



Republic of the Philippines
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
CENTRAL OFFICE
Manila



DEC 27 2023

DEPARTMENT ORDER)
NO. 158)
Series of 2023)

SUBJECT: New Standard Plan for Water Engineering Projects (CY 2023): CONCRETE MATTRESS

In line with DPWH Design Guidelines, Criteria and Standards (DGCS), 2015 Edition, issued through Department Order No. 179 series of 2015, new standard plan for concrete mattress for water engineering projects, is now available for reference.

The issuance of the said standard plan aims to ensure the safety, cost effectiveness and development of high-quality detailed design for water engineering projects incorporating the industry's best practice in design adaptable to local requirements. It shall also serve as a guide for District Engineering Offices, Regional Offices, Project Management Office Clusters and Engineering Consultants in the preparation of water engineering plans based on this new standard.

The aforementioned new plan for Concrete Mattress, consisting of 4 sheets, can be downloaded from the DPWH Intranet (<http://dpwhnet>) under Bureau of Design – Standard Design.


MANUEL M. BONOAN
Secretary

5.1 RFIL/LLL/DLB/AGC

Department of Public Works and Highways
Office of the Secretary



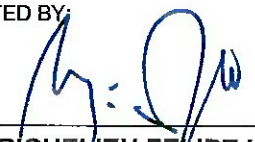
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REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN
BONIFACIO DRIVE, PORT AREA, MANILA

STANDARD PLAN OF CONCRETE MATTRESS

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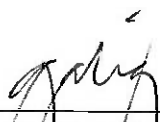

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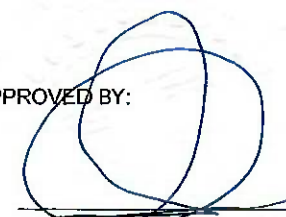

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GENERAL NOTES:

I. DESIGN CRITERIA AND SPECIFICATIONS

- A. DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS - DESIGN GUIDELINES, CRITERIA AND STANDARDS (DGCS), 2015. VOLUME 3 - WATER ENGINEERING PROJECTS.
- B. U.S. DEPARTMENT OF TRANSPORTATION (2005). BRIDGE SCOUR AND STREAM INSTABILITY COUNTERMEASURES: EXPERIENCE, SELECTION, AND DESIGN GUIDANCE, HYDRAULIC ENGINEERING CIRCULAR NO. 23, VOLUMES 1 AND 2
- C. U.S. DEPARTMENT OF TRANSPORTATION (2005). DESIGN OF ROADSIDE CHANNELS WITH FLEXIBLE LININGS, HYDRAULIC ENGINEERING CIRCULAR NO. 15, THIRD EDITION.
- D. DESIGN OF SEAWALLS AND DIKES - INCLUDING OVERVIEW OF REVETMENTS, PILARCZYK, K.W. (1990)
- E. U.S. DEPARTMENT OF TRANSPORTATION (2012). STREAM STABILITY AT HIGHWAY STRUCTURES, HYDRAULIC ENGINEERING CIRCULAR NO. 10, FOURTH EDITION.
- F. DPWH STANDARD SPECIFICATIONS FOR HIGHWAYS, BRIDGES AND AIRPORTS, VOLUME II.
- G. DPWH STANDARD SPECIFICATIONS FOR PUBLIC WORKS STRUCTURES, VOLUME III.

II. MATERIAL REQUIREMENTS

- A. GEOTEXTILE BAG / CONCRETE MATTRESS
ENSURE THOROUGH ADHERENCE TO INTERNATIONAL QUALITY AND RELIABILITY, CONSIDERING THE FOLLOWING MINIMUM SPECIFICATION FOR THE MATERIAL:

