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DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS  
OFFICE OF THE SECRETARY  
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DEPARTMENT ORDER )

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SUBJECT : Item 522 - Active and Passive Protection Systems for Unstable Slope (Amendments to Item 522 - DPWH Generic Specification for Rockfall Protection Systems and Item 522A - DPWH Standard Specification for Protection Systems for Unstable Slope)

In order to ensure uniformity in the application/ adoption of the Pay Items of Work to be used/ adopted by those who are involved in the preparation of the Design Plans and Quantities, Program of Works (POW) and Approved Budget for the Contract (ABC) for Infrastructure Projects Nationwide, the attached amendments to DPWH Standard Specification for **Item 522 – DPWH Generic Specification for Rockfall Protection Systems and Item 522A – DPWH Standard Specification for Protection Systems for Unstable Slope** (*henceforth unified and renamed as **Item 522 - Active and Passive Protection Systems for Unstable Slope***) is hereby prescribed for this purpose.

This Standard Specification shall form part of the revised 2012 edition of the DPWH Standard Specifications for Highways, Bridges and Airports, Volume II and will be included in the Project and Contract Management Application (PCMA).

This Order supersedes the following issuances and shall take effect immediately:

1. Department Order No. 33, Series of 2013, "DPWH Generic Specification for Rockfall Protection Systems, Item 522"
2. Department Order No. 63, Series of 2014, "DPWH Standard Specification for Item 522A - Protection Systems for Unstable Slope"

  
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Secretary

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WIN9U01716

14.1.2 FET/RGT

**DPWH Standard Specification for  
ITEM 522 – ACTIVE AND PASSIVE PROTECTION SYSTEMS FOR UNSTABLE SLOPE  
(Amendments to Item 522 - DPWH Generic Specification for Rockfall Protection  
Systems and Item 522A - DPWH Standard Specification for Protection Systems for  
Unstable Slope)**

**522.1 Description**

This Item shall consist of furnishing and installing active and passive protection systems on unstable slope in accordance with these Specifications and as shown on the Plans.

**522.2 General**

**522.2.1 Function**

The protection systems shall be used to keep soil and/or rock mass in place and/or hold debris, soil and rocks from causing damage to infrastructures and to protect users.

**522.2.2 Classification of Protection Systems**

There are two classes of protection systems, namely "active system" and "passive system".

**522.2.2.1 Active System**

Active system prevents detachment of rock and/or soil mass and prevents excessive movement of detached rock and/or soil mass once it has occurred. It shall stabilize the surface layer of slope containing potentially unstable rock and/or soil mass.

Active system is either mesh or non-mesh systems as shown in Table 522.1.

**Table 522.1 Kinds of Active System**

<b>Kind</b>	<b>Description</b>
1. Non-mesh system	The slope is stabilized using steel plates and anchors at specified spacing, diameter and length reinforced with wire rope. If necessary, the use of steel wire mesh can be allowed as a supplementary member for surface erosion control or surface rock pinning. If required, the use of erosion control materials (Items 512 and 622) and/or hydroseeding (Item 520) can be allowed.
2. Mesh system	The slope is stabilized using mesh systems reinforced with steel plates and anchor bolts/soil nails at specified spacing. Additional layer of erosion control materials (Items 512 and 622) and/or hydroseeding (Item 520) can be allowed.

**522.2.2.2 Passive System**

Passive system aims to contain and intercept falling, sliding and flowing debris. Kinds of passive system are shown in Table 522.2.

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**Table 522.2 Kinds of Passive System**

<b>Kind</b>	<b>Description</b>
1. Simple Drapery System and Hybrid Drapery System	<p>Simple drapery system refers to a mesh system where mesh is secured with minimal anchors at the crest and toe of the slope. No intermittent plates and anchor bolts/soil nails are required on the slope. In cases where the slope is steep additional anchors and plates are needed.</p> <p>Hybrid drapery system refers to a mesh system where mesh is hanged via posts. Falling rock debris is guided to fall down the slope while being contained safely behind the mesh, and then collected at the toe of the slope.</p>
2. Catch fences	<p>Catch fences are tested fence system consisting of posts, base plates, intercepting mesh panels, energy-dissipating devices, and anchor bolts/soil nails. It is a tested and certified system to withstand an energy of designed value as per ETAG027 or similar guidelines.</p> <p>Catch fences for controlling debris flow can also be installed in landforms created by natural running water like river tributaries and gullies. These are manufacturer certified and tested systems that can withstand minimum impact pressures as designed.</p>

