**GUIDELINES FOR DEVELOPING DETAILS FOR REPAIR OF MSE WALL FACING**

THESE SAMPLE DETAILS AND NOTES PROVIDE GUIDANCE ON REPAIR METHODS FOR DAMAGED PORTIONS OF MECHANICALLY STABILIZED EARTH (MSE) WALLS WITH PRECAST CONCRETE PANELS AND STEEL OR GEOSYNTHETIC REINFORCEMENTS. THE DESIGNER SHOULD SELECT THE APPROPRIATE REPAIR METHOD BASED ON THE TYPE AND LEVEL OF DAMAGE IN THE WALL FACING.

THE ODOT BRIDGE DESIGN MANUAL SHALL BE CONSULTED FOR GUIDANCE FOR APPROPRIATE METHODS FOR CONCRETE REPAIR AND RESTORATION. THIS INFORMATION SHOULD BE USED AS A GUIDE IN DEVELOPING APPROPRIATE PLAN NOTES.

IF RECONSTRUCTION IS DETERMINED TO BE MORE FEASIBLE IN COST AND/OR TIME THAN REPAIR, AND IF RECONSTRUCTION IS SELECTED, CONSTRUCTION SHALL BE PRECEDED BY DESIGN CALCULATIONS AND BE SUBJECT TO APPROVAL BY THE DEPARTMENT. THE MSE REINFORCEMENT SHALL BE OF THE SAME TYPE AS THE SOIL REINFORCEMENT USED IN THE REMAINDER OF THE WALL (STEEL OR GEOSYNTHETIC) TO AVOID DIFFERENT WALL DEFORMATION RESPONSES.

**REPAIR METHODS LIST**

**PANEL REPAIR METHOD 1:** MINOR COSMETIC FACING REPAIR BY PART DEPTH REMOVAL AND INSTALLATION OF FRESH CONCRETE WITH DOWELS AND BONDING AGENTS. THIS INCLUDES PAINTING OF THE REPAIRED AREA OF FACING AND VICINITY. THIS METHOD DOES NOT REQUIRE DETAILS. IT ONLY REQUIRES REMOVAL AND REPLACEMENT LIMITS.

**PANEL REPAIR METHOD 2:** FACING REPAIR BY PART OR FULL DEPTH GRUBBING OR SCRUBBING AND INSTALLATION OF EITHER A THICKER ZONE OF FRESH CIP CONCRETE WITH DOWELS, BONDING AGENTS, AND NEW ADDITIONAL STEEL REINFORCING REBAR OR A PRECAST PANEL WITH CONNECTION TO HELICAL ANCHORS. HELICAL ANCHORS TYPICAL LAYOUT IS ON SHEET 2. (SEE SHEETS 3 AND 4 OF 8 FOR DETAILS). THIS METHOD INCLUDES SEALING OF THE REPAIRED AREA OF FACING AND VICINITY TO MATCH SURROUNDING PANELS.

IF CONNECTION TO MSE REINFORCEMENT IS NOT FUNCTIONAL AND THE MSE REINFORCEMENT IS FUNCTIONAL, HELICAL ANCHORS CAN BE USED TO FASTEN THE REPLACEMENT PANEL. SIMILAR DETAILS FOR PROTECTION OF MSE FILL USING TEMPORARY FORMWORK CAN BE USED WITH THE HELICAL ANCHORS AND CIP OR PRECAST FACING PANEL. SUGGESTED DETAILS OF ANCHORS FOR 5' x 5' OR 5' x 10' PANELS ARE ON SHEET 2. THE LENGTH AND TYPE OF HELICAL ANCHOR ARE TO BE DETERMINED IN DETAIL PLANS.

**REINFORCEMENT REPAIR:** INSTALLATION OF DRILLED AND GROUTED SOIL NAILS WITH CORROSION PROTECTION.

**GROUT FILL:** BACKFILLING OF VOIDS PRODUCED BY LOSS OF REINFORCED FILL USING CMS 613 - LOW-STRENGTH MORTAR BACKFILL (LSM), TYPE 2.

