Republic of the Philippines
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
Bonifacio Drive, Port Area Manila

BAGONG PILIPINAS

097.13 DPWH
01.29.2024

JAN 26 2024

DEPARTMENT ORDER NO. 13 Series of 2024
JN 1/29/24

SUBJECT: Guidelines and Standard Design Drawings for Item 522 - Active and Passive Protection Systems for Unstable Slopes

In line with the continuing efforts of the Department to provide proper and uniform standards that will improve the efficiency and ensure the stability, and streamline the implementation of DPWH critical slope protection projects, the following references/guidelines are hereby issued for the implementation and compliance of all concerned:

1. All critical infrastructure projects utilizing Item 522 – Active and Passive Protection System for Unstable Slope, shall use the flowchart in **Annex "A"** in the selection of an appropriate and specific type/class of the item.

2. All implementing offices shall use/adopt the attached standard design drawings in **Annex "B"**, in the preparation of the Detailed Engineering Design (DED) plan, which indicate the generic characteristic/specifications of the following type/class of Item 522:

2.1 **Active Protection 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.

2.1.1 Non-Mesh System

The slope is stabilized by 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 (Item 512 and 622) and/or hydroseeding (Item 520) can be allowed.

2.1.2 Mesh System

The slope is stabilized by using mesh system reinforced with steel plates and soil nails at specified spacing. Additional layer of erosion control materials (Item 512 and 622) and/or hydroseeding (Item 520) can be allowed.

2.2 **Passive Protection System**

Aims to contain and intercept falling, sliding, and flowing debris.

2.2.1 Simple Drapery

Refers to a mesh system where mesh is secured with minimal soil nails 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.

2.2.2 Hybrid Drapery

Refers to a mesh system where mesh is hanged via post. Falling rock debris is guided to fall down the slope while being contained safety behind the mesh, and then collected at the toe of the slope.

2.2.3 Catch Fence

Catch fences are tested fence system consisting of posts, base plates, intercepting mess panels, energy-dissipating devices, and anchor bolts/soil nails.

This Order shall take effect immediately.

MANUEL M. BONOAN
Secretary

5.1.3 RCR/BSR/DLB/MGM/AGC

Department of Public Works and Highways
Office of the Secretary
WIN4R01619

ANNEX "A":
Selection Process of Item 522: Active and Passive Slope Protection System

SELECTION PROCESS OF ITEM 522: ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEM *(SEE PAGE NO. 5 FOR THE FLOWCHART)*

1. Selection of Passive and Active Protection Systems

1.1 *Conduct of Site Investigation Surveys*

A site investigation is carried out to determine the potential/extent of road slope failures; to classify soil/rock components, slope characteristics, and geological conditions of the site and to determine the size of the hazard zone and identify the applicable mitigations to be implemented.

The survey team shall be composed of the following members:

- Civil Engineer
- Geotechnical Engineer
- Geologist
- Other technical personnel, if needed

The scope of the site assessment shall include, but not be limited to the following:

- Site description (geological setting, slope characteristics);
- Engineering geological map (delineate source areas, slope materials, run-out areas, vegetation, location and size of fallen rock, location of structures at risk);
- Source rock characterization (rock type, strength, jointing, and block sizes);
- Characterization of slope materials (rock or soil type properties, as well as any climatic dependencies);
- Water conditions (surface and subsurface); and
- Vegetation (type and size).

1.2 *Rock and/or soil collapse scattered in more than one location*

The designer / engineer is responsible for selecting the most appropriate and cost-effective countermeasures for road slope failures based on the project's scope of work, site features, and the quantity and quality of information available from the result of site reconnaissance study. To prioritize long-term stability and consider economic aspect of construction and maintenance, the active protection system shall be considered for small scale road slope failure on a single location per field investigation/assessment survey.

1.3 *Classification of Site Condition*

Active Protection System shall be given priority if any of the following site conditions exist:

- Presence of highly weathered and fractured rock;
- Deep-seated failure which typically occurs due to weak foundation soils or after long period of heavy rainfall;
- Average vertical height of slope $\geq$ 15m;
- Distance from slope toe to the road $\leq$ 15m; and
- Steep slope (average) $\geq 60^{o}$.

1.4 *Afford Additional Movement of the Slope Failure*

Active Protection System should be considered as countermeasure if a potential ground movement might endanger the safety of road users, regardless of the scope of work or area of rock/soil slope collapse being measured. Otherwise, a passive protection mechanism should be implemented.

Risk Assessment and Analysis:

- Estimate the possibility that a rockfall will impact a person or structure at risk;
- Identify and evaluate consequences of rockfall impact; and
- Determine if mitigation is necessary.

2. Procedural Steps for Passive Protection Systems

2.1 *High Risk of Falling Rocks in Bouncing Motion*

Gravity is what makes rocks fall, and the size, shape, and coefficient of friction of the boulders in the area affect where and how they fall. The motion of falling rocks is a combination of sliding, rolling, and bouncing. Free fall typically occurs on slopes steeper than 76^{o}, bouncing on slopes between 45^{o} and 76^{o}, and rolling on slopes below 45^{o}. Due to the irregularity of the majority of the slope surface, the inspectorate team should determine the risk and motion of falling rocks based on the survey and/or historical information about the site, including any previously observed rockfall. In most cases, the size or volume of collapsed or collapsible materials is less than $5m^3$. Following are the recommended types of passive protection systems based on the bounce height of the rock block along the slope profile:

Low ($\leq$ 2m)	High (> 2m)
Simple Drapery	Catch Fence / Hybrid Drapery

2.2 *Possible to cover the whole slope*

A geologic and geotechnical assessment of the potential source of rock and soil slope collapse determines the area of coverage. Simple drapery shall be used if the observed/anticipated area of rock/soil slope collapse (the entire face of the slope) can be covered. Otherwise, other countermeasures such as a catch fence and hybrid drapery should be considered if there is sufficient space available between the toe of the unstable slope and the edge of the carriageway to receive the full volume of the potential rock fall.

2.3 *Enough Space to Accommodate Collapse Mass*

Catch fence shall be used if the space between the toe of the slope and the edge of the carriageway is wide enough to accommodate the anticipated collapsed mass and the foundation of the fence post.

2.4 *Possible Installation at the Middle of the Slope*

Depending on the actual circumstances, the installation of a catch fence at the middle of the slope can also be considered if there is not enough space available at the toe of the slope. Hybrid Drapery should be used if the source of rock fall

came from a greater height and the construction/installation of a catch fence is not applicable at the middle/toe of the slope.

3. Procedural Steps for Active Protection Systems

3.1 *Determine if the majority of slope failures are soil slope collapse or rock slope collapse*

Mechanism of soil slope collapse:

- Part of the mountainside suddenly falls down on the road, mostly triggered by rainfall infiltration;
- Collapsed/collapsible materials are residual soil and highly weathered rocks;
- The movement is very fast, and the material is widely scattered and spread, which distinguishes it from landslides; and
- In general, the size or volume of collapsed or collapsible materials is greater than 200 m^3.

Mechanism of rock slope collapse:

- Failure modes are free fall, rolling down the slope or sliding along the slope;
- The majority of rock slope collapses are associated with highly fractured and jointed hard rocks. Falls occurs due to gravity and are controlled by the distribution of joints;
- Materials are hard and jointed rocks;
- Prone to occur on steep slope and cliff; and
- Size/volume of collapsed/collapsible materials is generally less than 5m^3.

3.2 *Recommendation for soil slope collapse (Non-mesh System)*
The most influential aspect of soil stability is the sliding surface. By anchoring its mass to stable ground, a non-mesh mechanism must be used to avoid the failure caused by the sliding of the soil surface. If the roots of vegetation cannot reach the sliding surface's depth, a non-mesh method is recommended.

3.3 *Recommendation for rock slope collapse (Non-mesh System or Mesh System).*
In deciding the type of active protection system (i.e., mesh or non-mesh) to be implemented for rock slope collapse, the size of the rocks should be taken into consideration. Based on the size of the rock block, the geological condition, and the presence of trees and other obstructions on the slope profile, the following active protection system is recommended:

Geological Condition:

Geological Condition / Applicable System	Weathered Rock, Soft Rock	Rock
Non-mesh System	Suitable	Applicable with limitations
Mesh System	Applicable	Suitable

Rock Size:

Minimum Rock Size ≥ 0.5m Ø (with trees/obstruction)	**Maximum Rock Size < 0.5m Ø (without trees/obstruction)**
Non-Mesh System	Mesh System

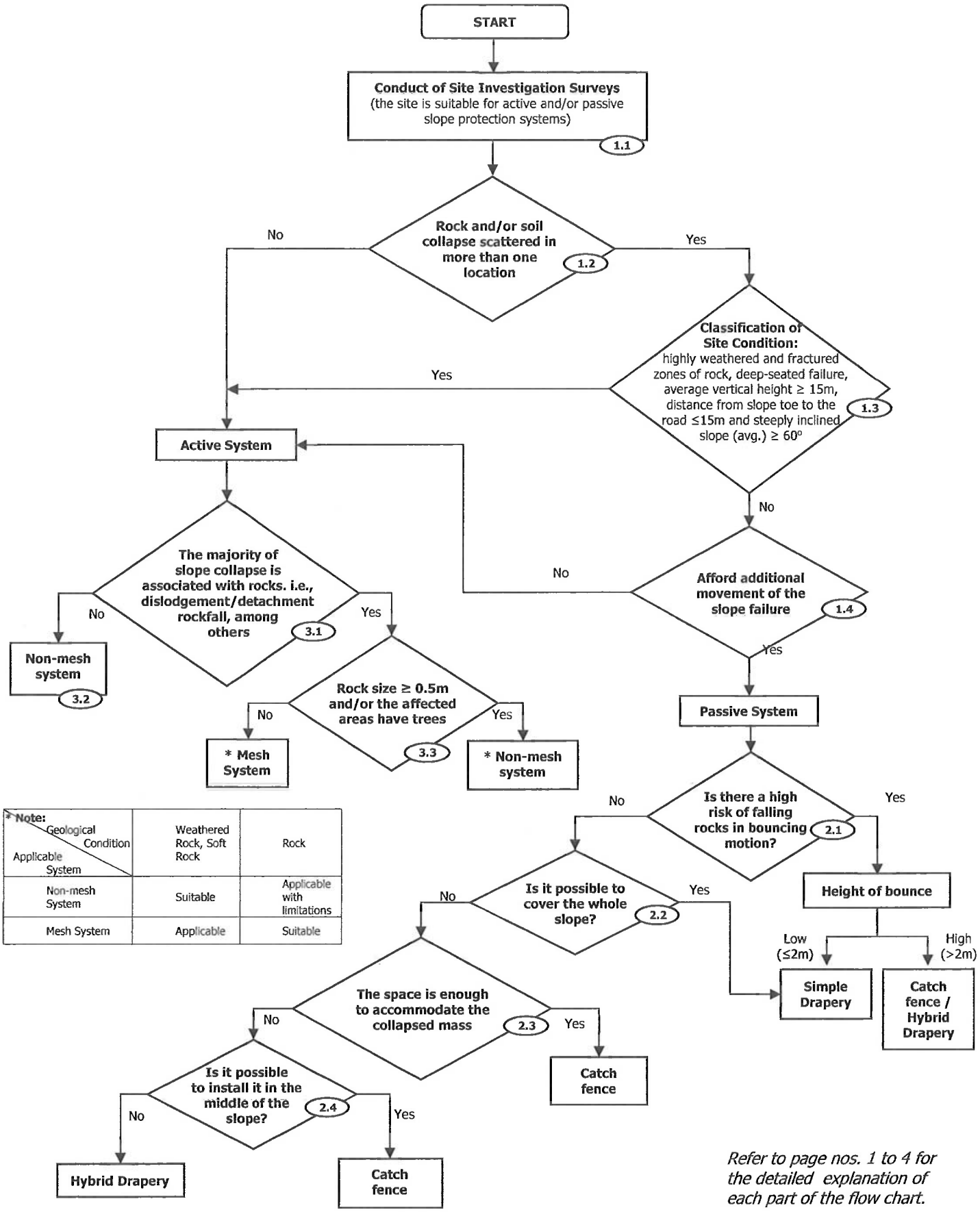
4. Combination of Passive and Active Protection Systems

Combination of countermeasures/protection works against rock falls may be allowed based on durability, construction accessibility, construction cost, maintenance requirements, road and slope conditions, and engineering judgment supported by design analysis and computation. The above-mentioned selection process should be used as a guide by the designer to ensure that the most appropriate type of Item 522 is implemented, taking into account the specific site requirements.