**522.3 Material Requirements**

All materials shall be accompanied with a certificate issued by the manufacturer or supplier stating compliance with the specification requirements, non-infringement of registered patents (with patent number clearly stated if available), and the material's country of origin.

**522.3.1 Non-mesh System**

The components of active non-mesh system shall conform to Table 522.3.

**Table 522.3 Non-Mesh System Components**

<b>Component</b>	<b>Specification</b>	<b>Test Method</b>
Steel Plate	<p>Welded Structural Steel</p> <p>Size: (Thickness) 6 mm × (Height) 95 mm × (Width) 680 mm</p> <p>Area: 0.22 m<sup>2</sup></p> <p>Yield strength: 245 MPa (Min.)</p>	ASTM A36M or any equivalent Standards such as JIS G3101:SS400
	<p>Coating: Galvanized</p> <p>Zinc coating: 550 g/m<sup>2</sup></p>	Coating: ASTM A653M / ASTM A90M or any equivalent Standards such as JIS H 8641 and JIS H 0401 / ISO 1459-1973

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Component	Specification	Test Method
Wire Rope	Diameter: 8 mm Breaking Load: 33.8 kN (Min.)	ASTM A1023M or any equivalent Standards such as JIS G 3525
	Zinc-alloy coating: 90%ZN & 10%Al (100 g/m <sup>2</sup> )	Coating: ASTM A90M or any equivalent Standards such as JIS H 0401
	Accelerated weathering (salt spray) test: 80% of tensile strength shall be retained after 3,500 hours	Corrosion resistance: ASTM B117 or any equivalent Standards such as JIS Z 2371
Anchor Bolt	Diameter of self-drilling type: 28.5 mm Yield strength: 450 MPa (Min.)	ASTM A615M / ASTM A29M or any equivalent Standards such as JIS G 3112 / JIS G 4051
	Diameter of insert-after-drilling type: 19 – 32 mm Yield strength: 345 MPa (Min.)	
	Zinc Coating: 550 g/m <sup>2</sup> or equivalent	
Wire Mesh (optional)	Diameter: 2mm (Min)	ASTM A 1023 /ASTM A931 (except wire tensile strength) or any equivalent standard
Grout	If necessary, grouting requirements shall conform to the applicable provisions of Item 513, Permanent Ground Anchors.	

### 522.3.2 Mesh System

The main components of active and passive mesh systems shall conform to Table 522.4. Additional components or accessories can be allowed as per manufacturer's recommendations and for approval by the Engineer.

**Table 522.4 Mesh System Components**

Component	Specification	Test Method
Mesh	See Tables 522.5 & 522.6	See Tables 522.5 & 522.6
Steel Plate	Spike plate Thickness: 7 mm (Min.) Effective area: 190 mm x 330 mm (Min.) 10 mm x 280 mm x 100 mm (Min.)	Spike plate: ASTM A656M / ASTM A36M or any equivalent Standards

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	Yield Strength: 185 MPa (Min.) Tensile Strength: 470 MPa (Min.)  HR plate – 8 mm x 250 mm x 250 mm (Min.)  Yield Strength: 185 MPa (Min.) Tensile Strength: 470 MPa (Min.)	HR plate: ASTM A36M or any equivalent Standards
Wire Rope (Border Rope)	Diameter: 6 mm (Min.)	ASTM A1023M /ASTM A931 or any equivalent Standards
Anchor bolt / Soil Nail	Diameter: 22 mm to 40 mm Yield strength: 345 MPa (Min.)  Coating: Galvanized, Epoxy, Resin  If necessary, grouting requirements shall conform to the applicable provisions of Item 513, Permanent Ground Anchors.	ASTM A615M or any equivalent Standards  Coating: ASTM A123M or any equivalent Standards