MINIMUM PROPERTY REQUIREMENTS FOR GEOTEXTILE FORM				
PROPERTY	UNITS	GEOTEXTILE BAG / CONCRETE MATTRESS MAX HEIGHT ≤ 2.0m MAX SLOPE ≤ 26° (1:2)	GEOTEXTILE BAG / CONCRETE MATTRESS MAX HEIGHT ≥ 2.0m MAX SLOPE ≤ 33.7° (1:1.5)	(DRAINAGE GEOTEXTILE)
PHYSICAL PROPERTIES		WOVEN	WOVEN	NON-WOVEN
MINIMUM THICKNESS AFTER FILLING	mm	180	120	1.7
MECHANICAL PROPERTIES				
WIDE WIDTH TENSILE STRENGTH (MD) (ASTM D4632/ASTM D1682)	kN/m	60 (MIN)	60 (MIN)	13.5 (MIN)
WIDE WIDTH TENSILE STRENGTH (CD) (ASTM D4632/ASTM D1682)	kN/m	60 (MIN)	60 (MIN)	13.5 (MIN)
TENSILE ELONGATION (MD/CD) (ASTM D4632/ASTM D1682)	%	15 (MAX)	15 (MAX)	73/35 (MAX)
FILTER POINT STRENGTH (ASTM D4632)	kN/m	28 (MIN)	28 (MIN)	-
HYDRAULIC PROPERTIES				
MAXIMUM APPARENT OPENING SIZE (AOS) (ASTM D4751)	mm	0.17	0.17	0.10
WATER PERMEABILITY (ASTM D4491)	l/m ² /min.	110 (MIN)	110 (MIN)	90 (MIN)

B. FILLER/MICRO CONCRETE

THE MICRO CONCRETE MIX TO FILL CONCRETE MATTRESS IS RECOMMENDED

- a. WATER:CEMENT RATIO OF 0.7:1.0 AND SAND:CEMENT RATIO OF 2:1
- b. THE SAND TO BE USED IN THE MICRO CONCRETE MIX SHOULD BE WELL-GRADED. WASHED RIVER OR SEA SAND IS PREFERABLE AS IT IS MORE ROUNDED IN NATURE. THE SAND SHOULD BE IN ACCORDANCE WITH THE GRADING REQUIREMENT SPECIFIED BELOW:

SIZE	PERCENTAGE PASSING (%)
5 mm	100
2.36 mm	80 - 100
1.18 mm	70 - 100
600 µm	55 - 100
300 µm	5 - 70
150 µm	0 - 15
75 µm	0 - 5

- c. THE CEMENT TO BE USED TO PRODUCE THE MICRO CONCRETE SHALL BE ORDINARY PORTLAND CEMENT.

- d. THE WATER TO BE USED TO PRODUCE THE MICRO CONCRETE SHALL BE FRESH AND POTABLE.

- c. THE EQUIPMENT FOR MIXING AND PLACING SHALL BE A COLLOIDAL MIXER AND A LOW PRESSURE PUMPING SYSTEM.

- D. SIDE SLOPE
THE SIDE SLOPE MUST NOT BE STEEPER THAN 1H:1.5V.

- E. FREEBOARD
ENSURE APPROPRIATE FREEBOARD AS PER DPWH DESIGN GUIDELINES, CRITERIA AND STANDARDS, VOL. 3, 2015.

- F. ANCHOR/TOP TERMINATION TRENCH
TO ENHANCE STABILITY AND EFFECTIVENESS, IT IS ADVISED TO INCORPORATE A SUITABLE ANCHORING SYSTEM ALONG WITH THE AFOREMENTIONED MATERIALS. THE ANCHORING SYSTEM SERVES VARIOUS PURPOSES, ENCOMPASSING:
 - a. REINFORCING EXISTING SLOPES ;
 - b. RESTORING FAILED SLOPES ;
 - c. ENSURING SLOPE AND GROUT-FILLED MATTRESS STABILITY THROUGHOUT ALL CONSTRUCTION STAGES ; AND
 - d. MANAGING BUOYANCY AND UPLIFT PRESSURES DURING EXTREME FLOODING CONDITION ALONG THE PROTECTED BANKS.