References:

1. *DPWH Road Slope Protection Manual, 2019 Edition*
2. *DPWH Department Order No. 32, Series of 2019 re: Item 522 - Active and Passive Protection Systems for Unstable Slope (Amendments to Item 522 - DPWH Generic Specification for Rockfall Protection System and Item 522A - DPWH Standard Specification for Protection Systems for Unstable Slope*
3. *DPWH Design Guidelines, Criteria and Standards, 2015 Edition*
4. *DPWH Guidebook for Road Construction and Maintenance Management, 2014 Edition*
5. *Final Report Guide II: The Study on Risk Management for Sediment-Related Disaster in Selected National Highways in the Republic of The Philippines, Japan International Cooperative Agency, 2007*
6. *Road Slope Management (RSM) FY 2024: Guideline in Filing Out Survey Sheets for Road Slope Management in DPWH, Part III: Screening Criteria for Road Slope Disaster (except landslide)*

FLOW CHART FOR THE SELECTION PROCESS OF ITEM 522: ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEM



* Note:

Geological Condition / Applicable System	Weathered Rock, Soft Rock	Rock
Non-mesh System	Suitable	Applicable with limitations
Mesh System	Applicable	Suitable

Refer to page nos. 1 to 4 for the detailed explanation of each part of the flow chart.

ANNEX "B":
Guidelines and Standard Design Drawings for Item 522: Active and Passive Slope Protection System

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

GUIDELINES AND STANDARD DESIGN DRAWINGS FOR ITEM 522 - ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEMS FOR UNSTABLE SLOPE

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MEDMIER G. MALIG
ASSISTANT SECRETARY FOR
TECHNICAL SEVICES AND
INFORMATION MANAGEMENT SERVICE
DATE:

APPROVED:

ADOR G. CANLAS, CESO IV
UNDERSECRETARY FOR
TECHNICAL SEVICES AND
INFORMATION MANAGEMENT SERVICE
DATE:

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

SHEET TITLE: GUIDELINES AND STANDARD DESIGN DRAWINGS FOR ITEM 522 - ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEM FOR UNSTABLE SLOPE

SHEET CONTENT: INDEX OF DRAWINGS

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SET NO. I/1

SHEET NO. 1/1

GENERAL NOTES

1. STANDARD SPECIFICATIONS

1.1 ALL WORKS SHALL COMPLY WITH DPWH STANDARD SPECIFICATIONS FOR HIGHWAYS, BRIDGES AND AIRPORTS, 2013, OR THE LATEST APPLICABLE EDITION. THE MINIMUM MATERIAL SPECIFICATION AND TESTING REQUIREMENTS OF THE COMPONENTS (I.E., STEEL PLATE, WIRE ROPE, ANCHOR BOLT, SOIL NAIL), AND ITS MISCELLANEOUS MATERIALS SHOULD BE BASED ON THE DPWH DEPARTMENT ORDER NO 32, SERIES OF 2019 OR THE LATEST DEPARTMENT ORDER PERTAINING TO ITEM 522 - ACTIVE AND PASSIVE PROTECTION SYSTEMS FOR UNSTABLE SLOPE, OR ANY ISSUANCES RELATED THERETO.

1.2 THE DPWH ROAD SLOPE PROTECTION MANUAL 2019 OR THE LATEST APPLICABLE EDITION MAY BE USED FOR THE SELECTION AND IMPLEMENTATION OF APPROPRIATE COUNTERMEASURES.

1.3 FOR ITEMS OF WORK THAT ARE NOT FOUND IN THE REVISED STANDARD PAY ITEM LIST, THE CONCERNED IMPLEMENTING OFFICE SHALL SUBMIT TECHNICAL SPECIFICATIONS OF THE SAID SPECIAL PAY ITEM TO THE BUREAU OF RESEARCH AND STANDARDS (BRS) FOR REVIEW AND EVALUATION PRIOR TO THE APPROVAL BY THE UNDERSECRETARY FOR TECHNICAL SERVICES AS PRESCRIBED IN DEPARTMENT ORDER NO. 35, SERIES OF 2018.

2. DIMENSIONS

2.1 DISTANCES, ELEVATIONS, AND OTHER DIMENSIONS SHOWN IN THE STANDARD DRAWINGS ARE IN METERS (M) AND IN MILLIMETERS (MM), UNLESS OTHERWISE SPECIFIED.

3. CLASSIFICATION OF PROTECTION SYSTEM

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 ROAD USERS, WHILST MAINTAINING SAFETY.

3.1 **TWO CLASSES**

3.1.1 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.

- NON-MESH SYSTEM - THE SLOPE IS STABILIZED BY 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 (ITEM 512: EROSION CONTROL MATS, RAVING AND CELLULAR CONFINEMENT SYSTEMS AND ITEM 622: COCONET BIO-ENGINEERING TECHNOLOGY) AND/OR HYDROSEEDING (ITEM 520) CAN BE ALLOWED.
- MESH SYSTEM - THE SLOPE IS STABILIZED BY USING MESH SYSTEM REINFORCED WITH STEEL PLATES AND SOIL NAILS AT SPECIFIED SPACING. AN ADDITIONAL LAYER OF EROSION CONTROL MATERIALS (ITEMS 512 AND 622) AND/OR HYDROSEEDING (ITEM 520) CAN BE ALLOWED.

3.1.2 PASSIVE SYSTEM: AIMS TO CONTAIN AND INTERCEPT FALLING, SLIDING, AND FLOWING DEBRIS. THE STRUCTURE ABSORBS ROCK FALL ENERGY BY PLASTIC DEFORMATION OF WIRE MESH, WIRE ROPE, AND POLE FOR POSSIBLE ABSORBABLE ENERGY.

- SIMPLE DRAPERY - REFERS TO A MESH SYSTEM WHERE MESH IS SECURED WITH MINIMAL SOIL NAILS AT THE CREST AND TOE OF THE SLOPE. NO INTERMITTENT PLATES AND SOIL NAILS ARE REQUIRED ON THE SLOPE. IN CASES WHERE THE SLOPE IS STEEP, ADDITIONAL ANCHORS AND PLATES ARE NEEDED.
- HYBRID DRAPERY - REFERS TO A MESH SYSTEM WHERE MESH IS HANGED VIA POST. FALLING ROCK DEBRIS IS GUIDED TO FALL DOWN THE SLOPE WHILE BEING SAFELY CONTAINED BY THE MESH, AND THEN COLLECTED AT THE SLOPE'S TOE.
- CATCH FENCES - TESTED FENCE SYSTEMS CONSISTING OF POSTS, BASE PLATES, INTERCEPTING MESH PANELS, ENERGY-DISSIPATING DEVICES, ANCHOR BOLTS AND SOIL NAILS. 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 MINIMAL IMPACT PRESSURES AS DESIGNED.

4. REQUIREMENTS/GUIDELINES

4.1 **ACTIVE SYSTEM**

4.1.1 NON-MESH OR MESH SYSTEM

- THIS CAN BE CATEGORIZED AS REINFORCED EARTH METHOD, WHICH STABILIZES THE SLOPES ENABLING THE PRESERVATION OF EXISTING VEGETATION/TREES, WHICH WILL CONTRIBUTE TO INCREASING DEMANDS IN SEVERAL SITES IN DANGER OF SLOPE FAILURE DISASTER. IT IS ALSO APPLICABLE TO CUT SLOPE WHICH NEEDS EARLY RECOVERY OF PLANT GROWTH WITH THE AID OF PLANT GROWTH-ENHANCING MATERIAL, IF NECESSARY.
- THIS PROTECTION SYSTEMS MUST TAKE INTO ACCOUNT MESH TENSILE STRENGTH, ROCK AND/OR SOIL TYPES, THE VOLUME OF ROCK AND/OR SOIL TO BE RETAINED, THE ANGLE OF THE SLOPE, THE PROPERTIES OF UNDERLYING SOIL AND/OR ROCK STRATA, AND CONDITIONS AT THE CREST AND TOE OF THE AFFECTED SLOPE AREA.
- THE DESIGN CALCULATIONS SHALL INCLUDE: STATEMENT OF ALL ASSUMPTIONS MADE AND REFERENCES USED IN THE CALCULATIONS, ANALYSES DEMONSTRATING COMPLIANCE WITH ALL APPLICABLE EARTH AND WATER SURCHARGES, SEISMIC OR OTHER LOADS, AND ANALYSES OR STUDIES DEMONSTRATING DURABILITY AND CORROSION RESISTANCE OF THE PROTECTION SYSTEM FOR THE PROPOSED LOCATION AND ENVIRONMENT WITH A MINIMUM SERVICE LIFE OF TEN (10) YEARS.
- THE PLACEMENT OF THE ANCHOR BOLT AND SOIL NAILS 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.

4.2 **PASSIVE SYSTEM**

4.2.1 SIMPLE DRAPERY

- SIMPLE DRAPERY SYSTEM REFERS TO A MESH SYSTEM WHERE MESH IS SECURED WITH MINIMAL ANCHORAGE AT THE CREST AND TOE OF THE SLOPE. NO INTERMITTENT PLATES AND SOIL NAILS ARE REQUIRED ON THE SLOPE.
- THE MESH TENSILE RESISTANCE (R_M) OF THE SIMPLE DRAPERY SYSTEM SHOULD BE GREATER THAN THE LOAD FROM THE SELF-WEIGHT OF THE MESH AND POSSIBLE DEBRIS ACCUMULATION AT THE TOE (I.E. FALLEN ROCKS WITHIN THE ENCLOSED AREA) AS GIVEN IN THE EQUATION BELOW:

$$R_M > W_M + W_D$$

WHERE:
W_M = SELF-WEIGHT OF THE MESH
W_D = POSSIBLE DEBRIS ACCUMULATION AT THE TOE

- DESIGN CALCULATIONS, INCLUDING ASSUMPTIONS AND INPUTS TO COMPUTE FOR THE MESH RESISTANCE, ANCHORAGE LENGTH, SPACING, AND MINIMUM PULL OUT STRENGTH, SHALL BE DULY CONSIDERED/ADOPTED BY THE PLANNING AND DESIGN DIVISION/SECTION OF THE CONCERNED IMPLEMENTING OFFICE IF A SOFTWARE PROGRAM IS USED.
- GEOTECHNICAL REPORT PRESENTING DETAILED SUBSURFACE INFORMATION (I.E., SLIDING SURFACE, STABLE LAYER, AMONG OTHERS) AND RECOMMENDATIONS MUST BE DULY SIGNED AND SEALED BY A REGISTERED CIVIL ENGINEER / GEOTECHNICAL ENGINEER.
- MINIMUM ANCHORAGE SHALL BE INSTALLED ON THE TOP AND/OR BOTTOM OF THE SLOPE. THE DISTRIBUTION OF THE TOP AND/OR BOTTOM ANCHORAGE 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.
- IN ORDER TO AVOID OVER-STRESS ON THE ANCHORAGE SYSTEM (ANCHORS AND CABLES), THE MAXIMUM TOP SOIL NAILING SPACING SHOULD BE 5 METERS.
- ANCHORAGE AT THE TOE OF THE SLOPE IN ORDER TO CONTAIN FALLEN ROCKS WITHIN THE SYSTEM MAY NOT BE REQUIRED IF ADEQUATE ROCK TRAP DITCH/TRENCH HAS BEEN PROVIDED.