**Table 522.5 Active System, Wire Mesh Components**

<b>Properties</b>	<b>Requirements</b>	<b>Test Method</b>
Wire Diameter: Wire	2.00 mm (Min.)	ASTM A856M
High Tensile	2.00 mm (Min.)	ASTM A854M or JIS G 3548
Wire Rope Diameter:	4.5 mm (Min.)	ASTM A1023M
Coating	<ul style="list-style-type: none"> <li>• Zinc,</li> <li>• Zinc - 10% Al</li> <li>• Zinc - 10% Al+Modified Saturated Polyester Resin (MSPR)</li> <li>• Zinc+MSPR</li> <li>• Zinc - 5% Al-Misch Metal (MM)</li> <li>• Zinc - 5% Al-MM+Polymeric</li> </ul>	ASTM A90M / ASTM B750 / ASTM A856M / ASTM A392 / ASTM A641/ ASTM A854M or JIS H8641
Weight of coating	Class 3 or A	ASTM A90M/ASTM D750/ ASTM A856M/ ASTM A392/ ASTM A641 or JIS H8641
Weathering (Salt Spray Test)	1000 hours (Min.)	ASTM B117

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Wire Tensile Strength: Wire	290 MPa (Min.)	ASTM A641
High Tensile Wire	970 MPa (Min.)	ASTM A854
Wire Rope (Breaking Force)	11.6 kN (Min.)	ASTM A1023M
Mesh Tensile Strength:  Wire Mesh	90 KN/m (Min.)	EAD 230008-00-0106 / EAD 230025-00-0106 / JIS G 3552
High Tensile Wire Mesh	150 KN/m (Min.)	
Wire Rope Mesh	150 KN/m (Min.)	

**Table 522.6 Passive System, Wire Mesh Components**

Properties	Requirements	Test Method
Wire Diameter	2.00 mm (Min.)	-
High Tensile	2.00 mm (Min.)	ASTM A854M / JIS G 3548
Wire Rope	8 mm (Min.)	ASTM A 1023M
Coating	<ul style="list-style-type: none"> <li>• Zinc</li> <li>• Zinc - 10% Al</li> <li>• Zinc - 10% Al+Modified Saturated Polyester Resin (MSPR)</li> <li>• Zinc+MSPR</li> <li>• Zinc - 5% Al-Misch Metal (MM)</li> <li>• Zinc - 5% Al-MM+Polymeric</li> </ul>	ASTM A90M / ASTM B750 / ASTM A856M / ASTM A392 / ASTM A641/ ASTM A854M or JIS H8641
Weathering (Salt Spray Test)	1000 hours (Min.)	ASTM B117
Wire Tensile Strength:  Wire	290 MPa (Min.)	ASTM A641
High Tensile Wire	970 MPa (Min.)	ASTM A854
Wire Rope (Breaking Force)	40.7 KN (Min.)	ASTM A1023M
Mesh Tensile Strength:	50 KN/m (Min.)	

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Wire Mesh	150 KN/m (Min.)	EAD 230008-00-0106 /
High Tensile Wire Mesh	50 KN/m (Min.)	EAD 230025-00-0106 /
Wire Rope Mesh		JIS G 3552

### 522.3.3 Catch Fences

The catch fence system shall comply with the requirements for Category 'A' Falling Rock Protection Kits under Guideline for European Technical Approval (ETAG 027) by the European Organisation for Technical Approvals (EOTA) or similar guidelines. Certificate from a recognized and independent authority attesting to the impact energy absorbing capacity of the flexible catch fence system under ETAG 027 or similar guidelines shall be submitted to the Engineer for approval.

All components shall be the same or equivalent to the components as declared in the ETAG 027 certificate or its approved equivalent.

The catch fence system for debris flow shall be designed based on information of the physical characteristics of the debris material, the nature of the debris flow event and the site geometry. These fences are normally constructed in-channel, perpendicular to the flow direction. A simple gully net is often sufficient for narrow spans e.g. less than 15 m, whereas a post and net system is required for wide channels applications.

