

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

MANILA

DEPARTMENT ORDER ) 43 NO.\_) Series of 2018 SUBJECT: DPWH Standard Specification for Item 1728 – Concrete Block Slope Protection

It has been the thrust of the Department to provide effective standard specifications in the implementation of various infrastructure projects. As such, there is a need to set a standard specification for the proper furnishing and placing of concrete block slope protection for flood control projects. The attached **DPWH Standard Specification for Concrete Block Slope Protection, Item 1728** is hereby prescribed for the guidance and compliance of all concerned.

This specification shall form part of the on-going revision of the DPWH Standard Specifications for Public Work Structures – Buildings, Ports and Harbors, Flood Control and Drainage Structure and Water Supply Systems, Volume III, 1995 Edition.

This Order shall take effect immediately.

MARK A. VILLAR

Secretary

14.1.2 FET/RGT

Department of Public Works and Highways Office of the Secretary



## DPWH STANDARD SPECIFICATION FOR ITEM 1728 – CONCRETE BLOCK SLOPE PROTECTION

### 1728.1 Description

This Item shall consist of furnishing and placing of precast concrete block for slope protection, in accordance with this Specification, and in conformity with the alignment, grades, dimensions and design, shown on the Plans or as directed by the Engineer.

#### **1728.2 Material Requirements**

### 1728.2.1 Handling and Placing of Concrete

### 1728.2.1.1 General

Concrete shall not be placed until forms and reinforcing steel have been checked and approved by the Engineer.

If lean concrete is required in the Plan or as directed by the Engineer prior to placing of reinforcing steel bar, the lean concrete should have a minimum compressive strength of 13.8 MPa.

In preparation for the placing of concrete, all sawdust, chips and other construction debris and extraneous matter shall be removed from inside the formwork. Struts, slays, and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached the required elevation. These temporary members shall be entirely removed from the forms and shall not be buried in the concrete.

No concrete shall be used which does not reach its final position in the forms within the time stipulated under the "Time of Hauling and Placing Mixed Concrete".

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs, chutes, and pipes for conveying concrete to the forms shall be permitted only on written authorization of the Engineer. The Engineer shall reject the use of the equipment for concrete transportation that will allow segregation, loss of fine materials, or in any other way will have a deteriorating effect on the concrete quality.

Open troughs and chutes shall be metal lined. Where steep slopes are required, the chutes shall be equipped with baffles or shall be in short lengths that reverse the direction of movement to avoid segregation.

All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the structure.

When placing operations would involve dropping the concrete more than 1.5 m, concrete shall be conveyed through sheet metal of approved pipes. The pipes shall be kept full of concrete during placing and their lower end shall be kept buried in the newly placed concrete. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of the projecting reinforcement bars.

The concrete shall be placed as nearly as possible to its final position and the use of vibrators for moving of the mass of fresh concrete shall not be permitted.

## 1728.2.2 Casting Yard

The precasting of concrete blocks may be done at a location, subject to the approval of the Engineer.

## 1728.2.3 Casting and Curing Concrete

All newly placed concrete shall be cured in accordance with this Specification, unless otherwise directed by the Engineer. The curing method shall be one or more of the following:

## 1728.2.3.1 Water Method

The concrete shall be kept continuously wet by the application of water for a minimum period of seven (7) days after the concrete has been placed.

The entire surface of the concrete shall be kept damp by applying water with an atomizing nozzle. Cotton mats, rugs, carpets, or earth or sand blankets may be used to retain the moisture. At the end of the curing period, the concrete surface shall be cleared of the curing medium.

## 1728.2.3.2 Curing Compound

Surfaces exposed to the air may be cured by the application of an impervious membrane if approved by the Engineer.

The membrane forming compound used shall be practically a colorless liquid. The use of any membrane-forming compound that will alter the natural color of the concrete or impart a slippery surface to any wearing surface shall be prohibited. The compound shall be applied with a pressure spray in such a manner as to cover the entire concrete surface with a uniform film and shall be of such character that it will harden within 30 minutes after application. The amount of compound applied shall be ample to seal the surface of the concrete thoroughly. Power-operated spraying equipment shall be equipped with an operational pressure gauge and means of controlling the pressure.