4.2.2 HYBRID DRAPERY (CURTAIN NET)

- THE HYBRID DRAPERY SYSTEM IS DESIGNED TO BE INSTALLED WITH AN INTENTIONAL GAP BETWEEN THE DRAPE AND THE SLOPE THAT OPENS WIDER TOWARD THE TOP.
- THE SAID GAP SHOULD EFFECTIVELY CATCH AND RECEIVE ROCKS FALLING FROM HIGH PLACES AND LET THEM ROLL DOWN SAFELY TO THE END OF THE SLOPE, THUS ABSORBING ENERGY AND MINIMIZING DAMAGE TO THE ROAD AND OTHER SURROUNDING STRUCTURES.
- THE ELASTIC DRAPE OF THE HYBRID DRAPERY SYSTEM MUST RECEIVE THE FALLING ROCKS TO ABSORB THEIR KINETIC ENERGY. FOR THIS, THE ENERGY ABSORPTION POTENTIAL OF THE SYSTEM (E_T), AS GIVEN IN THE EQUATION BELOW, SHOULD BE GREATER THAN THE KINETIC ENERGY OF THE ROCK IMPACT (KE):

$$E_T = E_W + E_R + E_P + E_C > KE$$

WHERE:
E_W = ENERGY ABSORPTION OF WIRE NETTING
E_R = ENERGY ABSORPTION OF THE ROPE
E_P = ENERGY ABSORBED BY THE POST
E_C = DIFFERENCE IN ENERGY BEFORE AND AFTER THE COLLISION OF FALLING ROCKS

REPUBLIC OF THE PHILIPPINES **DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS** BUREAU OF DESIGN HIGHWAYS DIVISION BONIFACIO DRIVE PORT AREA, MANILA	SHEET TITLE: GUIDELINES AND STANDARD DESIGN DRAWINGS FOR ITEM 522 - ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEM FOR UNSTABLE SLOPE	SHEET CONTENT: GENERAL NOTES	PREPARED: BENEDICT BM. LUALHATI, ENGINEER II; PAOLO CARLO M. SALVADOR, ENGINEER III DRAWN: MARCIAL D. ORION, ENGINEER I / ASSISTANT REVIEWED: EVIN G. TACTAC, OIC-ENGINEER IV, SECTION CHIEF	SUBMITTED: ROMEO C. RAAGAS, CHIEF - HIGHWAYS DIVISION B.O.D. DATE:	RECOMMENDING APPROVAL: SEE COVER SHEET: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN DATE:	SEE COVER SHEET: MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE DATE:	APPROVED: SEE COVER SHEET: ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE DATE:	SET NO. G 1	SHEET NO. 1 3

GENERAL NOTES

- THE ACTUAL ROCK WEIGHT, ANGLE OF FALL, VERTICAL HEIGHT OF FALL AND EQUIVALENT FRICTION COEFFICIENT SHOULD BE CONSIDERED IN THE COMPUTATION OF THE KINETIC ENERGY OF THE ROCK IMPACT.
- DESIGN CALCULATIONS, INCLUDING ASSUMPTIONS AND INPUTS TO COMPUTE FOR THE ENERGY ABSORPTION POTENTIAL, KINETIC ENERGY OF THE ROCK IMPACT, ANCHOR BOLT LENGTH, SPACING, AND MINIMUM PULL-OUT STRENGTH, SHALL BE DULY CONSIDERED/ADOPTED BY THE PLANNING AND DESIGN DIVISION/SECTION OF THE CONCERNED IMPLEMENTING OFFICE IF A SOFTWARE PROGRAM IS USED.
- GEOTECHNICAL REPORT PRESENTING DETAILED SUBSURFACE INFORMATION (I.E. POSSIBLE ROCKFALL ABOVE THE HYBRID DRAPERY SYSTEM, SLIDING SURFACE, STABLE LAYER, AMONG OTHERS) AND RECOMMENDATIONS MUST BE DULY SIGNED AND SEALED BY A REGISTERED CIVIL ENGINEER / GEOTECHNICAL ENGINEER.
- 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.
- TO BE ABLE TO CATCH FALLING ROCKS WITHIN THE DRAPE MOST EFFECTIVELY, AIM AT INSTALLING THE POSTS AT 90° TO THE AVERAGE SLOPE INCLINATION. THE ALLOWABLE VARIATION RANGE IS UP TO 30° UPWARD, 10° DOWNWARD AND 10° LATERALLY.
- ANCHORING AT THE TOE OF THE SLOPE IN ORDER TO CONTAIN FALLEN ROCKS WITHIN THE SYSTEM MAY NOT BE INSTALLED IF ADEQUATE ROCK TRAP DITCH/TRENCH HAS BEEN PROVIDED.

4.2.3 CATCH FENCES

- CATCH FENCE SYSTEM CONSIST OF FENCES MADE OF WIRE NET AND WIRE ROPE ATTACHED TO STEEL PIPES OR H-SECTION POSTS. THIS TYPE OF FENCE HAS THE CAPACITY TO ABSORB THE ENERGY OF FALLING ROCKS.
- THE DESIGN OF A CATCH FENCE SYSTEM INVOLVES CONSIDERATION OF THE ENERGY OF THE FALLING ROCK (KE) AND THE ENERGY ABSORBABLE BY THE FENCE (E_T), AS GIVEN IN EQUATION BELOW:

$$E_T = E_R + E_P + E_N > KE$$

WHERE:
E_R = ENERGY ABSORBED BY THE WIRE ROPE
E_P = ENERGY ABSORBED BY THE POSTS
E_N = ENERGY ABSORBED BY THE WIRE NETTING

- THE HEIGHT OF THE POINT OF IMPACT IS GENERALLY CONSIDERED TO BE TWO-THIRDS OF THE HEIGHT OF THE FENCE, AND FALLING ROCKS ARE ASSUMED TO COLLIDE WITH THE WIRE ROPES BETWEEN POSTS IN THE DESIGN.
- DESIGN CALCULATIONS, INCLUDING ASSUMPTIONS AND INPUTS TO COMPUTE FOR THE ENERGY ABSORPTION POTENTIAL, ENERGY OF THE FALLING ROCK, ANCHOR BOLT LENGTH, SPACING AND MINIMUM PULL OUT STRENGTH, SHALL BE DULY CONSIDERED AND ADOPTED BY THE PLANNING AND DESIGN DIVISION/SECTION OF THE CONCERNED IMPLEMENTING OFFICE IF A SOFTWARE PROGRAM IS USED.
- LOADS DUE TO FALLING ROCKS SHOULD BE CONSIDERED IN ADDITION TO EARTH PRESSURE AND DEAD LOAD WHEN DESIGNING THE FOUNDATION (RETAINING WALL OR DIRECT FOUNDATION) FOR THE FENCE.
- GEOTECHNICAL REPORT PRESENTING DETAILED SUBSURFACE INFORMATION (I.E. POSSIBLE ROCKFALL ABOVE THE CATCH FENCE SYSTEM, SLIDING SURFACE, STABLE LAYER, AMONG OTHERS) AND RECOMMENDATIONS MUST BE DULY SIGNED AND SEALED BY A REGISTERED CIVIL ENGINEER / GEOTECHNICAL ENGINEER.
- 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.
- THE CATCH FENCE SYSTEM SHALL COMPLY WITH THE REQUIREMENTS FOR CATEGORY 'A' FALLING ROCK PROTECTION KITS UNDER GUIDELINES FOR EUROPEAN TECHNICAL APPROVAL (ETAG 027) BY THE EUROPEAN ORGANIZATION 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.
- 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.

4.3 DESIGN VERIFICATION OF ANCHORING STRENGTH

4.3.1 **PULLOUT TESTING**

THE CONTRACTOR SHALL PERFORM TWO TYPES OF SOIL NAIL/ANCHOR BOLT PULL-OUT TEST:

- CONFORMITY PULL-OUT TEST WHICH IS PERFORMED FOR TRIAL SOIL NAILS AND ANCHOR BOLTS PRIOR TO ACTUAL SOIL NAIL AND ANCHOR BOLT INSTALLATION AT LOCATIONS SELECTED BY THE ENGINEER FOR THE VERIFICATION OF PERIPHERAL SURFACE FRICTION RESISTANCE AND THE ADEQUACY OF THE DESIGN LENGTH OF ANCHORS SPECIFIED IN THE DESIGN CALCULATION; AND
- PROOF PULL-OUT TEST WHICH IS PERFORMED ON SELECTED SET OF INSTALLED SOIL NAILS AND ANCHOR BOLTS FOR VERIFICATION OF THEIR ANCHORING STRENGTH TO MEET THE REQUIRED PERFORMANCE
- PULL-OUT TEST SHALL BE CARRIED OUT AT LEAST SEVENTY-TWO HOURS AFTER GROUTING OR AT LEAST THE SPECIFIED 7 DAYS STRENGTH (>25MPA).

4.3.2 **RECORDING OF SOIL NAIL/ANCHOR BOLTS INSTALLATION**

- THE CONTRACTOR SHALL KEEP RECORDS FOR EACH SOIL NAIL AND ANCHOR BOLT INSTALLED FOR EACH DAY OF OPERATION FOR APPROVAL OF THE ENGINEER PRIOR TO THE NEXT ANCHOR BOLT AND SOIL NAIL INSTALLATION. THE RECORD FOR EACH ANCHOR BOLT AND SOIL NAIL SHALL INCLUDE, BUT NOT LIMITED TO, ANCHOR BOLT AND SOIL NAIL REFERENCE NUMBER, DATE/TIME OF COMMENCEMENT AND COMPLETION OF DRILLING AND GROUTING, PLUS THE NECESSARY DRILLING (WITH OR WITHOUT GROUTING) DETAILS, ETC.
- THE SOIL NAIL AND ANCHOR BOLT REFERENCE NUMBERING SCHEME SHALL BE AS FOLLOWS:

A-9999, WHEREIN:

A - BATCH NO. (A TO Z),
9999 - INSTALLATION SEQUENCE (1 ONWARDS)

5. OTHER CONSIDERATION IN THE PROVISION OF ITEM 522

5.1 ALL DETAILS AND DRAWINGS PRESENTED FOR ITEM 522 IS FOR REFERENCE PURPOSES ONLY. ACTUAL DETAILS/DIMENSIONS SHALL BE BASED ON THE RESULT OF THE DESIGN ANALYSIS/COMPUTATIONS AND GEOTECHNICAL INVESTIGATIONS. THE CONTRACTOR SHALL PROVIDE DETAILS, DIMENSIONS, QUANTITIES, CROSS-SECTION, AND METHODOLOGY FOR INSTALLATION NECESSARY IN THE INSTALLATION/CONSTRUCTION OF THE SYSTEM

5.2 THE GEOTECHNICAL INVESTIGATION RESULT/REPORT SHALL BE REVIEWED AND APPROVED BY THE CONCERNED IMPLEMENTING OFFICE AND SHALL INCLUDE, BUT NOT LIMITED, TO THE FOLLOWING:

- SITE DESCRIPTION (GEOLOGICAL SETTING, SLOPE CHARACTERSITICS);
- ENGINEERING GEOLOGICAL MAP (DELINEATE SOURCE AREAS, SLOPE MATERIALS, RUN-OUT AREAS, VEGETATION, LOCATION AND SIZE OF FALLEN ROCK, LOCATION OF STRUCTURE AT RISK);
- SOURCE ROCK CHARACTERIZATION (ROCK/SOIL TYPE PROPERTIES AND ANY CLIMATIC DEPENDENCY);
- SLOPE MATERIALS CHARACTERIZATION (ROCK/SOIL TYPE PROPERTIES AND ANY CLIMATIC DEPENDENCY);
- WATER CONDITIONS (SURFACE AND SUBSURFACE);
- VEGETATION (TYPE AND SIZE); AND
- SLIDING SURFACE (POSSIBLE SHALLOW ROTATIONAL/ TRANSLATIONAL SLIDES).

