Supplementary Information

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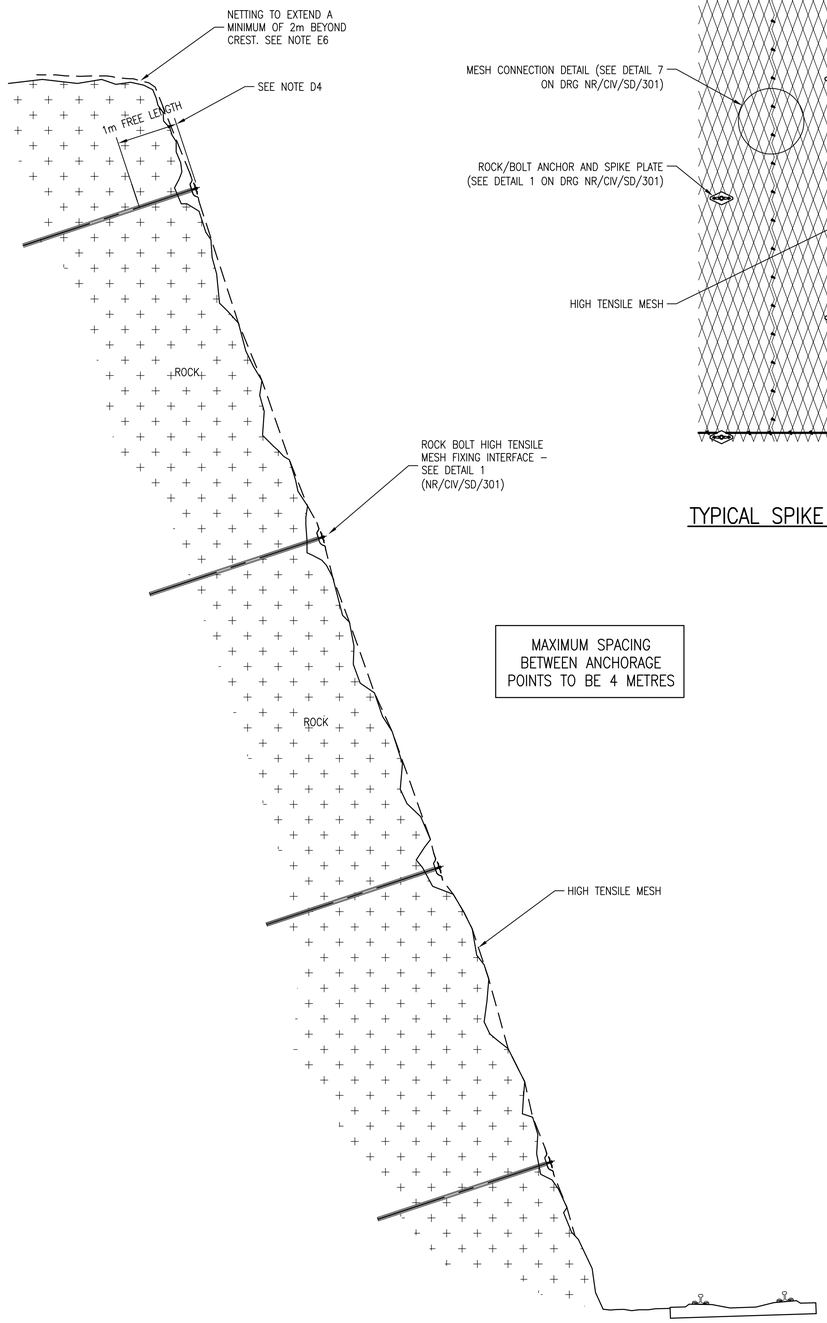
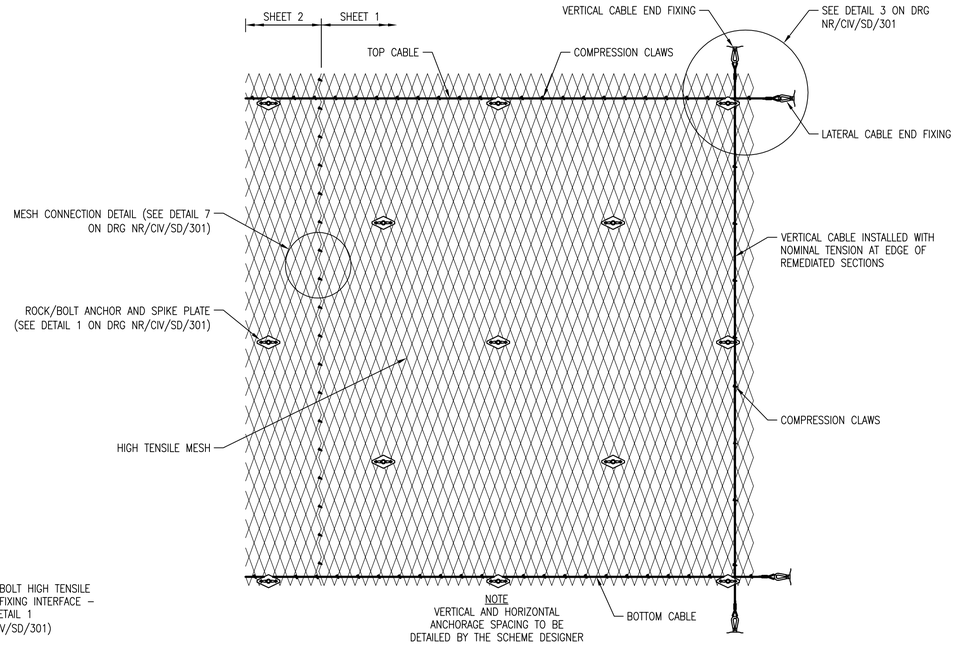