**CAUSES OF MSE WALL DAMAGE AND DETERIORATION**

THE MAIN CAUSE(S) FOR DAMAGE OF THE MSE WALL SHALL BE IDENTIFIED PRIOR TO SELECTING THE REPAIR METHOD.

**DAMAGE TYPES AND REPAIR METHODS**

FOUR TYPES OF DAMAGE ARE ADDRESSED:

**TYPE I:** EXTENSIVE TO MODERATE DAMAGE TO FACING PANEL(S) AND/OR JOINTS AND REINFORCEMENT OR REINFORCEMENT CONNECTIONS WITH PARTIAL LOSS OF REINFORCED FILL THROUGH THE DAMAGED PANELS OR JOINTS. THE DAMAGED REINFORCEMENT CAN BE MISALIGNED OR BENT, SEVERELY CORRODED, OR DETERIORATED. DAMAGE MAY INCLUDE SIGNIFICANT LATERAL OR UNEVEN VERTICAL MOVEMENTS. THIS TYPE OF DAMAGE CAN BE CAUSED BY IMPACT FROM VEHICLES, BOULDERS OR STONES, WATER, FOUNDATION ISSUES, EXCESSIVE SETTLEMENT OR LATERAL DEFORMATION, OVERSTRESSING OF THE FACING DUE TO WALL HEIGHT AND/OR ECCENTRIC LOADS ON THE FACING, LACK OF PADS BETWEEN THE PANELS, OR DAMAGE CAUSED BY AGGRESSIVE CHEMICALS THAT MIGHT BE HARMFUL TO CONCRETE OR THE REINFORCEMENT. THIS CAN BE A VISIBLE SINGLE KIND OF DAMAGE OR MULTIPLE KINDS OF DAMAGE TO ADJACENT PANELS OR GROUP OF PANELS.

THIS TYPE REQUIRES THE FOLLOWING REPAIRS:

1. PANEL REPAIR METHOD 2.

2. REINFORCEMENT REPAIR (WHERE MSE REINFORCEMENTS ARE NOT FUNCTIONAL).

3. GROUT FILL.

**TYPE II:** LOCAL DAMAGE LIMITED TO FACING PANEL(S) OR/AND JOINTS WHICH RESULTS IN PARTIAL LOSS OF REINFORCED FILL THROUGH THE DAMAGED FACING PANELS OR JOINTS BETWEEN PANELS WITH NO EFFECTS ON THE REINFORCEMENT OR REINFORCEMENT CONNECTIONS.

THIS TYPE REQUIRES THE FOLLOWING REPAIRS:

1. PANEL REPAIR METHOD 1 OR REPAIR METHOD 2.

2. GROUT FILL.

**TYPE III:** PARTIAL LOSS OF REINFORCED FILL DUE TO PANEL JOINT WIDENING OR UNEVEN SETTLEMENT OF PANELS WITHOUT DAMAGE TO THE PANEL UNITS.

THIS TYPE REQUIRES THE FOLLOWING REPAIRS:

1. PANEL REPAIR METHOD 1 OR REPAIR METHOD 2 TO CLOSE OUT JOINTS.

2. GROUT FILL.

**TYPE IV:** DAMAGE TO THE EXTERIOR OF PANELS WITH NO LOSS OF REINFORCED FILL AND NO EFFECTS ON THE REINFORCEMENT OR REINFORCEMENT CONNECTIONS.

THIS TYPE REQUIRES THE FOLLOWING REPAIRS:

1. PANEL REPAIR METHOD 1

**SAMPLE GENERAL NOTES FOR REPAIR METHODS:**

CONSTRUCTION SPECIFICATIONS:

ODOT BRIDGE DESIGN MANUAL AND ODOT CONSTRUCTION AND MATERIAL SPECIFICATIONS (C&MS).

MATERIALS:

CAST-IN-PLACE CONCRETE SHALL BE CLASS QC1, f'c=4,000 PSI @ 28 DAYS.