BOREHOLE DRILLING DETAILS ARE AS SHOWN BELOW

MINIMUM SPACING AND FREQUENCY OF BOREHOLES	FOR SLOPE HEIGHT(H) < 5.0M: ONE (1) AT EVERY PROPOSED SLOPE PROTECTION STRUCTURE TO BE LOCATED AT AN IDENTIFIED CRITICAL LOCATION. ADDITIONAL INTERMEDIATE BOREHOLE FOR EVERY 100M INTERVAL ALONG THE LENGTH OF THE SLOPE, IF NECESSARY.
	FOR SLOPE HEIGHT(H) ≥ 5.0M: ONE (1) AT THE TOP AND ONE(1) AT THE TOE (STAGGERED) OF THE SLOPE AND TO BE LOCATED AT THE SECTION WITH THE HIGHEST VERTICAL POINT OR AT AN IDENTIFIED CRITICAL LOCATION. ADDITIONAL INTERMEDIATE BOREHOLE FOR EVERY 100M INTERVAL ALONG THE LENGTH OF THE SLOPE, IF NECESSARY. NOTE: NO BOREHOLE DRILLING IS TO BE CONDUCTED IF THE EXISTING SLOPE IS DESIGNED FOR RESHAPING ONLY.

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

SHEET TITLE: GUIDELINES AND STANDARD DESIGN DRAWINGS FOR ITEM 522 - ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEM FOR UNSTABLE SLOPE

SHEET CONTENT: GENERAL NOTES

PREPARED: BENEDICT PAUL LUALHATI, ENGINEER II; PAOLO CARLO M. SALVADOR, ENGINEER III
DRAWN: MARCIAL D. ORO, ENGINEERING ASSISTANT
REVIEWED: [illegible], CIVIL ENGINEER IV, SECTION CHIEF

SUBMITTED: ROMEO C. RAAGAS, CHIEF - HIGHWAYS DIVISION, B.O.D., DATE:

RECOMMENDING APPROVAL: SEE COVER SHEET: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN, DATE:

SEE COVER SHEET: MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE, DATE:

APPROVED: SEE COVER SHEET: ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE, DATE:

SET NO. G 1

SHEET NO. 2 3

GENERAL NOTES

MINIMUM DEPTH OF BOREHOLES	EXTEND BORINGS DEPTH UP TO 0.75 AND 1.5 TIMES THE HEIGHT OF THE WALL. WHERE STRATIFICATION INDICATES A POSSIBLE DEEP STABILITY OR SETTLEMENT PROBLEM; BORINGS SHOULD EXTEND UNTIL THREE (3) SUCCESIVE SPT N-VALUES > 30 ARE OBTAINED.
REQUIRED LABORATORY TEST	MINIMUM REQUIREMENTS: • MECHANICAL SIEVE ANALYSIS • SPECIFIC GRAVITY • ATTERBERG LIMITS • NATURAL MOISTURE CONTENT • SOIL/ROCK STRENGTH TEST CONDITIONAL TEST BASED ON ACTUAL SITE CONDITION: • PERMEABILITY TEST • CONSOLIDATION TEST • HYDROMETER TEST • ROCK MASS RATING • GEOPHYSICAL SURVEY METHOD

5.3 IN ACCORDANCE WITH THE EXISTING LAW OF THE IMPLEMENTING RULES AND REGULATIONS (I.R.R.) OF REPUBLIC ACT (R.A.) NO. 9184, THE CONCERNED IMPLEMENTING OFFICE (I.O.) SHALL PROVIDE THE GENERIC TECHNICAL CHARACTERISTICS OR SPECIFICATIONS (SUCH AS MATERIAL REQUIREMENTS, CONSTRUCTION METHODOLOGIES, ETC.), AND NO BRAND NAMES SHALL BE ALLOWED IN THE PREPARATION OF THE DETAILED ENGINEERING DESIGN (DED) PLAN FOR ITEM 522 - ACTIVE AND PASSIVE SYSTEMS FOR UNSTABLE SLOPE. THIS STANDARD DRAWING INDICATING THE GENERAL SPECIFICATIONS OR DETAILS FOR EACH ITEM 522 COMPONENT WILL BE USED SOLELY AS REFERENCE IN THE PREPARATION OF THE DED PLAN AND AS A GUIDE OR BASIS IN THE PROCUREMENT PHASE.

5.4 THE CONTRACTOR IS SOLELY RESPONSIBLE FOR ENSURING THAT THE "AS-STAKED" PLAN CONFORMS TO THE DEPARTMENT'S CRITERIA AND DESIGN REQUIREMENTS ESTABLISHED IN THE DED PLAN. IF CHANGE IS NECESSARY, THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS TO THE PROJECT ENGINEER FOR EVALUATION AND APPROVAL BY THE CHIEF OF PLANNING AND DESIGN SECTION OR DIVISION.

5.5 MAINTENANCE OF THE SYSTEM SHALL BE IMPLEMENTED/UNDERTAKEN TO ENSURE THE REQUIRED PERFORMANCE DURING ITS SERVICE PERIOD AND TO EXTEND THE SERVICE LIFE AS LONG AS POSSIBLE. MAINTENANCE CONSISTS OF PERIODIC INSPECTION AND EMERGENCY INSPECTION (IN CASE OF EARTHQUAKE OR HEAVY RAIN), AND IT SHALL BE DONE FOR BOTH THE STRUCTURAL MEMBERS OF THE SYSTEM AND THE SURROUNDING AREA. UPON DETECTION OF ABNORMALITY, INVESTIGATION OF THE CAUSE AND COUNTERMEASURE STUDY SHALL BE CARRIED OUT, FOLLOWED BY ACTUAL REPAIR/REINFORCEMENT OF THE SYSTEM, IF NECESSARY.

5.6 PRIOR TO THE USE OF ITEM 522, THE DESIGN ENGINEER SHOULD PROVIDE SLOPE STABILITY ANALYSIS SHOWING THAT THE SUBJECT SLOPE IS UNSTABLE AND WILL, THEREFORE, NEEDS TO BE STABILIZED.

5.7 THE LENGTH OF SOIL NAIL AND ANCHOR BOLT TO BE USED FOR ACTIVE SLOPE PROTECTION SYSTEM ON UNSTABLE SLOPES SHOULD BE BASED ON DESIGN CALCULATION AND GEOTECHNICAL INVESTIGATION.

5.8 THE MAXIMUM VERTICAL ("A") AND HORIZONTAL ("B") SPACING OF SOIL NAILS AS SHOWN IN THE PLANS, SHALL BE ADOPTED/FOLLOWED AND NOT TO EXCEED 2.0 METERS CENTER TO CENTER IN A STAGGERED MANNER. IT SHOULD BE BASED ON THE RESULT OF THE DESIGN CALCULATION.

5.9 A MINIMUM OF 3 PIECES OF WIRE ROPE GRIPS OR CABLE GRIPS SHOULD BE USED TO CREATE THE LOOP TERMINATION AT THE END OF A WIRE ROPE.

5.10 THE TYPE AND THE CORRESPONDING DRAWINGS OR DETAILS OF WIRE, ROPE, SOIL NAIL/ANCHOR BOLT, AND OTHER COMPONENTS TO BE INDICATED IN THE "AS-STAKED" PLAN MUST BE ESTABLISHED BY THE CONTRACTOR'S CHOSEN MANUFACTURER OF THE ACTIVE OR PASSIVE SLOPE PROTECTION SYSTEM.

5.11 THE USE OF HIGH TENSILE WIRE MESH SHOULD ONLY BE ALLOWED IF ALL OF THE FOLLOWING CONDITIONS ARE MET:

- THE RATIO OF THE ALLOWABLE AND ACTUAL **SHEAR STRESS** ACTING ON THE WIRE AND WIRE MESH EXCEEDS 3.0 WHEN USING THE ORDINARY/NORMAL TENSILE STRENGTH WIRE MESH, BUT IT DOES NOT EXCEED 3.0 WHEN USING THE HIGH TENSILE WIRE MESH.
- THE RATIO OF THE ALLOWABLE AND ACTUAL **TENSILE STRESS** ACTING ON THE WIRE AND WIRE MESH EXCEEDS 3.0 WHEN USING THE ORDINARY/NORMAL TENSILE STRENGTH WIRE MESH, BUT IT DOES NOT EXCEED 3.0 WHEN USING THE HIGH TENSILE WIRE MESH.
- IF THE AVERAGE SLOPE ANGLE IS AT LEAST 80 DEGREES.
- IF THE SPACING OF THE SOIL NAIL EXCEEDS 2.0 METERS ON BOTH THE HORIZONTAL AND VERTICAL DIRECTION.

IF ONE OR MORE OF THE ABOVE CONDITIONS WERE NOT MET BUT THE DESIGN ENGINEER STILL INSIST ON USING HIGH TENSILE WIRE MESH, A WRITTEN JUSTIFICATION FULLY SUPPORTED AND APPROVED/SIGNED BY THE HEAD OF IMPLEMENTING OFFICE MUST BE PROVIDED.

5.12 WIRE MESH SHOULD HAVE A MINIMUM NUMBER OF TWIST OF AT LEAST TWO (2) AND SHOULD BE BASED ON THE SYSTEM PROVIDED BY THE CONTRACTOR'S CHOSEN MANUFACTURER OF ACTIVE/PASSIVE SLOPE PROTECTION SYSTEM.

5.13 THE SHAPE OF THE STEEL PLATE MAY VARY, BUT MUST NOT BE LOWER THAN THE MINIMUM SURFACE AREA REQUIRED IN THE LATEST DEPARTMENT ORDER PERTAINING TO ITEM 522 - ACTIVE AND PASSIVE PROTECTION SYSTEMS FOR UNSTABLE SLOPE, OR ANY ISSUANCES RELATED THERETO.

5.14 A MINIMUM OF TWO (2) SPOT WELDING SHOULD BE PROVIDED BETWEEN THE NUT AND STEEL PLATE CONNECTION (I.E. ONE AT THE TOP AND ONE AT THE BOTTOM OF THE NUT). THE DETAILS SHOULD BE INCLUDED BY THE CONTRACTOR IN THE "AS-STAKED" PLAN.