The curing compound shall be applied to the concrete following the surface finishing operation immediately after the moisture sheen begins to disappear from the surface, but before any drying shrinkage or craze cracks begin to appear. In the event of any delay, in the application of the curing compound, which results in any during or cracking of the surface, application of water with an atomizing nozzle as specified under Subsection 1728.2.3.1, shall be started immediately and shall be continued until the application of the compound is resumed or started, however, the compound shall not be applied over any resulting free standing water. Should the film of compound be damaged from any cause before the expiration of seven (7) days after the concrete is placed in the case of structures, the damaged portion shall be repaired immediately with additional compound.

Curing compound shall not be diluted or altered in any manner after manufacture. At the time of use, the compound shall be in a thoroughly mixed condition. If the compound has not been

used within 120 days after the date of manufacture, the Engineer may require additional testing before the use to determine compliance to requirements.

An anti-setting agent or a combination of anti-setting agents shall be incorporated in the curing compound to prevent cracking.

The curing compound shall be packaged in clean barrels or steel containers or shall be supplied from a suitable storage tank located on the site. The storage tank shall have a permanent system designed to completely redisperse any settled material without introducing air or any foreign substance. Containers shall be well-sealed with ring seals and lug type crimp lids. The linings of the containers shall be of a character that will resist the solvent of the curing compound. Each container shall be labeled with the manufacturer's name, specification number, batch number, capacity and date of manufacture, and shall have label warning concerning flammability. The label shall also warn that the curing compound shall be well-stirred before use. When the curing compound is shipped in tanks or tank trucks, a shipping invoice shall accompany each load. The invoice shall contain the same information as that required herein for container labels.

Curing compound may be sampled by the Engineer at the source of supply and on the site.

### 1728.2.3.3 Waterproof Membrane Method

The exposed finished surfaces of concrete shall be sprayed with water, using a nozzle that atomizes the flow, in which a mist and not a spray is formed until the concrete has set, after which a curing membrane of waterproof paper or plastic sheeting shall be placed. The curing membrane shall remain in place for a period of not less than 72 hours.

Waterproof paper and plastic sheeting shall conform to the specification of AASHTO M 171, Standard Specification for Sheet Materials for Curing Concrete.

The waterproof paper or plastic sheeting shall be formed into sheets of such width as to cover completely the entire concrete surface.

All joints in the sheets shall be securely weighed down by placing a bank of earth on the edges of the sheets or by other means satisfactory to the Engineer.

Should any portion of the sheets be broken or damaged within 72 hours after being placed, the broken or damaged portions shall be immediately repaired with new sheets properly cemented into place.

Sections of membrane which have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing, the concrete shall not be used.

### 1728.2.3.4 Forms-in-Place Method

Formed surfaces of concrete shall be cured by retaining the form-in-place. The forms shall remain in place for a minimum period of seven (7) days after the concrete has been placed, except that for members over 50 cm in least dimensions, the forms shall remain in place for a minimum period of five (5) days. Wooden forms shall be kept wet by watering during the curing period.

## 1728.2.3.5 Curing Cast-In-Situ Concrete

All newly placed concrete for cast-in-situ structures, other than highway bridge deck, shall be cured by the water method, the forms-in-place method, or as permitted herein, by the curing compound method.

The curing compound method may be used on concrete surfaces which are to be buried under ground and surfaces where only Ordinary Surface Finish is to be applied and on which a uniform color is not required and which will not be visible from public view.

The top surface of highway bridge decks shall be cured by either the curing compound method or the water method. The curing compound method shall be applied progressively during the deck finishing operations. The water cure shall be applied not later than four (4) hours after completion of the deck finishing.

When deemed necessary by the Engineer during periods of hot weather, water shall be applied to concrete surface being cured by the curing compound method or by the forms-inplace method until the Engineer determines that a cooling effect is no longer required.