A standardized stress model for design of torrential barriers under impact by debris flow under ONR 24801, Protection Works For Torrent Control – Static And Dynamic Actions On Structures or equivalent, is already in place for the application for this type of catch fences.

#### 522.3.3.1 Materials for Catch Fence System

**Table 522.7 Catch Fences Energy Levels**

Energy (kJ)	Values shall comply with ETAG 027 or similar guidelines supported by design analysis and shall be verified during implementation.
Mesh	As per manufacturer's test certificate or design specifications
Post Type	As per manufacturer's test certificate or design specifications
Post Height & Distances	As per design calculation
Components	Posts/support structures, base plates, intercepting panels (mesh, rope/cable net or ring net, etc), support wire ropes (upper, lower, lateral & junction bracing cables, etc.), energy-dissipating device, shackles, wire rope grips, wire rope anchors, bar anchors and turnbuckles

### **522.3.4 Miscellaneous Materials**

All miscellaneous material such as clips, ropes/cables, etc. shall be supplied by the manufacturer appropriate with the system. It shall be hot-dipped galvanized per AASHTO M 111 (ASTM A123M) or equivalent.

Screw bolts and nuts shall be galvanized and conform to the requirements of AASHTO M 164 (ASTM F3125M) or its equivalent.

### **522.4 Construction Requirements**

The Contractor shall provide construction methodology for installation necessary to construct the protection system.

#### **522.4.1 Non-Mesh System**

The placement of the anchor bolt shall be controlled in such a manner to maintain its positioning to be in line with the center line of the drilled hole, free from decentralization which may cause insufficient covering of grouting.

#### **522.4.2 Mesh System**

For mesh system (active), the anchorages using anchor bolt/soil nail shall be installed as per construction drawings, with a minimum grid spacing of 2 m x 2 m. Anchor bolt/soil nail lengths shall be based on results of a geotechnical investigation. Once the grouting of anchorages has achieved curing, the mesh panels are then installed. The rolls of mesh panel shall be positioned as per Plans. On the slope face, the side of mesh panels shall be securely and continuously joined together using connection clips or ropes. Erosion control materials and/or hydroseeding can be added to the protection system in cases as per the Engineer's recommendations.

For simple drapery (passive), minimum anchorages using anchor bolt/soil nail shall be installed on top and/or bottom of the slope. The distribution of the top and/or bottom anchorages shall be calculated based on the maximum load that may occur at each anchorage, bearing in mind the breaking strain of the drapery mesh panel. It shall be better to link the individual anchorages with a steel rope (crest and bottom cable), where the mesh is securely connected. Close the ends of drapery at the toe of the slope with anchorages and bottom cable to contain loose material. The bottom fixing shall allow for periodic removal of accumulated debris after which the mesh panel must be anchored again. On the slope face, the mesh panel shall be securely and continuously laced together using binding wire, with the provision of additional pins against the wind. Depending on the slope face condition, additional anchor bolts/soil nails shall be installed. The rolls of drapery shall be rolled into position as per Plans. New rolls shall be placed in the same direction directly overlapping the adjacent roll such that the selvedge of both rolls can be laced together by hand.

For hybrid drapery (passive), posts shall be installed as per construction drawings. Prior to installation, the Contractor shall place simulation posts that are of the same height as the actual ones and mark the anchorage points for wire ropes on site for the Engineer's verification. The post position and the anchorage points for wire ropes shall not be adjusted without the Engineer's approval.



### **522.4.3 Catch Fences**

Detailed method statements and drawings for construction of the catch fence system, in accordance with the manufacturer's recommendations for the delivery and handling of all components and for the construction of the anchorage/foundation of the said system, shall be submitted to the Engineer for comment before commencement of the construction.

In-situ boulder stabilization/splitting works along the proposed alignment of the catch fence system should be completed prior to the construction of the catch fence.

The sequence of installation and the connection details of catch fence components shall be in accordance with the manufacturer's recommendation and the approved method statement and construction drawings.