SHOTCRETE SHALL BE IN ACCORDANCE WITH THE ODOT CMS ITEM 520 (PNEUMATICALLY PLACED MORTAR), f'c=4,200 PSI @ 28 DAYS.

CMS ITEM 613 - LOW-STRENGTH MORTAR (LSM), TYPE 2.

REINFORCING STEEL SHALL BE IN ACCORDANCE WITH CMS 509, MIN. YIELD STRENGTH 60 KSI.

BENDS AND HOOKS IN REINFORCING STEEL SHALL MEET THE REQUIREMENTS OF THE MOST CURRENT EDITION OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, ARTICLE 5.10.2, UNLESS NOTED OTHERWISE.

ALL REINFORCING STEEL SHALL HAVE A MINIMUM 2 INCH CONCRETE COVER UNLESS NOTED OTHERWISE.

HELICAL ANCHORS SHALL BE GRADE 30 STEEL GALVANIZED PER ODOT CMS 711.02 AND MUST BE AT LEAST 4.0 FEET LONG WITH 6 INCH BLADE DIAMETER MOUNTED ON A 5#8 INCH DIAMETER SHAFT/ROD, SEE DETAILS ON SHEET 2 OF 8. THE NOMINAL GEOTECHNICAL RESISTANCE (HOLDING POWER) OF THE ANCHOR IS 4 KIPS. THE ANTICIPATED TORQUE TO ACHIEVE THE 4 KIPS IS 400 FT-LB.

BACKFILL MATERIALS PLACED OUTSIDE THE LIMITS OF THE NEW AND EXISTING WALLS SHALL MEET THE REQUIREMENTS OF ROADWAY EMBANKMENT PER CMS ITEM 203. BACKFILL PLACED BEHIND THE BACK OF THE WALL FACE SHALL MEET THE REQUIREMENTS OF ODOT SUPPLEMENTAL SPECIFICATION 840.

**SAMPLE CONSTRUCTION REQUIREMENTS:**

ALL EXPOSED SURFACES OF CAST-IN-PLACE CONCRETE SHALL BE FINISHED TO MATCH THE FINISH OF THE REMAINDER OF THE WALL UNLESS OTHERWISE SPECIFIED BY THE ENGINEER.

EXPOSED AREAS OF NEW CONCRETE SHALL BE PAINTED TO A MINIMUM OF 1.0 FOOT BELOW FINISHED GRADE. DAMAGED AND/OR SANDBLASTED AREAS OF EXISTING CONCRETE SURFACES SHALL BE PAINTED AT THE SAME TIME AS NEW CONCRETE SURFACES. THE COLOR OF NEW PAINT SHALL BE THE COLOR OF EXISTING PAINT.

ALL CONCRETE SEALING SHALL BE IN ACCORDANCE WITH CMS ITEM 512.

ALL EXPOSED CORNERS OF CAST-IN-PLACE CONCRETE SHALL BE CHAMFERED 3#4 INCH.

A PROPOSED SEQUENCE OF CONSTRUCTION SHALL BE PART OF THE PLAN NOTES, SAMPLE NOTES ARE PROVIDED BELOW:

**SAMPLE CONSTRUCTION SEQUENCE FOR REPAIR OF DAMAGED WALL FACING AND NON-FUNCTIONAL MSE REINFORCEMENT:**

1. EXCAVATE SPILLED SELECT GRANULAR BACKFILL AND DEBRIS FROM THE OUTSIDE OF THE DAMAGED WALL AREA TO THE LIMITS OF THE NEW CAST-IN-PLACE WALL FACING.

2. DEFINE THE LIMITS OF REMOVAL FOR LOOSE CONCRETE. REMOVE CONCRETE AND THE PRECAST CONCRETE PANEL REINFORCEMENT TO THE LIMITS SHOWN ON THE PLANS. THE CONCRETE SHALL BE REMOVED WITH HAND TOOLS THAT WILL GIVE SATISFACTORY RESULTS IN PREPARING AND SHAPING THE AREAS TO PROVIDE A CLEAN BOUNDARY FOR FORMING AND PLACING LOW STRENGTH MORTAR (LSM). EXPOSED REINFORCING BARS MAY BE SEVERED AS REQUIRED TO PROVIDE A SAFE WORK AREA AND FACILITATE PLACING FORMING MATERIALS IN THE AREA OF THE EXCAVATION.