TYPE N1 – TYPICAL INSTALLATION DETAIL HIGH TENSILE MESH – SECTION

SCALE 1:50



TYPICAL SPIKE LAYOUT, ORIENTATION AND EDGE DETAILS ELEVATION

N.T.S.

TABLE 1

SAFETY, HEALTH & ENVIRONMENT RISK ASSESSMENT		
DESIGNERS' NOTE – CDM REG. 13(2) THE FOLLOWING ARE SIGNIFICANT HAZARDS WHICH MIGHT AFFECT THE HEALTH AND SAFETY OF THOSE UNDERTAKING THE WORKS OUTLINED IN THIS SET OF DRAWINGS ON RAILWAY STRUCTURES OR THOSE AFFECTED BY THESE ACTIVITIES. A SITE SPECIFIC RISK ASSESSMENT SHOULD ALWAYS BE UNDERTAKEN PRIOR TO COMMENCING ANY OF THE WORKS DESCRIBED ON SITE. IT IS ASSUMED THAT A COMPETENT CONTRACTOR IS AWARE OF THE RISKS ASSOCIATED WITH GENERAL CONSTRUCTION ACTIVITIES UNDERTAKEN WITHIN THE RAILWAY ENVIRONMENT.		
HAZARD	STAGE	MITIGATING MEASURES
HAND ARM VIBRATION	D/C	WORKS TO BE COMPLETED TO AN AGREED WORK PACKAGE PLAN OUTLINING ANTICIPATED EXPOSURE LEVELS, LIMITS AND MITIGATING ACTIONS IN ACCORDANCE WITH THE 'CONTROL OF VIBRATION AT WORK REGULATIONS'
WORKING ON POTENTIALLY UNSTABLE SLOPE	D/C	DESIGNER TO SPECIFY BOLTS AWAY FROM UNSTABLE MATERIAL. UNSTABLE AREAS TO BE MARKED ON DRAWINGS. CONTRACTOR TO USE APPROPRIATE SAFE METHOD OF WORK.
UNSTABLE ROCK DUE TO ROOT WEDGING	D/C	LOCATIONS ADJACENT TO TREE ROOTS TO BE CLOSELY EXAMINED BY ENGINEER.
DRILLING ROCK BOLTS	D/C	CONTRACTOR TO DEVELOP SAFE METHOD OF WORK UNDER IRATA GUIDELINES AND BS 7985:2009 OR TO PROVIDE APPROPRIATE WORKING PLATFORMS. SUSPENDED DRILLING TO BE SUPPORTED BY SUITABLY DESIGNED AND TESTED ANCHORS AND SUBJECT TO TEMPORARY WORKS CHECK IN ACCORDANCE WITH NR/SP/CIV/003.
INSTALLING MESH	C	CONTRACTOR TO DEVELOP A SYSTEM FOR SUPPORTING AND ROLLING OUT MESH. NOTE THAT THE BEHAVIOUR OF HIGH TENSILE MESH IS DIFFERENT FROM MORE COMMON FORMS OF MESH.
WORKING ON OR BELOW SLOPES ABOVE THE OPERATIONAL RAILWAY	D/C	DESIGNER AND/OR CONTRACTOR TO CARRY OUT RISK ASSESSMENT TO ESTABLISH WHAT PROPORTION (IF ANY) OF THE WORK CAN BE CARRIED OUT DURING NORMAL OR RESTRICTED OPERATIONS.