## 1728.2.3.6 Curing Pre-Cast Concrete

Pre-cast concrete members shall be cured for not less than seven (7) days by the water method or by steam curing. Steam curing for pre-cast members shall conform to the following provisions:

- 1. After placement of the concrete, members shall be held for a minimum four-hour presteaming period.
- 2. To prevent moisture loss on exposed surfaces during the pre-steaming period, members shall be covered immediately after casting or the exposed surface shall be kept wet by fog spray or wet blankets.
- 3. Enclosures for steam-curing shall allow free circulation of steam about the member and shall be constructed to contain the live stream with a minimum moisture loss. The use of tarpaulins or similar flexible covers will be permitted, provided they are kept in good condition and secured in such a manner to prevent the loss of steam and moisture.
- 4. Steam at jets shall be low pressure and in a saturated condition. Steam jets shall not impinge directly on the concrete, test cylinders, or forms. During application of the steam, the temperature rise within the enclosure shall not exceed 20°C per hour. The curing temperature throughout the enclosure shall not exceed 65°C and shall be maintained at a constant level for a sufficient time necessary to develop the required compressive strength. Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where temperature of the enclosure will be the same as that of the concrete.
- 5. Temperature recording devices that will provide an accurate continuous permanent record of the curing temperature shall be provided. A minimum of one temperature recording device per 50 m continuous bed length will be required for checking temperature.
- 6. Curing of pre-cast concrete will be considered completed after the termination of the steam curing cycle.

## 1728.2.4 Bed Course

A bed course, where required, shall be granular material which satisfies the requirements for Item 1707, Aggregate Subbase Course, Grading A.

### 1728.2.5 Concrete

Unless otherwise shown on the Plans or specified in special provisions, concrete shall be of Class A.

## 1728.2.6 Concrete Filler

Unless otherwise shown on the Plans or specified in special provisions, concrete filler shall use lean concrete with a minimum compressive strength of 13.8 MPa.

# 1728.2.7 Precast Concrete Block

The appearance of precast concrete blocks for slope protection shall be superior and be free from harmful flaws. Requirements as to the minimum values for density and compression strength, and maximum percentage water absorption of precast concrete block are specified in Table 1728.1.

### Table 1728.1 Requirements for Precast Concrete Block

Property	Requirement	Remarks
Density in air (Minimum)	2350 kg/m <sup>3</sup> (23.0 kN/ m <sup>3</sup> )	
Compression Strength (Minimum)	20.7 MPa	Same as Concrete Class A
Water Absorption (Maximum)	3% of the Weight of Aggregates	

The precast concrete block shall also meet the dimensional requirements as shown in Table 1728.2 and defined as follows:

- 1. The width of a rectangular-shaped concrete block refers to the longer dimension measured from side to side on a horizontal plane, while the height refers to the shorter dimension measured from one side to the other on the same plane.
- 2. For a square-shaped concrete block, the width and the height refer to the dimensions of the sides measured on a horizontal plane.
- 3. The width and the height of the regular hexagon-shaped concrete block are the dimensions measured by the side length of the object on a horizontal plane.
- 4. The thickness of all the block shapes refer to the dimension measured vertically from the base of the object.

	Shape	Width (mm)	Height (mm)	Thickness (mm)
Rectangle	Dimension	350 - 500	250 - 350	350 - 500
_	Tolerance	<u>+</u> 3	<u>+</u> 3	<u>+</u> 3
Square	Dimension	300 – 350	300 – 350	350 - 500
•	Tolerance	<u>+</u> 3	<u>+</u> 3	<u>+</u> 5
Regular	Dimension	190 – 250 (Side Length)		350 - 500
Hexagon	Tolerance	<u>+</u> 3	<u>+</u> 3	<u>+</u> 5

## Table 1728.2 Requirements for Dimension of Precast Concrete Block

Note:

1. In case there is no problem on practical usage, rough surface finishing is acceptable.

2. Chamfering on the edge of plain is acceptable.

3. Chamfered portion is considered as the part of thickness.

### 1728.2.8 Joint Filler and Sealant

### 1728.2.8.1 Joint Filler

Unless otherwise shown on the Plans or in Special Provisions, materials for expansion joint filler shall conform to the requirements of the following specifications:

AASHTO M 33	Preformed Expansion Joint Filler for Concrete.		
AASHTO M 153	Preformed Sponge Rubber and Cork Expansion Joint Fillers for		
	Concrete Paving and Structural Construction.		
AASHTO M 173	Concrete Joint Sealer Hot Poured Elastic Type.		
AASHTO M 213	Preformed Expansion Joint Filler for Concrete Paving and Structural		
	Construction Non-Extruding and Resilient Bituminous Types.		
AASHTO M 220	Preformed Elastomeric Compression Joint Seals for Concrete.		

### 1728.2.8.2 Sealing Compound

Concrete joint sealing materials shall be homogenously composed of one substance, or of two or more substances that are to be mixed prior to application. The substance shall be of such a character that a homogenous preparation can readily be obtained by combining the separate components, when so supplied, by mechanical or manual stirring without heating the blended material above a temperature of 38°C. The sealing compound shall be resilient and adhesive material that is capable of sealing joints in concrete.

### **General Requirements**

The concrete joint sealant shall be capable of sealing joints and/or cracks against the infiltration of moisture and foreign materials throughout repeated cycles of expansion and contraction with temperature changes, and that will not flow from the joint/crack or be picked-up by vehicle tires on pavement at summer temperature.

The concrete joint sealant shall be capable at being brought to a uniform application consistency suitable for completely filling the joints without inclusion of large air holes or discontinuities and without damage to the material.

The sealing compound, after curing, shall be of such nature that it will adhere to dry but dustfree concrete or to damp concrete free from surface moisture.

## Physical Requirements

Sealant materials for hot-poured elastic type and cold applied type shall conform to the physical requirements as follows:

Property	Requirement		
	Hot-Poured Elastic Type	Cold-Applied Type	
Pour Point	At least 11°C lower than the safe heating temperature, which is the maximum temperature to which the material may be heated and still conform to this specification's requirements.	The material shall pour or extrude readily at a temperature of 21°C immediately after preparation for use and shall remain in a condition suitable for application for at least one (1) hour.	
Penetration	Non-immersed at 25°C and 150 grams for five (5) seconds shall not exceed 90 when tested in accordance with ASTM D 5329, Standard Test Methods for Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphalt Pavements and Portland Cement Concrete Pavements.	The sealing compound, after curing shall have a penetration, at 25°C and 150 grams for 5 seconds, not greater than 235.	
Flow	At 60°C shall not exceed five (5) mm when tested for five (5) hours in accordance with ASTM D 5329.	The sealing compound, after curing, shall show a flow not in excess of five (5) mm.	
Bond	It shall meet the requirements of ASTM D 5329.	The sealing compound, after curing, shall not fail in adhesion or cohesion after testing in accordance with ASTM E 1851, Standard Test Method for Measuring the Electromagnetic Shielding Effectiveness of Planar Materials.	

## Table 1728.3 Physical Requirements for Sealing Compound

# 1728.2.9 Backer Material

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Backer material shall conform to ASTM D/5249, Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints.

Backer material or bond breaker in the bottom of the joint to be filled with concrete joint sealer shall be used to control the depth of sealant and achieve the desired shape factor, and to support the sealant against indentation and sag. Backer materials shall be compatible with concrete joint sealer. It shall be compressible without extruding the sealant, and shall recover to maintain contact with the joint faces when the joint is open.

## **1728.3 Construction and Requirements**

### 1728.3.1 Bed Course

A bed course shall be provided and laid to the depth required on the Plans or directed by the Engineer, and as specified in Item 1707, Aggregate Subbase Course. The bed course shall be compacted at least 100 percent of the maximum dry density as determined by AASHTO T 180, Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop, Method D.