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SHEET TITLE:

STANDARD PLAN OF
CONCRETE MATTRESS
FOR FLOOD CONTROL

SHEET CONTENTS:

GENERAL NOTES 1-2

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01
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- G. TOE PROTECTION
TOE PROTECTION SHALL BE DESIGNED TO PREVENT SCOURING CAUSED BY FLOW ATTACKS AND MAY INCLUDE, BUT NOT LIMITED TO, FILL MATERIALS, CONCRETE TOE BEAM, CONCRETE MINI WALL, RIP-RAP, ETC.
- H. DRAINAGE (DRAINAGE GEOTEXTILE)
A SINGLE LAYER OF POLYPROPYLENE NON-WOVEN GEOTEXTILE FILTER FABRIC MEETING THE SPECIFIED THICKNESS, WEIGHT, AND PROPERTIES ACCORDING TO THE DESIGN REQUIREMENTS. SHALL BE POSITIONED BEHIND THE GROUT-FILLED MATTRESS LINING.
- I. END PROTECTION WORKS/TERMINATION DETAILS
THE REVETMENT ARMOR SHOULD BE CONTINUOUS UPSTREAM AND DOWNSTREAM OF AREAS WITH SEVERE HYDRAULIC FORCES, WITH MINIMUM DISTANCES OF 1.0 CHANNEL WIDTH UPSTREAM AND 1.5 CHANNEL WIDTH DOWNSTREAM. IDENTIFICATION OF THESE AREAS IS DONE THROUGH SITE INSPECTION, AERIAL PHOTOGRAPHY, OR HYDRAULIC MODELING.

III. DESIGN CONSIDERATIONS

STABILITY AGAINST FLOW ATTACK

THE STABILITY CRITERION OF CONCRETE MATTRESS UNDER LONGITUDINAL FLOW ATTACK IS AS FOLLOWS (PILARCZYK 1990; CUR 217, 2006):

$$D_e \geq (0.035 / \Delta) (\Phi / \Psi) (K_T K_h / K_s) ((u_{cr})^2 / 2g)$$

WHERE:

- D_e = EFFECTIVE THICKNESS OF REVETMENT (m)
 Δ = BOUYANT RELATIVE DENSITY OF STRUCTURAL UNIT
 1.4 (CONCRETE USED TO FILL THE MATTRESS)
 Φ = STABILITY PARAMETER
 Ψ = SHIELD PARAMETER (0.07 FOR GEOMATTRESSES)
 K_T = TURBULENCE FACTOR
 K_h = DEPTH PARAMETER
 K_s = SLOPE PARAMETER (1.0 FOR CONCRETE MATTRESS ANCHORED AT THE TOP OF SLOPE)
 u_{cr} = CRITICAL FLOW VELOCITY ALONG THE STRUCTURE (m/s)
 g = GRAVITATIONAL ACCELERATION (9.81 m/s²)

THE STABILITY PARAMETER Φ DEPENDS ON THE APPLICATION. SOME GUIDE VALUES ARE GIVEN BELOW:

	CONTINUOUS TOPLAYER	EDGES AND TRANSITIONS
GEOBAGS AND GEOMATTRESSES	1.0	1.5

THE DEGREE OF TURBULENCE CAN BE TAKEN INTO ACCOUNT WITH THE TURBULENCE FACTOR K_T . SOME GUIDE VALUES FOR K_T ARE GIVEN BELOW:

	K_T
NORMAL TURBULENCE: ABUTMENT WALLS OF RIVERS	1.0
INCREASED TURBULENCE: RIVER BENDS DOWNSTREAM OF STILLING BASINS	1.5
HEAVY TURBULENCE: HYDRAULIC JUMPS SHARP BENDS STRONG LOCAL DISTURBANCES	2.0

WITH THE DEPTH PARAMETER K_h , THE WATER DEPTH IS TAKEN INTO ACCOUNT, WHICH IS NECESSARY TO TRANSLATE THE DEPTH-AVERAGED FLOW VELOCITY INTO THE FLOW VELOCITY JUST ABOVE THE REVETMENT. THE DEPTH PARAMETER ALSO DEPENDS ON THE MEASURE OF DEVELOPMENT OF THE FLOW PROFILE AND THE ROUGHNESS OF THE REVETMENT.