FAILURE OF NETTING SYSTEM	D	IT IS EXPECTED THAT THE NETTING SYSTEM WILL BE DESIGNED USING A RISK BASED APPROACH AS DESCRIBED IN CLAUSE 11.2 OF NR/L3/CIV/071. THE ASSESSMENT SHALL CONSIDER THE RELATIVE CONSEQUENCE OF ROCK FALL VERSUS NETTING SYSTEM FAILURE ON THE OPERATION OF THE RAILWAY.
ENVIRONMENTAL RISK: PROTECTED SPECIES ON SITE PROHIBITING SITE ACCESS, E.G. BADGERS, BATS, PLANTS	D/C	UNDERTAKE AN ENVIRONMENTAL WALKOVER SURVEY TO ESTABLISH ECOLOGICAL CONSTRAINTS.
REMOVAL OF TREES AND VEGETATION DURING NESTING SEASON	C	CHECK WITH ENVIRONMENTAL EXPERT AS TO WHETHER TREES CAN BE REMOVED.
IMPROPER MAINTENANCE METHOD	O	DESIGNER TO WRITE SLOPE MAINTENANCE MANUAL HIGHLIGHTING THAT THE MESH IS PRESTRESSED, INCLUDING METHODS OF DESTRESSING IF IT IS NECESSARY TO REMOVE DEBRIS.
CUTTING MESH TO FORM OPENINGS	O	SLOPE MAINTENANCE MANUAL TO STATE THAT OPENINGS IN OR CUTTING OF MESH SHOULD NOT BE CARRIED OUT WITHOUT A FULL DESIGN ASSESSMENT
LINESIDE FIRE DAMAGE TO NON_METALLIC ELEMENTS	D/C	NON-METALLIC ELEMENTS TO BE SUITABLY PROTECTED
SPACING OF ROCK BOLTS	D/C	DESIGN TO BE BASED ON THOROUGH GEOTECHNICAL INSPECTION OF CUTTING TO ENSURE SAFE OPERATION.
NOTE : C=CONSTRUCTION, D=DESIGN, O=OPERATION		

REFERENCE DRAWINGS – HIGH TENSILE NETTING

DRAWING No.	DRAWING TITLE
NR/CIV/SD/300	GENERAL ARRANGEMENT
NR/CIV/SD/301	TYPICAL DETAILS

NOTES CONT.

E5 JOINTS IN THE HIGH TENSILE MESH SHALL CONFORM TO THE MANUFACTURES GUIDELINES. OVERLAP, CLIP TYPE AND CLIP POSITION SHALL BE DETERMINED BY THE SCHEME DESIGNER. CLIP DETAILS ARE GIVEN ON DRAWING NR/CIV/SD/301.

E6 NETTING SHALL EXTEND BEYOND THE CREST BY A MINIMUM 2m TO REDUCE EROSION. TOP ANCHORAGE IS NOT REQUIRED TO BE BEYOND THE CREST, HOWEVER THE MESH MUST BE ADEQUATELY RESTRAINED TO PREVENT LIFTING.

F STEEL CABLES.

F1 THE ANCHORAGE CABLES AS A MINIMUM SHALL BE MULTISTRAND 6 X 19 CLASS 16mm DIAMETER FIBRE CORE ZINC GALVANISED WIRE ROPE TO BS EN 12385 PARTS 1 AND 4 (2002). THE MINIMUM WIRE TENSILE GRADE SHALL BE 1770 N/mm². ALL CABLE ENDS SHALL BE PREVENTED FROM UNRAVELLING.