5.15 A PROTRUDING LENGTH ("C") OF AT LEAST 0.15 METERS FROM THE FACE OF THE STEEL PLATE SHOULD BE PROVIDED.

5.16 CENTRALIZER SHOULD BE INSTALLED AT REGULAR INTERVALS, NOT EXCEEDING 3 METERS CENTER-TO-CENTER SPACING WITH THE UPPER ONE LOCATED AT A MAXIMUM OF 1.50M FROM THE TOP OF THE SOIL NAIL LENGTH AND THE LOWER ONE LOCATED AT 0.30M FROM THE BOTTOM OF THE SOIL NAIL BOND LENGTH. CENTRALIZERS MUST BE SECURELY ATTACHED TO THE ANCHOR BOLT / SOIL NAIL AND MUST BE ADEQUATELY FITTED TO ALLOW:

- POSITIONING THE SOIL NAIL/ANCHOR BOLT WITHIN 25MM OF THE CENTER OF THE DRILL-HOLE;
- INSERTING THE SOIL NAIL/ANCHOR BOLT TO THE BOTTOM OF THE DRILL HOLE; AND
- GROUT TO FREELY FLOW UP THE DRILL HOLE

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SHEET TITLE: GUIDELINES AND STANDARD DESIGN DRAWINGS FOR ITEM 522 - ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEM FOR UNSTABLE SLOPE

SHEET CONTENT: GENERAL NOTES

PREPARED: BENEDICT B.M. LUALHATI, ENGINEER II; PAOLO CARLO M. SALVADOR, ENGINEER III
DRAWN: MARCIAL D. ORTIZ, ENGINEER I; ELVIRA G. TACTAC, ENGINEER IV, SECTION CHIEF
REVIEWED:

SUBMITTED: ROMEO C. RAAGAS, CHIEF - HIGHWAYS DIVISION, B.O.D. — DATE:

RECOMMENDING APPROVAL: SEE COVER SHEET: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN — DATE:

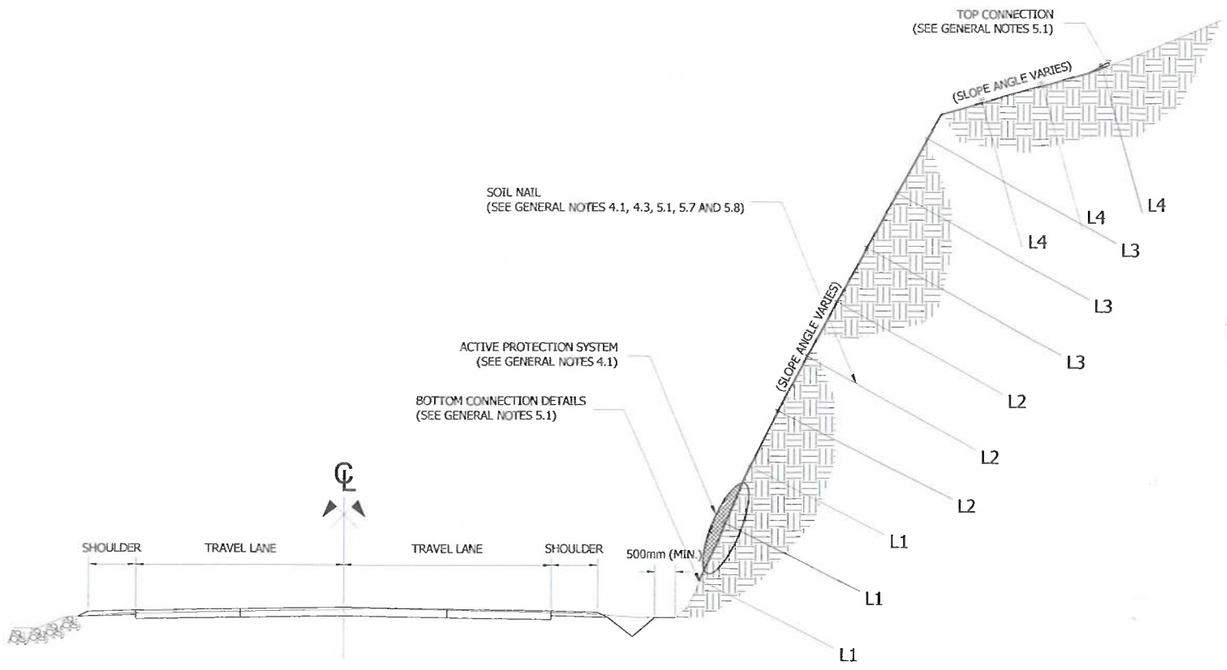
SEE COVER SHEET: MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE — DATE:

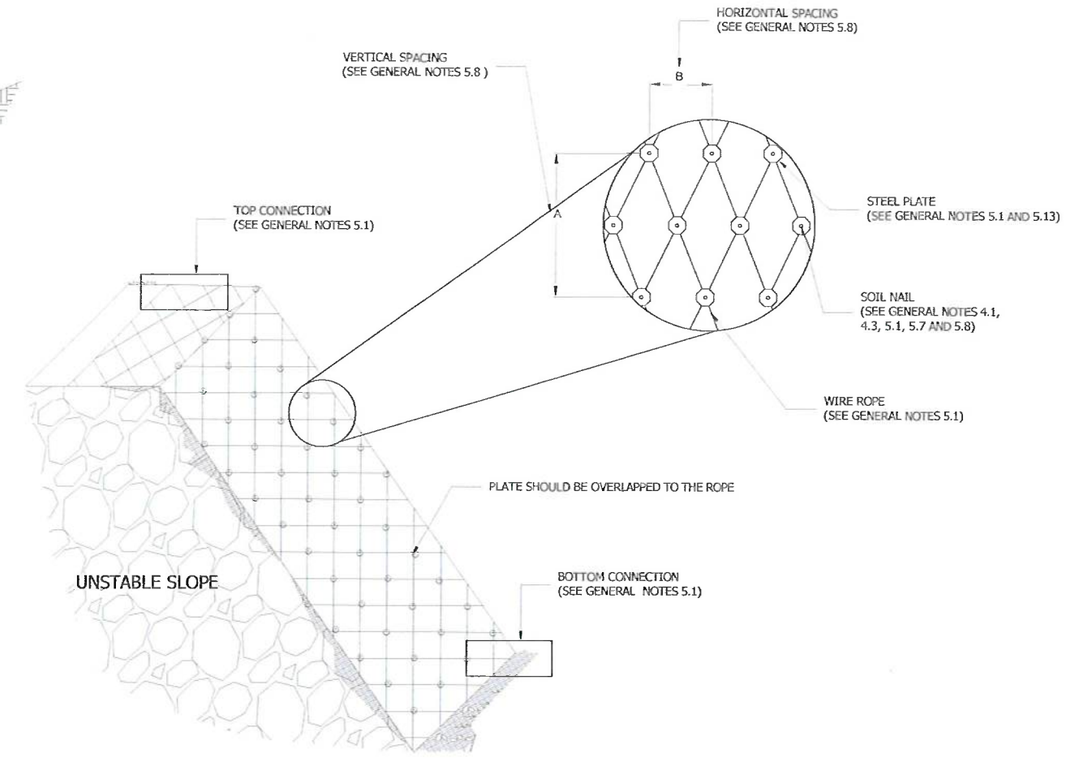
APPROVED: SEE COVER SHEET: ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE — DATE:

SET NO. G 1

SHEET NO. 3 3

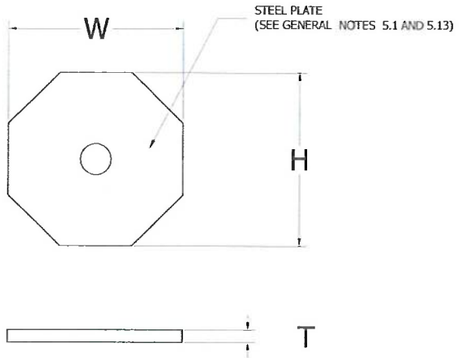
ACTIVE SLOPE PROTECTION (NON-MESH SYSTEM)

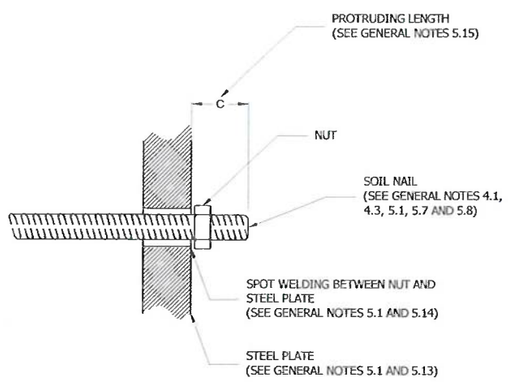


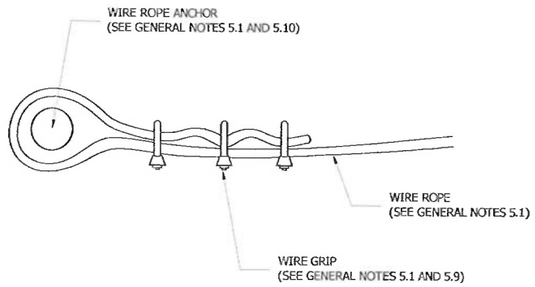


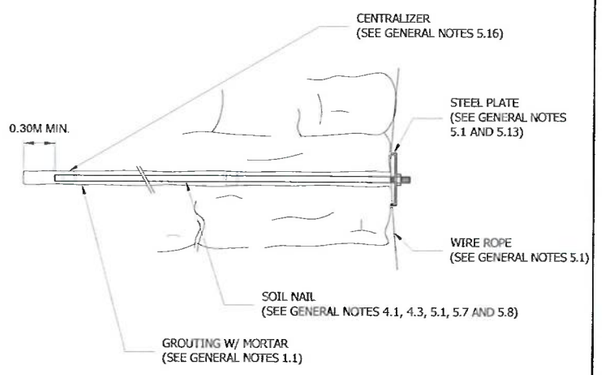
H-1 / 1 TYPICAL CROSS-SECTION DETAILS
NOT TO SCALE

H-1 / 2 ACTIVE NON-MESH SYSTEM ACCESORIES
NOT TO SCALE









H-1 / 3 STEEL PLATE DETAILS
NOT TO SCALE

H-1 / 4 HEAD OF SOIL NAILING DETAILS
NOT TO SCALE

H-1 / 5 WIRE GRIP DETAILS
NOT TO SCALE

H-1 / 6 SOIL NAIL DETAILS
NOT TO SCALE

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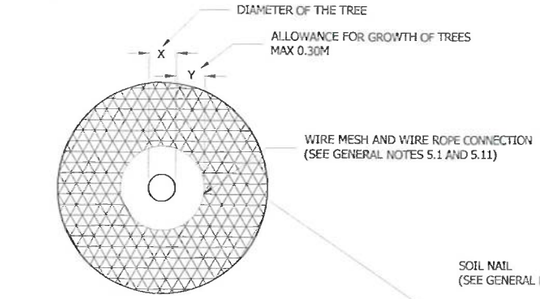
SHEET TITLE:	GUIDELINES AND STANDARD DESIGN DRAWINGS FOR ITEM 522 - ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEM FOR UNSTABLE SLOPE
SHEET CONTENT:	ACTIVE SLOPE PROTECTION (NON-MESH SYSTEM) *(TYPICAL CROSS-SECTION DETAILS, ACTIVE NONE-MESH SYSTEM ACCESORIES, STEEL PLATE DETAILS, HEAD OF ANCHORING DETAILS, WIRE GRIP DETAILS, ANCHOR DETAILS)*
PREPARED:	BENEDICT M. LUALHATI, ENGINEER II; PAOLO [illegible], ENGINEER III
DRAWN:	MARCIAL D. C[illegible], ENGINEERING ASSISTANT
REVIEWED:	ELVIN [illegible], OIC - ENGINEER IV, SECTION CHIEF
SUBMITTED:	ROMEO C. RAAGAS, CHIEF - HIGHWAYS DIVISION, B.O.D. DATE:
RECOMMENDING APPROVAL:	SEE COVER SHEET: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN DATE:
	SEE COVER SHEET: MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE DATE:
APPROVED:	SEE COVER SHEET: ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE DATE:
SET NO.	H / 1
SHEET NO.	1 / 5

ACTIVE SLOPE PROTECTION (MESH SYSTEM)



DETAILS OF MESH FOR AREAS WITH TREES

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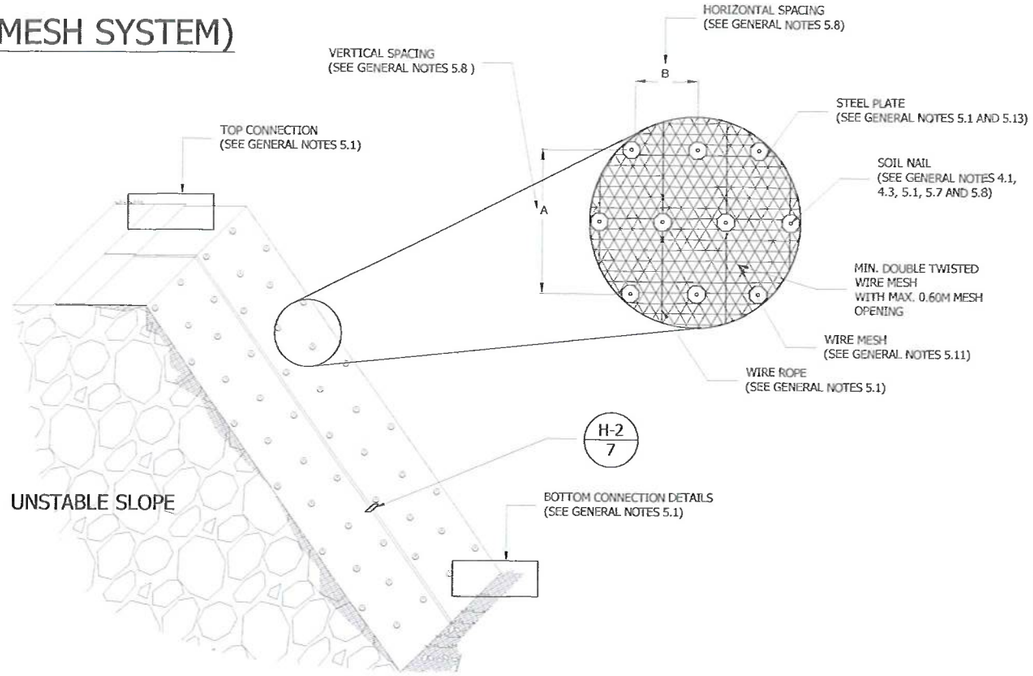

H-2 / 2 ACTIVE MESH SYSTEM ACCESORIES
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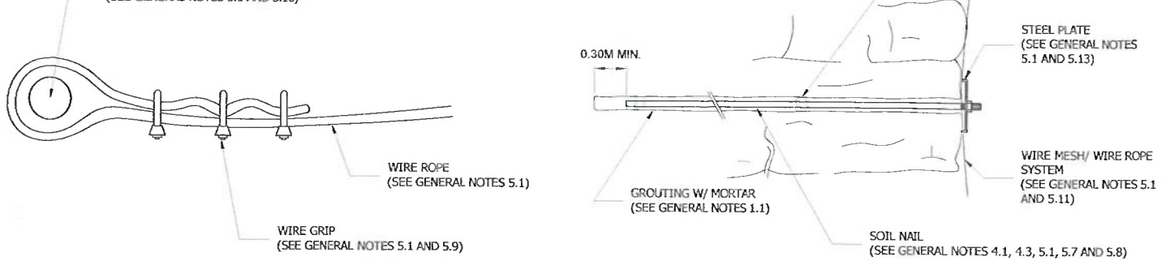
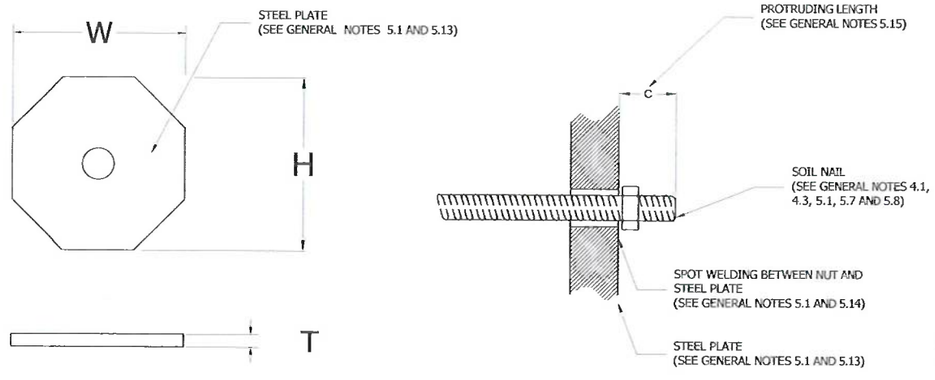


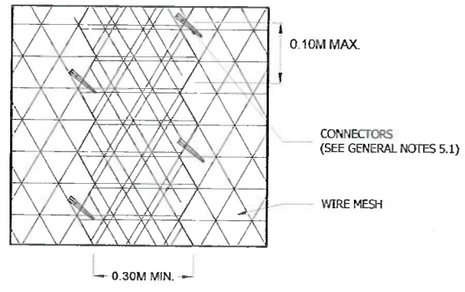
H-2 / 5 WIRE GRIP DETAILS
NOT TO SCALE

H-2 / 6 SOIL NAIL DETAILS
NOT TO SCALE



H-2 / 3 STEEL PLATE DETAILS
NOT TO SCALE

H-2 / 4 HEAD OF SOIL NAILING DETAILS
NOT TO SCALE



H-2 / 7 SELVEDGE CONNECTION DETAILS
NOT TO SCALE

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN
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SHEET TITLE:	GUIDELINES AND STANDARD DESIGN DRAWINGS FOR ITEM 522 - ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEM FOR UNSTABLE SLOPE
SHEET CONTENT:	ACTIVE SLOPE PROTECTION (MESH SYSTEM) (TYPICAL CROSS-SECTION DETAILS, ACTIVE MESH SYSTEM ACCESORIES, STEEL PLATE DETAILS, HEAD OF ANCHORING DETAILS, WIRE GRIP DETAILS, ANCHOR DETAILS, SELVEDGE CONNECTION DETAILS)
PREPARED:	BENEDICT M. LUALHATI, ENGINEER II; PABLO [illegible], ENGINEER III
DRAWN:	MARC [illegible], ENGINEER I; ASSISTANT
REVIEWED:	[illegible], CHIEF ENGINEER IV, SECTION CHIEF
SUBMITTED:	ROMEO C. RAAGAS, CHIEF - HIGHWAYS DIVISION, D.O.
RECOMMENDING APPROVAL:	SEE COVER SHEET: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN
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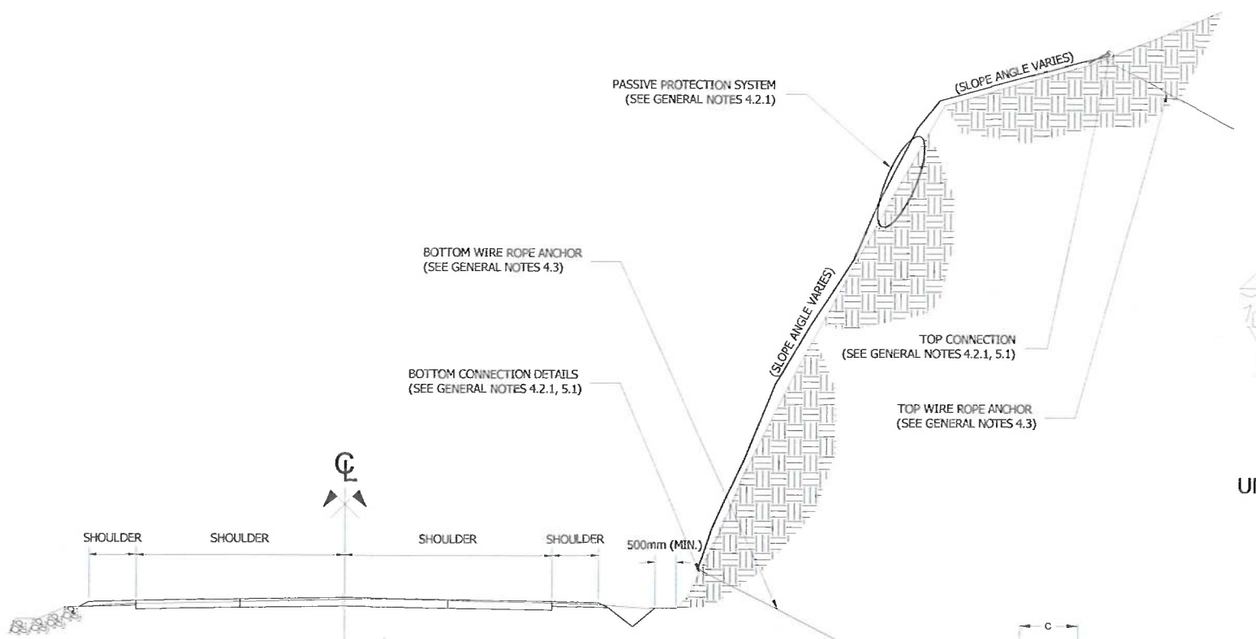
SET NO.	H / 2
SHEET NO.	2 / 5

PASSIVE SLOPE PROTECTION (SIMPLE DRAPERY)