## 1728.3.2 Cap, Base and Partition Walls

Concrete works such as base and partition wall as called for on the Plans and/or as directed by the Engineer shall be constructed prior to placing precast concrete blocks and concrete filling. Cap, base and partition wall shall be constructed to the alignment, elevation, location, and dimension as shown on the Plans. Top concrete shall be placed after placing the concrete blocks in the same manner.

## 1728.3.3 Placement of Precast Concrete Block

Concrete blocks shall be cleaned prior to placing. The blocks shall be placed such that they are aligned neatly with the surrounding blocks. Concrete filling shall be used for jointing in such a manner that it is in complete contact with the blocks in all sides. The blocks shall be laid as shown on the drawings and thoroughly bedded in the filling concrete to provide a uniform surface and solid bedding under each block. Half-blocks at ends shall be cast and cut blocks shall not be used.

### 1728.3.4 Concrete Filling

Concrete filling shall be provided at the back of the precast concrete block as described in Subsection 1728.2.1 as shown on the approved Plans or as directed by the Engineer. When the concrete block slope protection is applied for the revetment at a river, concrete filling shall not be applied in principle except for the following cases:

- 1. The gradient of the slope is equal to or steeper than 0.5:1.0, and the edge of the crown is loaded with wheel loads which affect the stability of the slope in significant way.
- 2. The gradient of the slope is equal to or steeper than 0.5:1.0, the bank consists of sandy material and the concrete filling is required for the stability of the slope.
- 3. The gradient of the slope is equal to or steeper than 0.5:1.0, the bank consists of weak ground material and the concrete filling is required for the stability of the slope.

### 1728.3.5 Joint Filler and Sealant

The joint filler shall be provided at the expansion joint of the precast concrete block slope protection as shown on the approved Plans or as directed by the Engineer. When one piece is necessary for a joint, abutting ends shall be fastened and held securely to shape by stapling or other positive fastening. Joints, comprising vertical partition walls and 10 mm thick rubber joint strips, shall be generally placed at intervals of not more than 10 m.

The rubber joint strips shall be furnished in lengths of not less than four (4) m. All rubber joint strips shall be stored in as cool a place as practical, and in no case, shall the rubber joint strips be stored in the open or exposed to the direct rays of the sun.

## 1728.3.6 Weepholes and Filter Cloths

All walls of the abutments shall be provided with weepholes. Unless otherwise shown on Plans or as directed by the Engineer, the weepholes shall be placed horizontally at the lowest points where free outlets for water can be obtained and shall be spaced at not more than two (2) m center to center in a staggered manner. The length of the weepholes shall not be less than the thickness of the walls of the abutment. It shall be made of PVC or other pipe material accepted by the Engineer and shall be at least 50 mm in diameter. Weepholes shall be provided with filter bags as specified in special provisions or as directed by the Engineer.

### **1728.4 Method of Measurement**

The work under this Item shall be measured by square meter actually furnished and placed concrete block slope protection as indicated on the Plans.

### 1728.5 Basis of Payment

The accepted quality, measured as prescribed in Section 1728.4, shall be paid for at the contract unit price for concrete block slope protection, which price and payment shall be the full compensation for furnishing all materials, labor, equipment, tools and incidental necessary to complete this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1728	Concrete Block Slope Protection	Square Meter

References:

### 1. American Society for Testing and Materials (ASTM)

ASTM D 1851 – Standard Test Method for Measuring the Electromagnetic Shielding Effectiveness of Planar Materials

ASTM D 5249 – Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

ASTM D 5329 – Standard Test Methods for Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphalt Pavements and Portland Cement Concrete Pavements

#### 2. American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M 33 – Preformed Expansion Joint Filler for Concrete.

- AASHTO M 153 Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- AASHTO M 171 Standard Specification for Sheet Materials for Curing Concrete
- AASHTO M 173 Concrete Joint Sealer Hot Poured Elastic Type.
- AASHTO M 213 Preformed Expansion Joint Filler for Concrete Paving and Structural Construction Non-Extruding and Resilient Bituminous Types.
- AASHTO M 220 Preformed Elastomeric Compression Joint Seals for Concrete.
- AASHTO T 180 Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop