FLH-03-001) / DOWNLOADED @ FHA WEBSITE ON MARCH 2007.
- 3. DPWH DESIGN GUIDELINES CRITERIA AND STANDARDS. BRIDGE DESIGN (LATEST EDITION). (AASHTO 1996 DIVISION II)
- 4. TECHNICAL SPECIFICATION FOR MECHANICALLY-STABILIZED EARTH (MSE) RETAINING WALLS. / DOWNLOADED @ REINFORCEDEARTH.COM WEBSITE ON MAY 08 2007.
- 5. INSTALLATION MANUAL RETAINED EARTH[™] WALLS WITH CONCRETE FACING PANELS. / DOWNLOADED @ REINFORCEDEARTH.COM WEBSITE ON MAY 08 2007.
- 6. TECHNICAL SPECIFICATION FOR PERMANENT WIRE FACED RETAINING WALLS. / DOWNLOADED @ REINFORCEDEARTH.COM WEBSITE ON MAY 2007.

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