The Contractor shall provide and install the catch fence systems at locations indicated in the Plans. Prior to installation, the Contractor shall mark the alignment of the fence and the positions of the steel posts and the anchorage points for wire ropes on site for the Engineer's verification. The fence location and the anchorage points for wire ropes shall not be adjusted without the Engineer's approval.

After the installation, all galvanized steel components such as shackles, wire rope grips, bolts and nuts, as well as repairs to galvanization coating for other steel parts shall be treated with zinc-rich cold-galvanizing paint.

### **522.4.4 Quality Control & Assurance**

For pull testing, the Contractor shall perform two (2) types of soil nail/anchor pull test; (1) Conformity Pull Test which is performed for trial anchor bolts/soil nails prior to actual anchor bolts/soil nails installation for the verification of peripheral surface friction resistance, and (2) Proof Pull Test which is performed for selected set of installed soil nails/anchors for the verification of their anchoring strength to meet the required performance. It is preferable to conduct one (1) Conformity Pull Test if the soil condition of the site is unpredictable only from the available data, but it can be omitted if it is predictable from the available data.

The Contractor shall provide all necessary resources including all torque wrenches, jacks, gauges, reaction frame, pump, load cell, bearing plates, and other equipment required to carry out the pull test of the anchor bolts/soil nails specified.

#### **522.4.4.1 Conformity Pull Test**

The Contractor shall install the trial or preliminary anchor bolts/soil nails and carry out conformity (verification) pull test at locations selected by the Engineer. The number of anchor bolts/soil nails to be tested shall normally be three (3).

The soil nails shall be tested in accordance with the following conditions:

1. Maximum load; 90% of the yield strength of the anchor bolt
2. Loading cycle; single or multiple cycle

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3. Record items; load value, anchor bolt displacement, settlement of reaction plate, and time of testing

#### **522.4.4.2 Proof Pull Test (Mandatory)**

Arbitrarily selected 3% of total number or a minimum of three (3) of installed anchor bolts/soil nails shall be proof tested in accordance with the following conditions:

1. Maximum load; design load
2. Loading cycle; single cycle
3. Record items; load value and time of testing

#### **522.4.4.3 Recording of Anchor Bolts Installation**

The Contractor shall keep records for each anchor bolt installed for each day of operation for approval of the Engineer prior to the next anchor bolt installation. The record for each anchor bolt shall include but not limited to anchor bolt reference number, date/time of commencement and completion of drilling and grouting, plus the necessary drilling (with or without grouting) details, etc.

#### **522.4.4 Handling & Storage**

Rolls or panels of meshes, soil nails/anchor bolts, cement, and all other materials shall be marked, kept dry, and protected against direct sunlight and possible damage during periods of shipment and storage.

#### **522.5 Method of Measurement**

The quantities to be paid for under this Item shall be the number of square meters or lump sum of active or passive drapery system installed and accepted, and the number of linear meters (LM) of catch fences of the required resistance, including the necessary posts, supports and energy-dissipating devices, anchorages, steel bolts, clips, ropes/cables, erected/installed and accepted, and related accessories or components.

#### **522.6 Basis of Payment**

The quantities measured as determined in Section 522.5, Method of Measurement shall be paid for at the Contract Unit Price shown in the Bid Schedule, which price and payment shall be full compensation for the necessary design and for furnishing and installing/erecting active and/or passive protection systems, for excavation, backfilling and construction of components related to the systems, and for furnishing all labor, equipment, tools and incidentals necessary to complete the Item.

Payment shall be made under:

<b>Pay Item Number</b>	<b>Description</b>	<b>Unit of Measurement</b>
522(1)	Active System	Lump Sum

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<b>Pay Item Number</b>	<b>Description</b>	<b>Unit of Measurement</b>
522(2)	Passive System	Lump Sum
522(3)a	Active Non-mesh System	Square meter
522(3)b	Active Non-mesh System with Erosion Control	Square meter
522(4)a	Active Wire Mesh System	Square meter
522(4)b	Active Wire Mesh System (High Tensile)	Square meter
522(5)a	Passive System, Simple Drapery	Square meter
522(5)b	Passive System, Simple Drapery (High Tensile)	Square meter
522(6)a	Passive System, Hybrid Drapery	Square meter
522(6)b	Passive System, Hybrid Drapery (High Tensile)	Square meter
522(7)a	Catch Fences	Linear meter
522(7)b	Catch Fences (Debris Flow)	Linear meter

**References:**

1. DPWH Standard Specifications for Highways, Bridges and Airports, Volume II, 2012 Edition
  - Item 512, Erosion Control Mats, Roving, and Cellular Confinement Systems
  - Item 520, Hydroseeding
  - Item 522, Rockfall Protection System
  - Item 522A, Protection System for Unstable Slope
  - Item 522B, Landslide Protection System
  - Item 622, Coconet Bio-Engineering Solutions
2. Guideline for European Technical Approval (ETAG 027)
3. Japan Road Association
  - Guide on Rockfall Countermeasures
4. American Society for Testing Materials (ASTM)
  - ASTM A36/A36M-14, Standard Specification for Carbon Structural Steel
  - ASTM A653/A653M-17, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  - ASTM A90/A90M-13, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
  - ASTM A1023/A1023M-2015, Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
  - ASTM B117-16, Standard Practice for Operating Salt Spray (Fog) Apparatus
  - ASTM A615/A615M-16, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
  - ASTM A29/A29M-16, Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought
  - ASTM A656/A656M-18, Standard Specification for Hot-Rolled Structural Steel, high-Strength Low-Alloy Plate with Improved Formability
  - ASTM A370-17a, Standard Test Methods and Definitions for Mechanical Testing of Steel Products

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- *ASTM A123/A123M-17, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*
- *ASTM B750-16, Standard Specification for GALFAN*
- *ASTM A856/A856M-03(2014), Standard Specification for Zinc-5% Aluminum-Mischmetal Alloy-Coated Carbon Steel Wire*
- *ASTM A392-11a(2017), Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric*
- *ASTM A854/A854M-08(2017), Standard Specification for Metallic-Coated Steel Smooth High-Tensile Fence and Trellis Wire*
- *ASTM F3125/F3125M-15a, Standard Specification for Structural Bolts, Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions*
- 5. *Japan Industrial Standards (JIS)*
  - *JIS G3101:SS400, Structural Carbon Steel Plate Specification*
  - *JIS H8641:2007, Hot Dip Galvanized Coatings*
  - *JIS H0401:2007, Test methods for Hot Dip Galvanized Coatings*
  - *JIS G3525, Wire Ropes*
  - *JIS Z2371:1994, Methods of Neutral Salt Spray Testing*
  - *JIS G3112:2010, Steel Bars for Concrete Reinforcement*
  - *JIS G4051, Carbon Steel for Machine Structural Use*
- 6. *International Organization for Standardization*
  - *ISO 1459-1973, Metallic Coatings-Protection against corrosion by Hot Dip Galvanizing-Guiding Principles*
  - *ISO 2408:2017, Steel Wire Ropes-Requirements*
  - *ISO 9227:2017, Corrosion Tests in Artificial Atmospheres- Salt Spray Tests*
  - *ISO 6935-2:2015, Steel for the Reinforcement of Concrete-Part 2:Ribbed Bars*
  - *ISO 683-1:2016, Heat-Treatable Steels, Alloy Steels and Free-Cutting Steels- Part 1: Non-Alloy Steels for Quenching and Tempering*
  - *ISO 1461:2009, Hot Dip Galvanized Coatings on Fabricated Iron and Steel Articles-Specifications and Test Methods*
- 7. *Philippine National Standards*
  - *PNS 49:2002, Steel bars for Concrete Reinforcement-Specification*
- 8. *American Association of State Highway and Transportation Officials (AASHTO)*
  - *AASHTO M 111, Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products (ASTM A123)*
  - *AASHTO M 164, Standard Specification for High-Strength Bolts for Structural Steel Joints*
- 9. *ONR 24801, Protection Works For Torrent Control – Static And Dynamic Actions On Structures*
- 10. *State of OHIO Department of Transportation Supplemental Specification 862 Rockfall Protection*
- 11. *The Japanese Geotechnical Society*
  - *Design/Installation Manual for Ground Reinforcing Method*