F2 WIRE ROPE GRIPS TO BE IN ACCORDANCE WITH DIN 1142 GALVANISED.

F3 TURN BUCKLES TO BE INSTALLED AT A MAXIMUM OF 30m CENTRES, WHERE CABLES ARE SPECIFIED.

F4 AT ALL ROPE TERMINATION POINTS, WHERE CLEATS ARE USED TO SECURE ROPE, THE MINIMUM ROPE OVERLAP SHALL BE 350mm.

F5 160KN ULTIMATE LOAD CAPACITY DROP FORGED CLOSED SOCKETS OR SIMILAR APPROVED TO BE IN ACCORDANCE WITH BS 463:1970 PART 2.

F6 DEE SHACKLES TO BE IN ACCORDANCE WITH BS 3032:1958 TABLE 2.

F7 MAXIMUM BOUNDARY CABLE LENGTH 30m. TYPICALLY ALLOW 1m BEYOND MESH FOR HORIZONTAL CABLE CONNECTION DETAILS.

G INSTALLATION GUIDANCE

G1 INSTALLATION SHALL BE CARRIED OUT IN ACCORDANCE WITH MANUFACTURERS INSTALLATION GUIDELINES.

G2 ROCK BOLTS/ANCHORS ANCHORING THE HIGH TENSILE MESH ARE TO BE LOCATED IN NATURAL OR MAN MADE HOLLOWS, TO ENABLE TENSIONING. THE EXACT LOCATION TO BE DETERMINED BY A THE SCHEME DESIGNER ON SITE. NUT TO BE TIGHTENED TO 0.3kNm TORQUE TO PROVIDE 30kN PRELOAD. THE SCHEME DESIGNER MAY CONSIDER A STAGED METHOD OF PRE-TENSIONING THE MESH.

G3 THE CONTRACTOR SHALL COMPLY WITH NETWORK RAIL COMPANY PROCEDURES RELATING TO BURIED SERVICES; NR/L1/AMG/1010, NR/L2/AIF/1020 AND NR/L2/AMG/1030.

G4 HIGH VISIBILITY MARKERS ARE TO BE INSTALLED IN LOWER ROW OF BOLTS/ANCHORS AND ANY OTHERS WITHIN 2.5m OF CESS LEVEL.

H SLOPE PREPARATION

H1 PRIOR TO INSTALLATION THE SLOPE SURFACE SHALL BE PREPARED IN ACCORDANCE WITH THE MANUFACTURERS GUIDELINES AND CURRENT NETWORK RAIL STANDARDS.

H2 AS DEEMED APPROPRIATE THE FOLLOWING METHODS OF SITE CLEARANCE SHOULD BE UNDERTAKEN, SUPPORTED BY A DETAILED SPECIFICATION COVERING AS A MINIMUM THE EXTENT, LOCATION, DEGREE AND PURPOSE OF THE WORKS.

H2a VEGETATION REMOVAL.
ALL WOODY VEGETATION REMOVED AT LEAST 2m BEYOND THE CREST, INCLUDING TREES, SHRUBS, PLANTS AND FALLEN MATTER, CUT BACK AS CLOSE TO GROUND LEVEL AS PRACTICALLY POSSIBLE. ALL ROOTS, STUMPS AND CUT ENDS SHALL BE TREATED TO PREVENT REGROWTH.

H2b SCALING
LOOSE OR UNSTABLE ROCK OR SOIL SHALL BE REMOVED. SMALL SIZED BLOCKS MAY BE REMOVED BY HAND OR NON-POWERED HAND HELD TOOLS. LARGER MASSES MAY REQUIRE POWER TOOLS, LOW ENERGY BLASTING, EXPANDING GROUT OR STITCH DRILLING. ALL SCALING WORK MUST BE CARRIED OUT IN A SAFE AND CONTROLLED MANNER. WHERE NECESSARY LARGER MASSES MAY BE BROKEN UP IN-SITU TO FACILITATE SAFE REMOVAL. THE CONTRACTOR SHALL PROVIDE A WORK PACKAGE PLAN WHICH SHALL BE SUBMITTED TO THE SCHEME DESIGNER FOR APPROVAL PRIOR TO COMMENCEMENT OF THE WORK.