THE FOLLOWING FORMULAS ARE RECOMMENDED:

DEVELOPED PROFILE: $K_h = 2 / (\log(12h / k_s))^2$

NON-DEVELOPED PROFILE: $K_h = (h / k_s)^{-0.2}$

VERY ROUGH FLOW ($h/k_s < 5$): $K_h = 1.0$

WHERE:

- h = WATER DEPTH (m)
 k_s = EQUIVALENT ROUGHNESS

IN THE CASE OF DIMENSIONING THE REVETMENT ON A SLOPE, THE WATER LEVEL AT THE TOE OF THE SLOPE MUST BE FILLED IN FOR h . THE EQUIVALENT ROUGHNESS DEPENDS ON THE TYPE OF REVETMENT/GEOSYSTEM. FOR MATTRESSES, IT DEPENDS ON THE TYPE: k_s OF ABOUT 0.05m FOR SMOOTH TYPES AND ABOUT HEIGHT OF THE RIB FOR ARTICULATING MATS.



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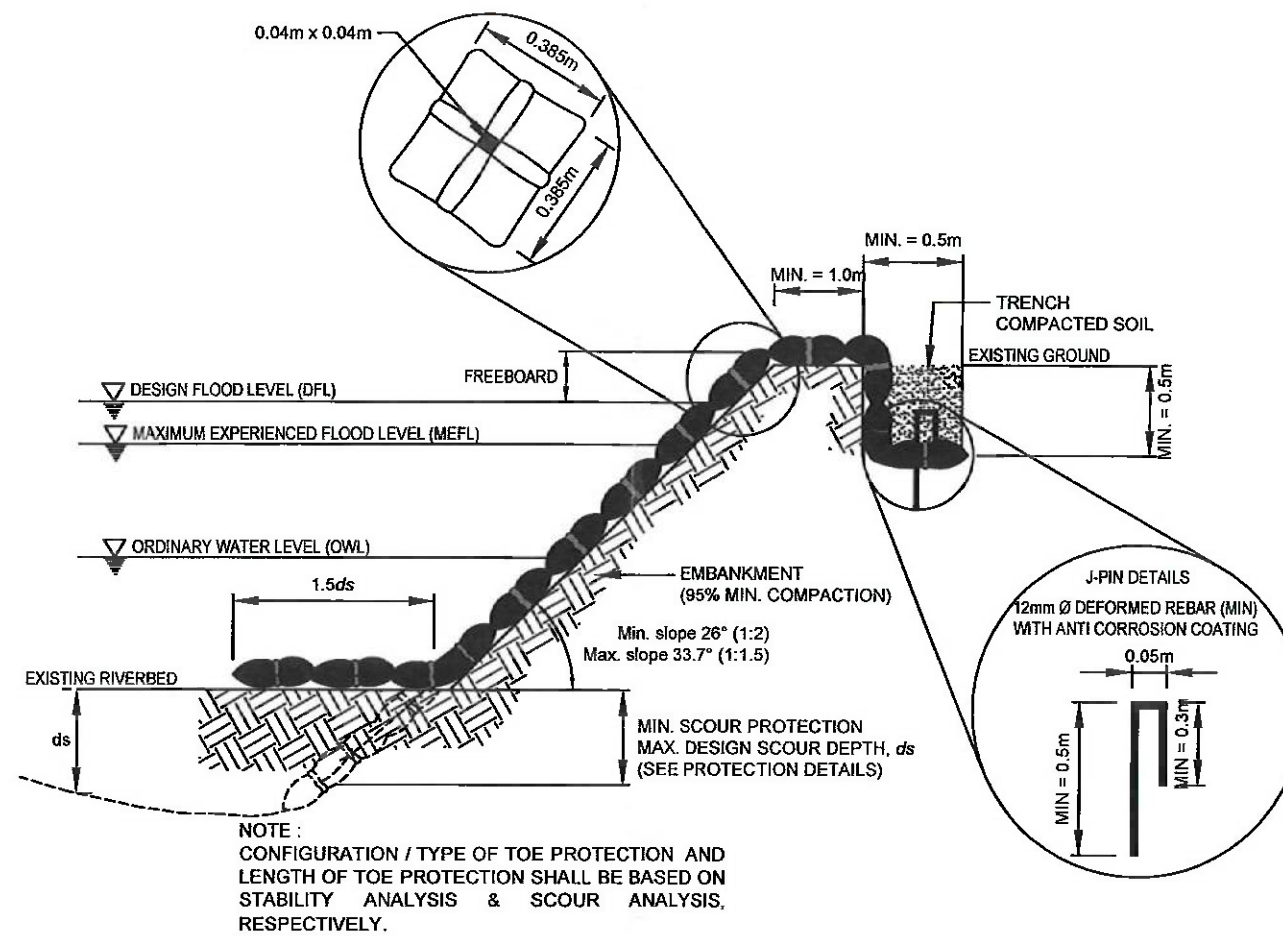
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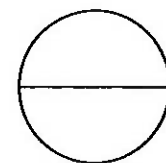
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TYPICAL CROSS-SECTION WITH "SOFT-BED" CHANNEL



SCALE

NTS



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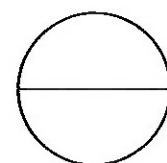
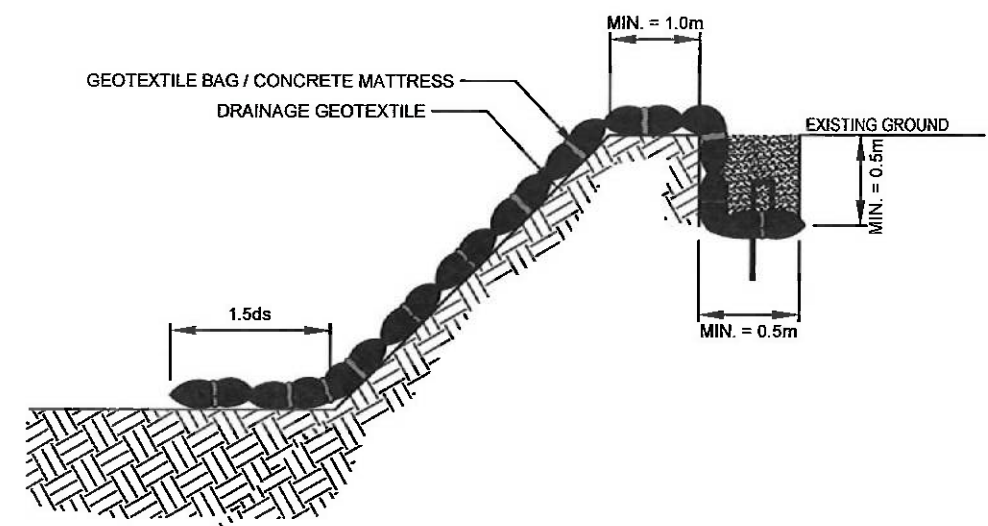
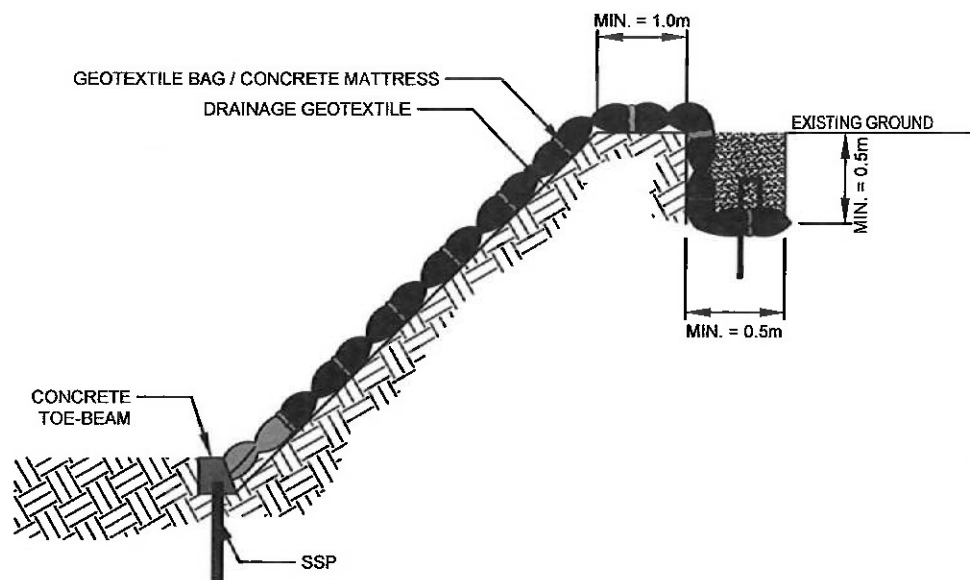
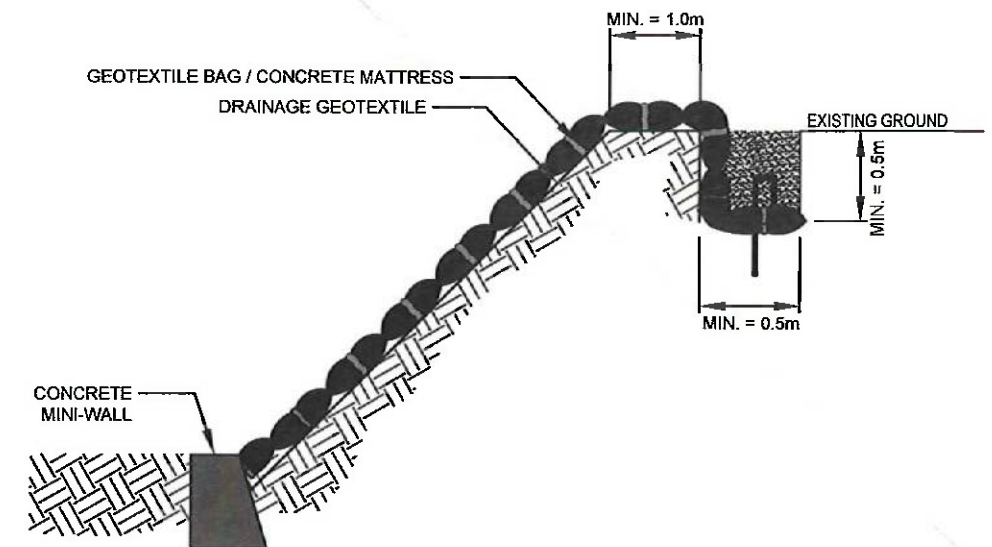
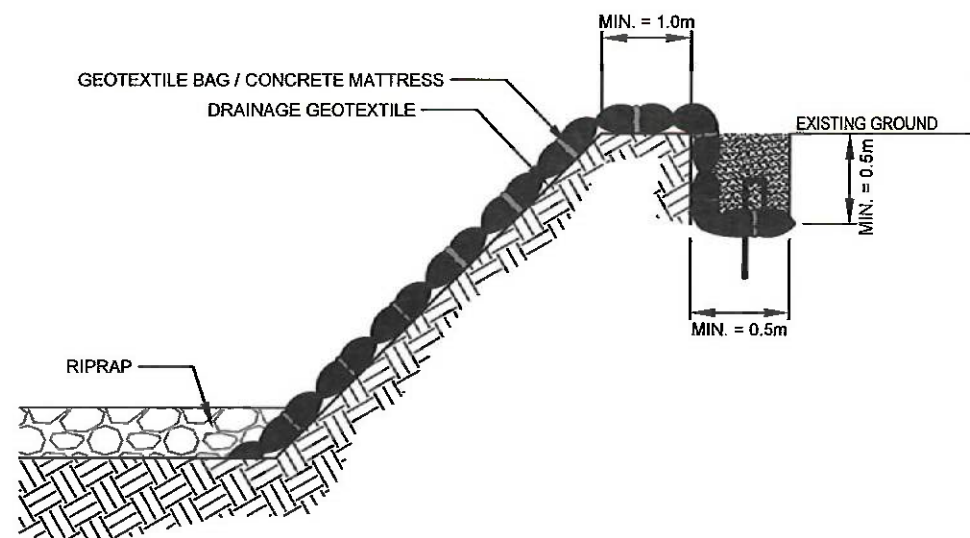
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TOE PROTECTION TYPES

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