3. SANDBLAST EXISTING CONCRETE SURFACES BEHIND THE NEW CAST-IN-PLACE FACING TO PRODUCE SURFACE CONDITIONS SUITABLE FOR BONDING WITH NEW CONCRETE.

4. COVER THE OPENING IN THE EXISTING WALL WITH TEMPORARY FORMWORK BEHIND THE MSE WALL PRECAST CONCRETE PANELS AND SEAL THE JOINTS BETWEEN THE PANELS TO THE LIMITS NEEDED TO PREVENT ITEM 613 TYPE 2 LOW STRENGTH MORTAR (LSM) BACKFILL FROM ESCAPING FROM BEHIND THE EXISTING WALL DURING PLACEMENT. THE FORMING MATERIALS SHALL BE SECURELY BRACED TO THE EXISTING GROUND TO WITHSTAND THE HYDROSTATIC PRESSURE OF THE LSM.

5. BRACE EXISTING PRECAST CONCRETE PANELS IN THE DAMAGED AREA AND VICINITY TO PREVENT OUTWARD MOVEMENT OR ROTATION DURING PLACEMENT OF THE LSM.

6. CORE-DRILL HOLES THROUGH THE CONCRETE OF THE EXISTING WALL OR THE FORMWORK TO PERMIT PUMPING AND VENTING OF THE LSM. ENTRY AND VENT HOLES SHALL BE IN THE LOCATIONS SHOWN ON SHEET 6 OF 8.

7. PUMP LSM INTO THE VOID SPACE BEHIND THE EXISTING WALL UNTIL IT EXITS THROUGH THE VENT HOLES.

8. FORMING MATERIALS AND BRACING MAY BE REMOVED 3 DAYS AFTER PLACING LSM. NO WOOD SHALL REMAIN IN OR AROUND THE DAMAGED AREA.

9. PLACE REINFORCING AND CONSTRUCT A SHOTCRETE SUB-FACIA.

10. INSTALL A PROOF TEST SOIL NAIL AND PERFORM PROOF TESTING AS SPECIFIED AND SHOWN ON SHEET 8 OF 8. THE SHOTCRETE SUB-FACIA SHALL ATTAIN A MINIMUM COMPRESSIVE STRENGTH OF 3,000 PSI BEFORE PERFORMING PROOF TESTING.

11. FOLLOWING THE ENGINEER'S APPROVAL OF THE PROOF TEST RESULTS, CONSTRUCT THE REMAINING SOIL NAILS IN THE LOCATIONS SHOWN ON THE PLANS AND PER THE DETAILS SHOWN ON THE PLANS.

12. CONSTRUCT A NEW UNREINFORCED CONCRETE FOOTING AND PERMANENT CAST-IN-PLACE CONCRETE FACING PER THE DETAILS SHOWN ON THE PLANS.

13. PAINT NEW AND EXISTING CONCRETE SURFACES, BACKFILL, AND RESTORE THE GRADE IN FRONT OF THE WALL TO MATCH THE ADJACENT AREA.

**SAMPLE CONSTRUCTION SEQUENCE FOR REPAIR OF DAMAGED WALL FACING WITH FUNCTIONAL MSE REINFORCEMENT:**

1. EXCAVATE SPILLED SELECT GRANULAR BACKFILL AND DEBRIS FROM THE OUTSIDE OF THE DAMAGED WALL AREA TO THE LIMITS OF THE NEW CAST-IN-PLACE WALL FACING.