H-2 / 1 TYPICAL CROSS-SECTION DETAILS
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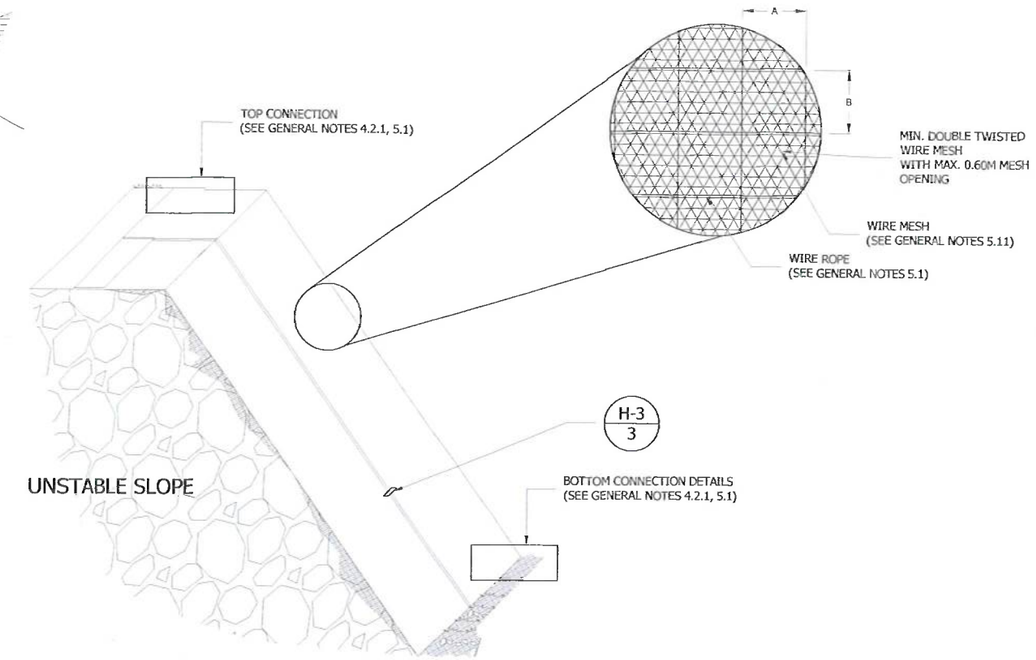
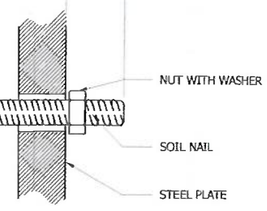
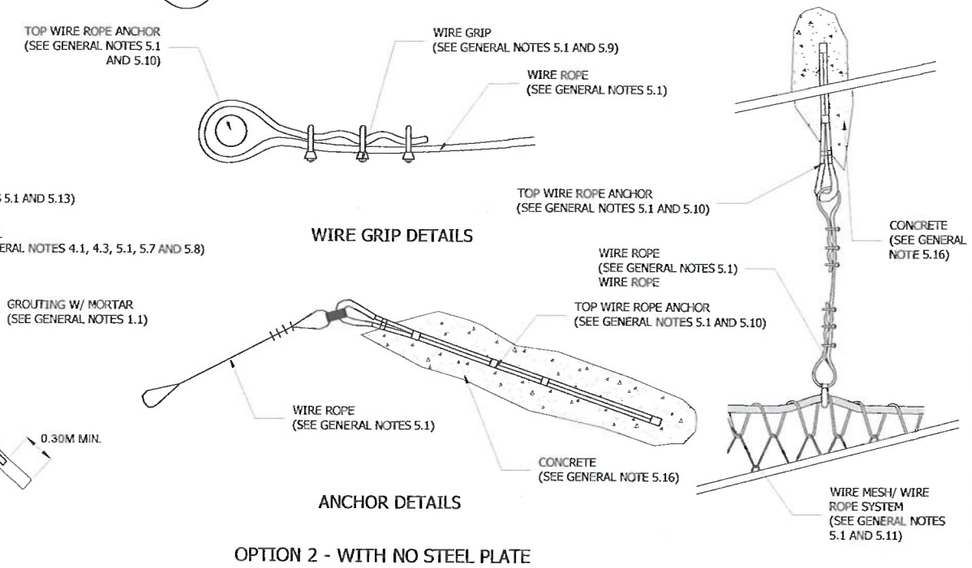
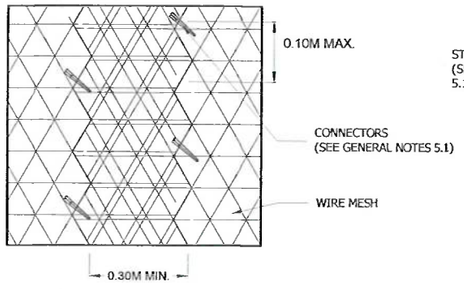




HEAD OF SOIL NAILING DETAILS

H-2 / 2 PASSIVE SIMPLE DRAPERY SYSTEM ACCESORIES
NOT TO SCALE





H-3 / 3 SELVEDGE CONNECTION DETAILS
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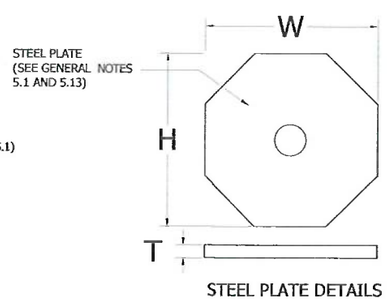
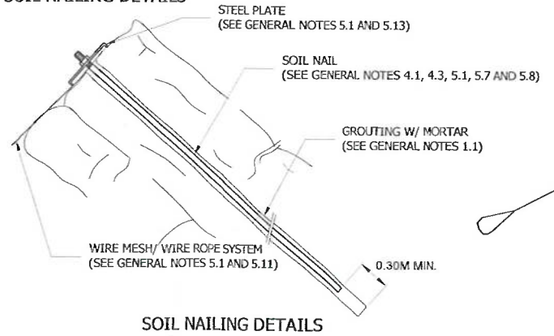


STEEL PLATE DETAILS



SOIL NAILING DETAILS

OPTION 1- WITH STEEL PLATE
(FOR TOP AND BOTTOM WIRE ANCHOR)

OPTION 2 - WITH NO STEEL PLATE
(FOR TOP WIRE ANCHOR ONLY)

H-3 / 4 TOP CONNECTION DETAILS
NOT TO SCALE

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

SHEET TITLE: GUIDELINES AND STANDARD DESIGN DRAWINGS FOR ITEM 522 - ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEM FOR UNSTABLE SLOPE

SHEET CONTENT: PASSIVE SLOPE PROTECTION (SIMPLE DRAPERY) *(TYPICAL CROSS-SECTION DETAILS, PASSIVE SIMPLE DRAPERY ACCESORIES, SELVEDGE CONNECTION DETAILS, TOP CONNECTION DETAILS)*

PREPARED: BENEDICT M. LUALHATI, ENGINEER II; PAOLO CRISTOBAL, ENGINEER III
DRAWN: MARCIAL D. CRUZ, ENGINEERING ASSISTANT
REVIEWED: [illegible], OIC-ENGINEER IV, SECTION CHIEF

SUBMITTED: ROMEO G. RAAGAS, CHIEF - HIGHWAYS DIVISION, B.O.D., DATE:

RECOMMENDING APPROVAL: SEE COVER SHEET: DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN, DATE:

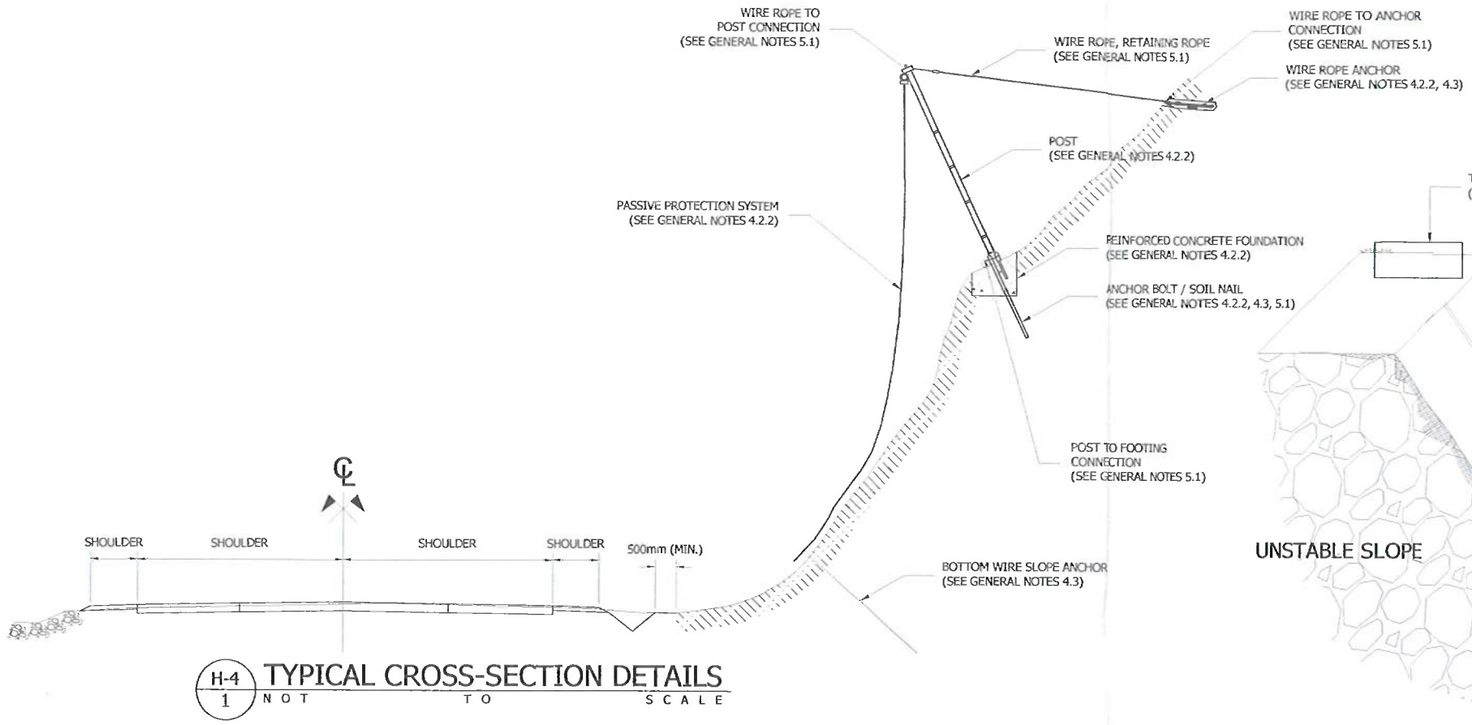
SEE COVER SHEET: MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE, DATE:

APPROVED: SEE COVER SHEET: ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE, DATE:

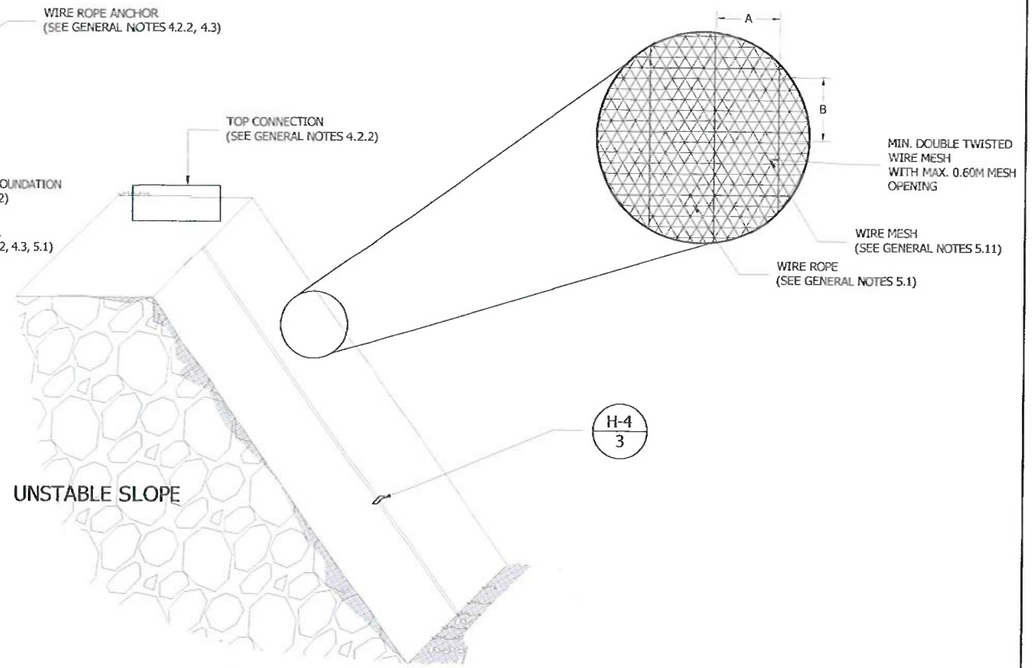
SET NO. H / 3

SHEET NO. 3 / 5

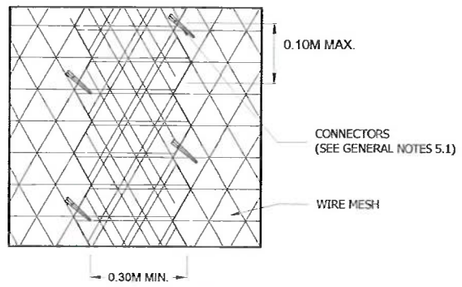
PASSIVE SLOPE PROTECTION (HYBRID DRAPERY)