I REPORTING

I1 THE CONTRACTOR SHALL KEEP FULL RECORDS OF ALL MATERIALS USED, INCLUDING THE BAR, FACE PLATES, WASHERS AND NUTS AND THE TYPE AND QUALITY OF EACH RESIN/GROUT USED. MANUFACTURER'S TEST AND CONFORMITY CERTIFICATES SHALL BE SUPPLIED TO THE SCHEME DESIGNER.

I2 THE CONTRACTOR SHALL PROVIDE AS BUILT PHOTOGRAPHS OR DRAWINGS SHOWING THE LOCATION AND WHERE SPECIFIED THE UNIQUE IDENTIFICATION NUMBER OF EACH ANCHORAGE.

J MAINTENANCE STRATEGY

J1 A MAINTENANCE STRATEGY MUST BE DEVELOPED FOR THE ADOPTED SYSTEM BY THE SCHEME DESIGNER IN CONJUNCTION WITH THE ASSET MANAGER AND MANUFACTURES RECOMMENDATIONS.

J2 A MAINTENANCE MANUAL SHALL BE PRODUCED AS PART OF THE DESIGN DELIVERABLES.

J3 GUIDANCE ON MAINTENANCE STRATEGY IS GIVEN IN THE TUM NR/CIV/SD/TUM/301

NOTES CONT.

B8 GEOTECHNICAL INVESTIGATION SHALL FULFIL THE REQUIREMENTS SPECIFIED IN BS EN 1537 AND EN 1997-1.

B9 ALL DESIGN SHALL BE ACCORDANCE WITH NETWORK RAIL COMPANY STANDARD NR/L3/CIV/071.

B10 WHERE LATERAL CLEARANCES ARE TO BE REDUCED, THESE SHALL BE AGREED WITH THE GAUGING ENGINEER.

B11 THE DESIGN LIFE OF THE ANCHORAGES SHALL BE 60 YEARS.

C SPECIFICATION:

C1 TECHNICAL APPROVAL OF THE USE OF SDD TO BE IN ACCORDANCE WITH NR/L3/CIV/151

C2 THE SCHEME DESIGNER SHALL PREPARE A PARTICULAR SPECIFICATION FOR THE WORKS TO DEFINE THE REQUIREMENTS FOR THE PROJECT. AS A MINIMUM COVERING;
- LOCATION AND EXTENT OF NETTING
- TYPE OF ANCHORAGES INCLUDING TYPE, SPACING, INCLINATION, AZIMUTH, WORKING LOAD, CONNECTION DETAILS, BOREHOLE DIMENSIONS, GROUT TYPE AND TESTING REQUIREMENTS.
- ANCHORAGE CABLE DIAMETER AND TENSION

D ROCK BOLT/ANCHORS.

D1 ROCK BOLTS DETAILS ARE GIVEN ON STANDARD DRAWINGS NR/CIV/SD/285 AND NR/CIV/SD/286. PROPRIETY SPIKE PLATES MAY BE USED AS DETAILED BY MANUFACTURER.

D2 ROCK BOLTS/ANCHORS SHALL BE INSTALLED AND TESTED IN ACCORDANCE WITH THE SCHEME SPECIFICATION AND IN ACCORDANCE WITH BS EN 1537 AND BS 8081:1989.

D3 ROCK BOLT/ANCHOR DIAMETER, STRENGTH AND LENGTH SHALL BE DEFINED BY THE SCHEME DESIGNER AND SHALL BE IN ACCORDANCE WITH BS EN 1537, EN 1997-1, HIGHWAY ADVICE NOTE BA80/99 OR BS8081.

D4 UNLESS OTHERWISE STATED BY THE SCHEME DESIGNER, ANCHORAGES SHALL HAVE A MINIMUM 2m BONDED EMBEDMENT INTO COMPETENT ROCK.

D5 ALL ROCK BOLTS/ANCHORS SHALL HAVE A LEVEL OF CORROSION PROTECTION SUITABLE FOR THE SITE ENVIRONMENT. METALLIC NON-STAINLESS STEEL ANCHORS SHALL BE GALVANISED AND SHALL HAVE EXPOSED ENDS PROTECTED.

D6 IF NON-METALLIC BOLTS/ANCHORS ARE PROPOSED, PROTECTIVE MEASURES SHALL BE INTRODUCED TO MINIMISE THE RISK OF ANCHOR HEAD DAMAGE IN THE EVENT OF LINE SIDE FIRES. THE SCHEME DESIGNER IS TO BE PROVIDED WITH MANUFACTURERS DETAILS AND RELEVANT CERTIFICATES OF COMPLIANCE FOR APPROVAL.

D7 ROCK BOLTS/ANCHORS TO BE INSTALLED PERPENDICULAR TO THE CUTTING FACE UNLESS SPECIFIED OTHERWISE BY THE SCHEME DESIGNER.

D8 ON ENCOUNTERING UNSTABLE MATERIAL, A MINIMUM FREE LENGTH EQUAL TO MATERIAL DEPTH IS TO BE MAINTAINED. AN ADEQUATE ANCHORAGE WILL BE OBTAINED BY BORING A FURTHER 2m (MIN). INTO THE STABLE MATERIAL BEYOND.

D9 ON PROVIDING ANCHORAGE IN SOUND ROCK, 1m FREE LENGTH WILL BE MAINTAINED FROM SURFACE, WITH A MINIMUM BONDED SOCKET OF 2m.

D10 INSTALLATION OF ROCK BOLTS/ANCHORS SHALL NOT USE WATER FLUSH UNLESS OTHERWISE AGREED BY NETWORK RAIL. AIR-MIST OR FOAM FLUSHES ARE ACCEPTABLE. THE ENVIRONMENTAL IMPACT OF FLUSH SYSTEMS SHALL BE CONSIDERED.

D11 THE EDGE OF THE NETTING SHALL BE A MINIMUM 300mm FROM THE END ANCHORAGES.

D12 ANCHORAGES SHALL BE TESTED IN ACCORDANCE WITH BS EN 1537 AND WHERE APPLICABLE BS 8081. THE SCHEME DESIGN SHALL PRODUCE A SCHEME PARTICULAR SPECIFICATION FOR THE TESTING REQUIREMENTS. TESTING REQUIREMENTS DEPEND ON ANCHORAGE SYSTEM SPECIFIED, SEE ASSOCIATED STANDARD DRAWING FOR DETAILED GUIDANCE ON TESTING.

E PRESTRESSED HIGH TENSILE MESH NETTING.

E1 ALL NETTING SHOULD BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS INSTRUCTIONS.

E2 MESH NETTING TO BE A HIGH TENSILE CARBON STEEL WIRE MESH (3mm DIA), ZINC COATED BY ZN/Al PROCESS 'SUPERCOATING' WITH MINIMUM DEPOSIT OF 150g/m² OR SIMILAR, TO FORM A MESH WITH A MAXIMUM WIDTH 80mm X 140mm (± 3mm).

E3 ALL MESH EDGES REINFORCED WITH COMPRESSION CLAWS AS PER MANUFACTURERS INSTRUCTIONS. CONNECTION ELEMENTS AND SPIKE PLATES TO BE PROPRIETARY ITEMS, HOT DIP GALVANISED WITH A MINIMUM CORROSION PROTECTION DEPOSIT OF 500g/m².

E4 OTHER REQUIREMENTS FOR THE SYSTEM INCLUDE;
- MESH MINIMUM TENSILE STRENGTH IN VERTICAL DIRECTION 150kN/m.
- MIN PUNCTURE RESISTANCE 180kN
- MIN SHEARING RESISTANCE OF THE TOP ANCHOR 90kN
- ELEMENTS CONNECTING TWO NEIGHBORING PANELS MUST HAVE A MIN EQUAL TENSILE STRENGTH AND NOT ALLOW INCREASING DEFORMATION OF THE SYSTEM.

DRAWING No. NR/CIV/SD/300

NOTES

A DEFINITIONS

A1 ANCHORAGE – A SYSTEM WHICH PROVIDES A TENSILE RESISTANCE DEVELOPED FROM STABLE GROUND.

A2 ROCK BOLT – A "SHORT" (UP TO 10M LONG) LOW CAPACITY REINFORCEMENT COMPRISING A BAR FIXED INTO ROCK SUBSEQUENTLY TENSIONED TO A PREDETERMINED LOAD. THE LENGTH OF A ROCK BOLT IS DIVIDED INTO A FREE AND BONDED (FIXED) LENGTH.

A3 ANCHORS – A LONG HIGH CAPACITY REINFORCEMENT TYPICALLY COMPRISING MULTISTRAND CABLE ANCHORED INTO ROCK OVER A FIXED LENGTH. ANCHORS ARE TENSIONED TO A PREDETERMINED LOAD.

A4 GOOD GROUND – GROUND THAT IS SELF SUPPORTING ALLOWING OPEN HOLE BORING TECHNIQUES FOR INSTALLATION.

A5 POOR GROUND – GROUND THAT IS NOT SELF SUPPORTING REQUIRING SUPPORT OF THE DRILL HOLE DURING INSTALLATION.

B DESIGN ASSUMPTIONS

B1 THE STANDARD DETAILS DO NOT APPLY TO STABILISATION OF SOFT OR POTENTIALLY SOFT MATERIALS.

B2 THE USE OF HIGH TENSILE MESH TO STABILISE A ROCK SLOPE REQUIRES INVESTIGATION AND STABILITY ANALYSIS TO DETERMINE ITS SUITABILITY. THE ARRANGEMENT AND DETAILS SHOWN ON THIS AND OTHER REFERENCED DRAWINGS SHOW TYPICAL CONFIGURATIONS AND DETAILS THAT MAY BE ENHANCED AND DEVELOPED BY THE SCHEME DESIGNER.

B3 THERE ARE LIMITED SUPPLIERS OF HIGH TENSILE ROCK MESH SYSTEMS. THE DETAILS SHOWN ON THIS AND OTHER REFERENCED DRAWINGS ARE BASED ON THE 'GEOBRUGG' SYSTEM. THE SCHEME DESIGNER SHALL MAKE REFERENCE TO THIS OR ANY ALTERNATIVE MANUFACTURERS TECHNICAL AND TESTING DATA TO ENSURE APPROPRIATE USE OF THE MATERIAL.

B4 THE DETAILS SHOWN WILL ENABLE UNSTABLE SUPERFICIAL MATERIAL TO BE ACTIVELY RETAINED ON THE ROCK FACE. THE SPECIFIC POSITIONING AND SPACING OF THE ROCK BOLTS IS CRITICAL TO THE PERFORMANCE OF THE SYSTEM AND SHALL BE ESTABLISHED FROM SITE TOPOGRAPHY (GLOBAL AND LOCAL), DISCONTINUITY SURVEYS, DESIGN CALCULATION AND REFERENCE TO THE MANUFACTURERS TECHNICAL DATA.

B5 REFER TO THE TECHNICAL USER MANUAL (TUM) DOCUMENT NR/CIV/SD/TUM/301 FOR MORE COMPREHENSIVE GUIDANCE ON DESIGN, INSTALLATION AND MAINTENANCE.

B6 THE SCHEME DESIGNER IS RESPONSIBLE FOR THE DESIGN AND CORRECT SIZING OF ALL COMPONENTS IN ACCORDANCE WITH THE DESIGN REQUIREMENTS. THE SCHEME DESIGNER SHALL SPECIFY THE TYPE OF ANCHORAGE SYSTEM THAT IS SUITABLE FOR THE GROUND CONDITIONS.

B7 WHEN IT IS NECESSARY TO STABILISE SIGNIFICANT VOLUMES OF ROCK, ROCK MECHANICS ANALYSIS AND DESIGN SHALL BE CARRIED OUT BY THE SCHEME DESIGNER WITH REFERENCE TO THE MANUFACTURERS TECHNICAL DATA AND APPROPRIATE ROCK BOLTS OR ANCHORS SHALL BE INCORPORATED INTO THE DESIGN.

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C	MAY 2011	THIRD ISSUE	GPR	SWMF
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CIVIL ENGINEERING STANDARD DESIGN

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EARTHWORKS

HIGH TENSILE NETTING GENERAL ARRANGEMENT

Scale	AS SHOWN	
Drawing Number	NR/CIV/SD/300	REV. P3

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