2. DEFINE THE LIMITS OF REMOVAL FOR LOOSE CONCRETE. REMOVE CONCRETE AND THE PRECAST CONCRETE PANEL REINFORCEMENT TO THE LIMITS SHOWN ON THE PLANS. THE CONCRETE SHALL BE REMOVED WITH HAND TOOLS THAT WILL GIVE SATISFACTORY RESULTS IN PREPARING AND SHAPING THE AREAS TO PROVIDE A CLEAN BOUNDARY FOR FORMING AND PLACING LOW STRENGTH MORTAR (LSM). EXPOSED REINFORCING BARS MAY BE SEVERED AS REQUIRED TO PROVIDE A SAFE WORK AREA AND FACILITATE PLACING FORMING MATERIALS IN THE AREA OF THE EXCAVATION. REPLACE REINFORCEMENT CONNECTORS IF DAMAGED DURING THE CONCRETE REMOVAL OPERATION. THE REINFORCEMENT CONNECTORS SHOULD BE ACQUIRED FROM THE ORIGINAL WALL SYSTEM SUPPLIER THAT MEET THE REQUIREMENT OF THE SUPPLEMENTAL SPECIFICATION SS 840. EXERCISE CARE DURING THE CONCRETE REMOVAL OPERATION SO THAT THE SOIL REINFORMENTS ARE NOT DAMAGED.

3. SANDBLAST EXISTING CONCRETE SURFACES BEHIND THE NEW CAST-IN-PLACE FACING TO PRODUCE SURFACE CONDITIONS SUITABLE FOR BONDING WITH NEW CONCRETE.

4. COVER THE OPENING IN THE EXISTING WALL WITH TEMPORARY FORMWORK BEHIND THE MSE WALL PRECAST CONCRETE PANELS AND SEAL THE JOINTS BETWEEN THE PANELS TO THE LIMITS NEEDED TO PREVENT ITEM 613 TYPE 2 LOW STRENGTH MORTAR (LSM) BACKFILL FROM ESCAPING FROM BEHIND THE EXISTING WALL DURING PLACEMENT. THE FORMING MATERIALS SHALL BE SECURELY BRACED TO EXISTING GROUND TO WITHSTAND THE HYDROSTATIC PRESSURE OF THE LSM.

5. BRACE EXISTING PRECAST CONCRETE PANELS IN THE DAMAGED AREA AND VICINITY TO PREVENT OUTWARD MOVEMENT OR ROTATION DURING PLACEMENT OF THE LSM.

6. CORE-DRILL HOLES THROUGH THE CONCRETE OF THE EXISTING WALL OR THE FORMWORK TO PERMIT PUMPING AND VENTING OF THE LSM. ENTRY AND VENT HOLES SHALL BE IN THE LOCATIONS AS SHOWN ON THE PLANS.

7. PUMP LSM INTO THE VOID SPACE BEHIND THE EXISTING WALL UNTIL IT EXITS THROUGH THE VENT HOLES.

8. FORMING MATERIALS AND BRACING MAY BE REMOVED 3 DAYS AFTER PLACING LSM. NO WOOD SHALL REMAIN IN OR AROUND THE DAMAGED AREA.

9. INSTALL CONCRETE PANEL STEEL REINFORCEMENT IN THE DOWEL HOLES AS SHOWN ON THE PLANS. INSTALL ALL ADDITIONAL STEEL REINFORCEMENT AS SHOWN ON THE PLANS.

10. PLACE EXPANDED POLYSTYRENE BETWEEN THE EXISTING MSE WALL PANELS AND THE PANEL UNDER REPAIR, AND INSTALL TEMPORARY FORMWORK WITH THE APPROPRIATE ARCHITECHTURAL FINISH THAT MATCHES THE ORIGINAL FINISH PROVIDED ON THE EXISTING MSE WALL PANELS.

11. PLACE PREFORMED EXPANSION JOINT FILLER (PEJF) AS SHOWN ON THE PLANS WHEN REQUIRED FOR TOP PANELS.

12. CAST THE CONCRETE TO FORM THE PANEL AND REMOVE THE TEMPORARY FORMWORK AFTER 48 HOURS.

13. REMOVE EXPANDED POLYSTYRENE THAT WAS PLACED BETWEEN THE EXISTING MSE WALL PANELS AND THE PANEL UNDER REPAIR.

14. FILL JOINTS WITH FOAM BACKER ROD OR EXPANDING FOAM. FOLLOW THE MANUFACTURER'S RECOMMENDATIONS FOR APPLICATION. IF USING EXPANDING FOAM, USE A FOAM THAT CAN BE APPLIED IN COLD WEATHER.

15. SEAL THE JOINTS BY APPLYING A SILICONE SEALANT TO THE FOAM IN THE JOINTS. FOLLOW THE MANUFACTURER'S RECOMMENDATIONS FOR APPLICATION. USE A SEALANT THAT CAN BE APPLIED IN COLD WEATHER, AND THAT COMES IN A COLOR TO MATCH OR COMPLEMENT THE COLOR OF THE MSE WALL FACING PANELS.

16. SMOOTH THE SURFACE OF THE SEALANT.

**SAMPLE GENERAL NOTES FOR REINFORCEMENT REPAIR:**

1. ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THESE GENERAL NOTES, THE SPECIAL PROVISIONS, AND ODOT SPECIFICATIONS.

2. ALL SOIL NAIL LENGTHS AND BAR SIZES SHALL BE IN ACCORDANCE WITH THE DETAILS.

3. SHOTCRETE REINFORCING REQUIREMENTS ARE SHOWN ON SHEET 6 OF 8.

4. SOIL NAIL INCLINATION REQUIREMENTS ARE SHOWN ON SHEET 6 OF 8.

5. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES IN THE VICINITY OF THE SOIL NAIL WALL PRIOR TO BEGINNING CONSTRUCTION.

6. PROOF TESTING SHALL BE CONDUCTED IN ACCORDANCE WITH THE SPECIAL PROVISIONS PROVIDED. THE DESIGN BOND STRENGTH FOR TESTING PURPOSES SHALL BE 0.5 KIPS/FT.

7. DETAILS ON THIS SHEET APPLY TO ALL SOIL NAIL WALL DRAWINGS UNLESS OTHERWISE NOTED.

**MATERIALS:**

1. SOIL NAIL GROUT SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH OF 3,000 PSI, AND A MINIMUM 3-DAY COMPRESSIVE STRENGTH OF 1,500 PSI. SOIL NAIL GROUT MAY BE NEAT-CEMENT GROUT OR READY-MIX GROUT. TYPE I/II PORTLAND CEMENT CONFORMING TO ASTM C150/AASHTO M85 SHALL BE USED FOR SOIL NAIL GROUT. SUBMIT MIX DESIGN TO THE ENGINEER FOR REVIEW AND APPROVAL PRIOR TO CONSTRUCTION.

2. SOIL NAILS SHALL BE HOLLOW BAR SOIL NAILS (DYWIDAG TYPE MAI R 25, CONTECH IBO-TITAN TYPE 30/16, OR SIMILAR), MIN. YIELD STRENGTH 60 KSI.

3. SOIL NAILS SHALL NOT BE EPOXY COATED.

4. STRUCTURAL STEEL FOR BEARING PLATES SHALL BE IN ACCORDANCE WITH ASTM A36, Fy=36,000 PSI.

5. WELDED STUD SHEAR CONNECTORS SHALL BE IN ACCORDANCE WITH CMS ITEM 513.

6. HIGH STRENGTH THREADED BOLTS, NUTS AND WASHERS SHALL CONFORM TO 711.09, ASTM 325.

**INSPECTION AND MONITORING:**

1. SERVICES FOR WORK INSPECTION, MATERIAL TESTING, AND SURVEYING AND MONITORING OF SOIL NAIL INSTALLATION WILL BE PROVIDED BY THE CONTRACTOR. THE DRILLING CONTRACTOR SHALL COOPERATE WITH THE INSPECTION AND TESTING AGENCIES SELECTED BY THE CONTRACTOR, AND SHALL FURNISH EQUIPMENT, TOOLS, AND LABOR ON SITE AS REQUIRED TO FACILITATE SUCH TASKS.