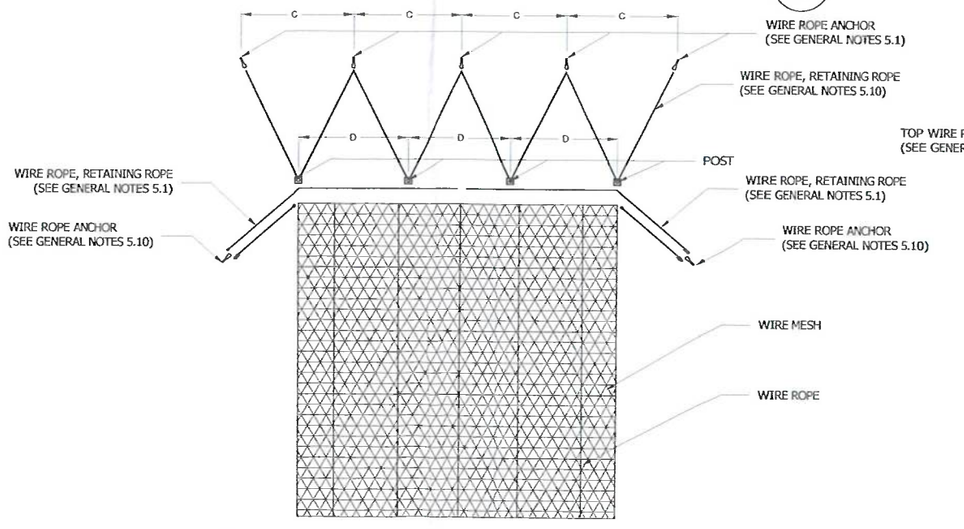
H-4 / 1 TYPICAL CROSS-SECTION DETAILS
NOT TO SCALE



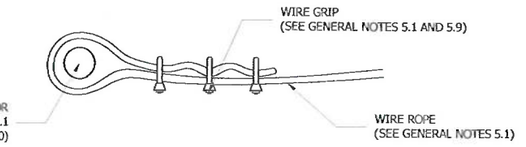
H-4 / 2 PASSIVE HYBRID DRAPERY SYSTEM ACCESORIES
NOT TO SCALE



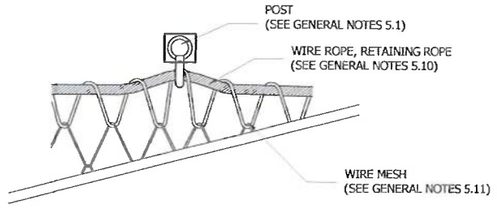
H-4 / 3 SELVEDGE CONNECTION DETAILS
NOT TO SCALE



H-4 / 4 ANCHOR-POST-WIRE ROPE-WIRE MESH LAYOUT PLAN
NOT TO SCALE



H-1 WIRE GRIP DETAILS
NOT TO SCALE



H-4 / 5 WIRE ROPE TO POST CONNECTION DETAIL
NOT TO SCALE

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

SHEET TITLE: GUIDELINES AND STANDARD DESIGN DRAWINGS FOR ITEM 522 - ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEM FOR UNSTABLE SLOPE

SHEET CONTENT: PASSIVE SLOPE PROTECTION (HYBRID DRAPERY) *(TYPICAL CROSS-SECTION DETAILS, PASSIVE HYBRID DRAPERY ACCESORIES, SELVEDGE CONNECTION DETAILS, ANCHOR-POST-WIRE ROPE-WIRE MESH LAYOUT PLAN, WIRE GRIP DETAILS, WIRE ROPE TO POST CONNECTION DETAIL)*

PREPARED: BENEDICT P.M. LUALHATI, ENGINEER II; PAOLO C. [illegible], ENGINEER III
DRAWN: MARCIAL D. CANAL, ENGINEERING ASSISTANT
REVIEWED: [illegible], OIC-ENGINEER IV, SECTION CHIEF

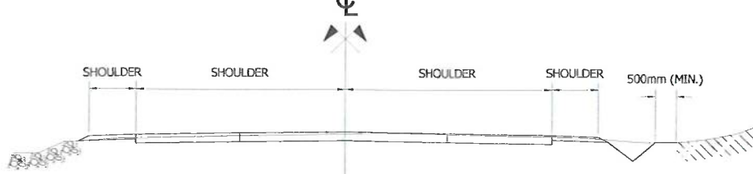
SUBMITTED: ROMEO C. RAAGAS, CHIEF - HIGHWAYS DIVISION, BOD.D. — DATE:

RECOMMENDING APPROVAL: SEE COVER SHEET · DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN — DATE:
SEE COVER SHEET · MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE — DATE:

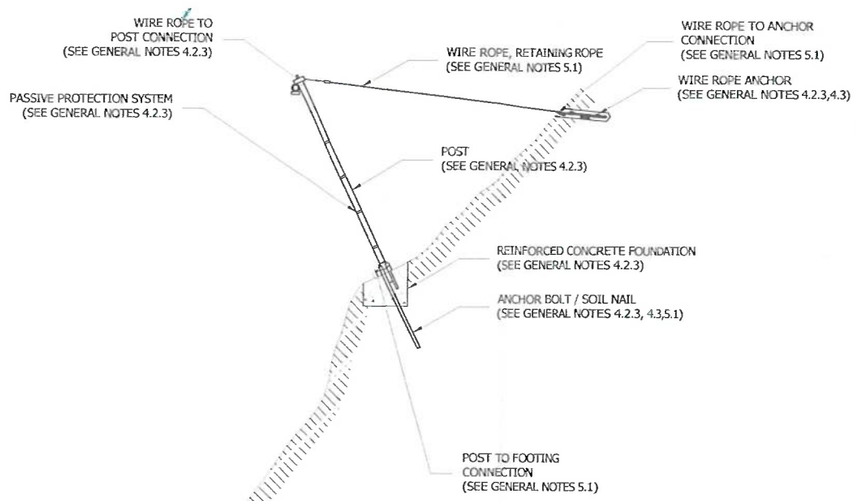
APPROVED: SEE COVER SHEET · ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE — DATE:

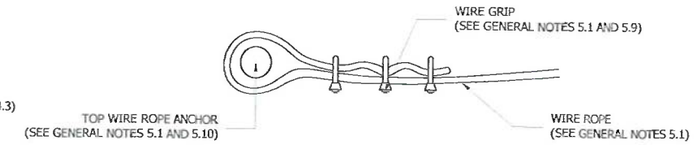
SET NO.: H / 4
SHEET NO.: 4 / 5

PASSIVE SLOPE PROTECTION (CATCH FENCE)

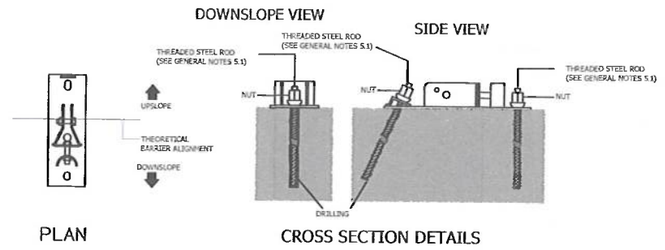


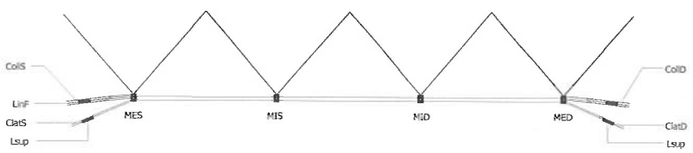
H-5 / 1 TYPICAL CROSS-SECTION DETAILS
NOT TO SCALE





H-1 WIRE GRIP DETAILS
NOT TO SCALE

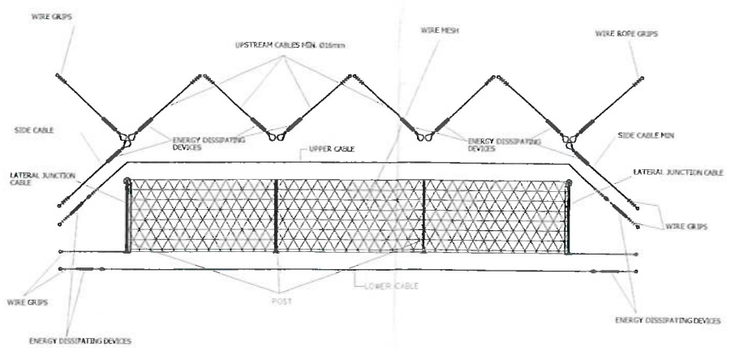




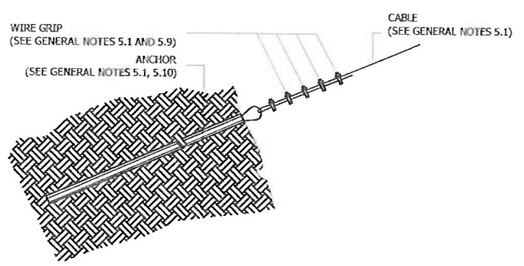
MES = LEFT LATERAL POST
MIS = LEFT INTERNAL POST
MID = RIGHT INTERNAL POST
MED = RIGHT LATERAL POST

Lsup = UPPER LONGITUDINAL CABLE
LinF = LOWER LONGITUDINAL CABLE
ClatS = LEFT SIDE CABLE
ClatD = RIGHT SIDE CABLE
ClolIS = LEFT LATERAL JUNCTION CABLE
ClolID = RIGHT LATERAL JUNCTION CABLE

H-5 / 3 SCHEMATIC VIEW OF BARRIER WITH 3 SPANS
NOT TO SCALE



H-5 / 4 GENERAL SCHEME OF COMPONENTS
NOT TO SCALE



H-5 / 5 CONNECTION BETWEEN ANCHOR AND WIRE ROPE
NOT TO SCALE

H-5 / 2 CONNECTION BETWEEN POST AND FOOTING
NOT TO SCALE

REPUBLIC OF THE PHILIPPINES **DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS** BUREAU OF DESIGN HIGHWAYS DIVISION BONIFACIO DRIVE PORT AREA, MANILA	SHEET TITLE: GUIDELINES AND STANDARD DESIGN DRAWINGS FOR ITEM 522 - ACTIVE AND PASSIVE SLOPE PROTECTION SYSTEM FOR UNSTABLE SLOPE	SHEET CONTENT: PASSIVE SLOPE PROTECTION (CATCH FENCE) *(TYPICAL CROSS SECTION DETAILS, PASSIVE SPIKE DRIVERY ACCESORIES, SELVEDGE CONNECTION DETAILS, TOP CONNECTION DETAILS)*	PREPARED: BENEDICT M. DUALHATI, ENGINEER II; PABLO T. [illegible], ENGINEER III DRAWN: MARCIAL P. [illegible], ENGINEERING ASSISTANT REVIEWED: [illegible], OIC-ENGINEERING SECTION CHIEF	SUBMITTED: ROMEO C. RAAGAS, CHIEF - HIGHWAYS DIVISION, P.D.D. DATE:	RECOMMENDING APPROVAL: SEE COVER SHEET · DANILO L. BALISI, DIRECTOR IV, BUREAU OF DESIGN DATE: SEE COVER SHEET: MEDMIER G. MALIG, ASSISTANT SECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE DATE:	APPROVED: SEE COVER SHEET: ADOR G. CANLAS, CESO IV, UNDERSECRETARY FOR TECHNICAL SERVICES AND INFORMATION MANAGEMENT SERVICE DATE:	SET NO. H 5	SHEET NO. 5 5