2. THE DRILLING CONTRACTOR SHALL TAKE PHOTOGRAPHS TO DOCUMENT CONDITIONS OF ADJACENT EXISTING STRUCTURES, WALLS, STREET PAVEMENTS, UTILITIES, ETC. PRIOR TO COMMENCEMENT OF WORK. ONE SET OF THESE PHOTOS SHALL BE SUBMITTED TO THE ENGINEER BEFORE BEGINNING ANY WORK.

3. THE CONTRACTOR SHALL SURVEY EVERY OTHER NAIL IN THE TOP ROW OF NAILS TO MONITOR HORIZONTAL AND VERTICAL GROUND MOVEMENTS. THE SURVEY SHALL BE DONE ON A DAILY BASIS UNTIL WALL CONSTRUCTION IS COMPLETE, AND THE DAILY RESULTS SHALL BE MADE AVAILABLE TO THE ENGINEER BY THE FOLLOWING WORK DAY.

4. SHOULD EXCESSIVE (GREATER THAN 1#2 INCH) OR A SUDDEN INCREASE IN GROUND SETTLEMENT, LATERAL DEFORMATION, OR SOIL NAIL WALL MOVEMENT BE DETECTED, THE SOIL NAIL WALL CONTRACTOR SHALL NOTIFY THE ENGINEER IMMEDIATELY.

**CONSTRUCTION PROCEDURES:**

1. SOIL NAIL TOLERANCES: PLAN LOCATION WITHIN 1.0 INCH (NOT CUMULATIVE); ORIENTATION WITHIN 2 DEGREES.

2. SOIL NAILS SHALL BE DRILLED WITHOUT LOSS OF GROUND AND WITHOUT ENDANGERING PREVIOUSLY INSTALLED SOIL NAILS OR ADJACENT WALL SECTIONS.

3. HOLLOW BAR SOIL NAILS SHALL BE ADVANCED DURING DRILLING AND GROUTED FROM BOTTOM OF THE HOLES TO THE SURFACE IN ONE CONTINUOUS OPERATION. HOLLOW BARS SHALL BE HELD OFF THE BASE OF THE DRILL HOLE IMMEDIATELY PRIOR TO AND DURING GROUTING. CONTINUOUSLY AGITATE THE GROUT AND DELIVER GROUT TO THE HOLE FREE OF LUMPS AND UNDISPOSED CEMENT. CONTROL PRESSURE TO PREVENT SOIL HEAVE. INITIALLY, GROUT MAY BE DILUTED BUT UPON COMPLETION OF THE HOLE THE GROUT SHALL BE THICKENED TO PROVIDE A GROUT COLUMN WITH UNIFORM STRENGTH AND CONSISTENCY. CENTRALIZERS SHALL NOT BE REQUIRED WHEN USING THIS METHOD.

4. PERFORM SOIL NAIL PROOF TESTING PER SPECIFICATIONS AFTER SHOTCRETE AND ALL GROUT HAVE ATTAINED THEIR SPECIFIED STRENGTHS. LEAVE A GAP IN THE SHOTCRETE SUB-FACIA AND REINFORCEMENT A MINIMUM OF THREE TIMES THE DIAMETER OF THE SOIL NAIL DRILLED HOLE, CENTERED ON THE DRILLED HOLE, TO AVOID INTERFERENCE OF THE WALL FACING WITH THE MEASURED PULLOUT RESISTANCE DURING PROOF TESTING.

**RECORDS:**

PREPARE AND SUBMIT TO THE ENGINEER COMPLETE INSTALLATION RECORDS FOR EACH NAIL INSTALLED WITHIN 24 HOURS OF INSTALLATION. THE INSTALLATION RECORD SHALL INCLUDE THE FOLLOWING INFORMATION: NAIL HEAD ELEVATION, HOLE DIAMETER, UNUSUAL DRILLING STRATIGRAPHY, GROUNDWATER, BAR SIZE, GROUT PRESSURE, AND OTHER USEFUL DATA.

**PROOF TESTING:**

1. SUBMIT DETAILED RECORDS OF TESTING METHODS AS SPECIFIED BELOW PRIOR TO BEGINNING ANY TESTS. INCLUDE DRAWINGS AND DETAILS TO CLEARLY DESCRIBE METHODS. SUBMIT CALIBRATION REPORTS AND DATA FOR EACH TEST JACK, PRESSURE GAUGE, AND LOAD CELL TO BE USED. CALIBRATION REPORTS SHALL NOT BE OLDER THAN 60 DAYS.

2. THE WOOD CRIBBING TO SUPPORT THE PROOF TESTING APPARATUS STEEL BEARING PLATE SHALL BE OFFSET FROM THE SOIL NAIL DRILLED HOLE A MINIMUM DISTANCE OF ONE HOLE DIAMETER ON ALL SIDES TO AVOID INTERFERENCE WITH THE MEASURED PULLOUT RESISTANCE.

3. PROOF TESTING FOR THE SOIL NAILS SHALL CONFORM TO FHWA-NH1-14-007, SOIL NAIL WALLS REFERENCE MANUAL (GEC 7) AS MODIFIED BY THESE NOTES AND THE SPECIAL PROVISIONS. THE PROOF TEST SHALL BE PERFORMED AT THE LOCATION NOTED ON SHEET 6 OF 8.

4. THE ALIGNMENT LOAD (AL) SHOULD BE THE MINIMUM LOAD REQUIRED TO ALIGN THE TESTING APPARATUS AND SHOULD NOT EXCEED 2.5 PERCENT OF THE PROOF TEST LOAD (PTL). DIAL GAUGES SHOULD BE SET TO "ZERO" AFTER THE LOAD HAS BEEN APPLIED.

5. EACH LOAD INCREMENT SHALL BE HELD FOR AT LEAST 10 MINUTES. THE PROOF TEST NAIL SHALL BE MONITORED FOR CREEP AT THE 1.00 PTL INCREMENT. NAIL MOVEMENTS DURING THE CREEP PORTION OF THE TEST SHALL BE MEASURED AND RECORDED AT 1, 2, 3, 4, 5, 6, 10, 20, 30, 50, AND 60 MINUTES. THE LOAD DURING THE CREEP TEST SHALL BE MAINTAINED WITHIN 2 PERCENT OF THE PTL BY USE OF THE LOAD CELL. THE NAIL SHALL BE UNLOADED IN INCREMENTS OF 25% OF THE PTL WITH MOVEMENTS RECORDED AT EACH UNLOAD INCREMENT. EACH UNLOAD INCREMENT SHALL BE HELD FOR A SUFFICIENT TIME TO ALLOW STABILIZATION OF THE MOVEMENT READING.

6. DO NOT STRESS THE NAIL BAR TO MORE THAN 80 PERCENT OF ITS MINIMUM GUARENTEED ULTIMATE TENSILE STRENGTH FOR GRADE 150 STEEL OR MORE THAN 90 PERCENT OF THE MINIMUM YIELD STRENGTH FOR GRADE 60 OR 75 STEEL.

**PROOF TEST ACCEPTANCE CRITERIA:**

THE FOLLOWING TEST ACCEPTANCE CRITERIA SHALL BE USED. NAILS FAILING THIS CRITERIA SHALL NOT BE ACCEPTED AND REPLACEMENT NAILS SHALL BE PROPOSED AND INSTALLED AFTER APPROVAL BY THE ENGINEER.

1. TOTAL MOVEMENT AT THE PTL MUST EXCEED 80 PERCENT OF THE THEORETICAL ELASTIC MOVEMENT OF THE UNBONDED LENGTH.

2. CREEP MOVEMENT BETWEEN THE 1 AND 10 MINUTE READINGS MUST BE LESS THAN 0.04 INCH.

3. CREEP MOVEMENT BETWEEN THE 6 AND 60 MINUTE READINGS MUST BE LESS THAN 0.08 INCH.

4. PULLOUT FAILURE MUST NOT OCCUR AT THE PTL.