OHIO DEPARTMENT OF TRANSPORTATION

CENTRAL OFFICE, 1980 W. BROAD ST., COLUMBUS, OHIO 43216-0899

January 21, 2005

To: Users of the Bridge Design Manual

From: Tim Keller, Administrator, Office of Structural Engineering

By: Sean Meddles, Bridge Standards Engineer

Re: 2005 First Quarter Revisions

Revisions have been made to the ODOT Bridge Design Manual, January 2004. This package contains the revised pages. The revised pages have been designed to replace the corresponding pages in the book and are numbered accordingly. Revisions, additions, and deletions are marked in the revised pages by the use of one vertical line in the right margin. The header of the revised pages is dated accordingly.

To keep your Manual correct and up-to-date, please replace the appropriate pages in the book with the pages in this package.

To ensure proper printing, make sure your printer is set to print in the 2-sided mode.

The January 2004 edition of the Bridge Design Manual may be downloaded at no cost using the following link: http://www.dot.state.oh.us/se/BDM/BDM2004/bdm2004.htm

The January 2004 edition is also available for purchase from the Ohio Department of Transportation, Office of Contracts, 1980 W. Broad St., Columbus, Ohio 43223.

Attached is a brief description of each revision.

Summary of First Quarter, 2005 Revisions to the ODOT BDM

BDM Section	Affected Pages	Revision Description
102.3	1-4 through 1-9	This section has been removed with the release of the Office of Production's *Ohio Department of Transportation CADD – Engineering Standards*.
102.7	1-11	This section was revised in accordance with ODOT Policy 16-004(P).
Fig. 102		This figure was retired due to changes in BDM section 102.3.
Fig. 103		This figure was retired due to changes in BDM section 102.3.
Fig. 104		This figure was retired due to changes in BDM section 102.3.
Fig. 105		This figure was retired due to changes in BDM section 102.3.
Fig. 106		This figure was retired due to changes in BDM section 102.3.
Fig.102M		This figure was retired due to changes in BDM section 102.3.
Fig.103M		This figure was retired due to changes in BDM section 102.3.
Fig.104M		This figure was retired due to changes in BDM section 102.3.
Fig.105M		This figure was retired due to changes in BDM section 102.3.
Fig.106M		This figure was retired due to changes in BDM section 102.3.
204.6.2	2-26 through 2-27.2	This section was revised to provide the designer a better understanding of the preliminary design requirements for a proprietary retaining wall. The "Traditional" plan preparation method for MSE walls has been eliminated in favor of the "Three-Line Diagram" method.
205.5	2-29 through 2-30	This section was revised to eliminate confusion regarding acceptable beam spacings for prestressed I-beam superstructures.
207.1	2-34	The terminology has been changed from "Minimum Vertical Clearance" to simply "Vertical Clearance" to eliminate confusion with the L&D Manual's terminology of "Minimum" vs. "Preferred". All grade separations should be designed to meet the "Preferred" clearances.
Fig. 202		This figure was retired due to the development of new Figure 333.
Fig.202M		This figure was retired due to the development of new Figure 333.
302.1.4.3	3-12	Reference for sealer specifications updated from SS 864 to CMS 512 to reflect changes in the 2005 CMS.
302.5	3-37 through 3-38.2	An additional design requirement for multi-span, composite prestressed beams has been adopted to ensure that new provisions in BDM Section 902.1 will be met.
303.1.1	3-51	Reference for sealer specifications updated from SS 864 to CMS 512 to reflect changes in the 2005 CMS.

BDM Section	Affected Pages	Revision Description
303.5	3-76 through 3-81	This section was revised to provide the designer a better understanding of the detail design requirements for a proprietary retaining wall.
Fig. 329		This new figure details sample plan and elevation views of an MSE Wall supported abutment.
Fig. 330		This new figure details a cross section through an MSE Wall supported abutment with undercut and backfill requirements.
Fig. 331		This new figure details a cross section through an MSE Wall supported abutment with no undercut and backfill requirements.
Fig. 332		This new figure details an MSE wall supported abutment, MSE Wall backfill drainage and MSE wall coping.
Fig. 333		This new figure replaces Fig. 202 and details an MSE wall supporting a roadway embankment including a traffic barrier.
412/413	4-17 4-19 4-21	The section headings were renumbered to correct for a typographical error that occurred on page 4-17.
605.3	6-15	The word “granular” was removed from both note [26] and [27]. The intent of these notes was not to modify the embankment materials specified by Item 203 but to reduce the lift thickness to 6 inches.
605.4	6-16	Note [28] has been retired to the Appendix as ARN-21. The 2005 CMS now includes the abutment backfill requirements in 503.08.
605.5	6-16 through 6-16.2	This section has been added as a result of BDM revisions regarding plan preparation of MSE walls.
702.15	7-12	This is a correction of a typing error that occurred with the January 2003 Edition of the BDM. The revision reflects the requirements of AASHTO Table 10.3.1B.
804/805	8-4 through 8-6	This revision updates the BDM to the Department’s current approval process for noise walls.

BDM Section	Affected Pages	Revision Description
900	9-1 through 9-18	This entire section has been revised in order to clarify the load rating requirements for buried bridges and non-buried bridges. Also included in this revision are new load rating report submission guidelines as well as guidelines for the following: Major, Minor and Minimal PDP projects, Minor Design-Build projects, Minimal Design-Build projects and projects redesigned under a Value Engineering Change Proposal (VECP). The Department has also restricted the use of rating software for standard ODOT non-buried bridge types. Only AASHTO BARS ratings will be accepted. The Department will now require the load rating of new and rehabilitated bridges to equal or exceed the design loading. Details for the load rating report submission have been modified including requirement for a P.E. stamp.
AN-1	Appendix-2 through Appendix-10.4	The MSE wall special provisions have been extensively modified to address shortcomings with current construction and contracting practices.
AN-2	Appendix-11 through Appendix-19.4	
AN-3	Appendix-20 through Appendix-28.4	
AN-4	Appendix-29 through Appendix-37.4	
ARN-21	Appendix-109.1 through Appendix-109.2	Note [28] has been retired. Refer to Section 605.4 comment above.

SECTION 100 – GENERAL INFORMATION 1-1
101 INTRODUCTION 1-1
101.1 GENERAL CONSIDERATIONS 1-1
101.2 TABLE OF ORGANIZATION 1-1
102 PREPARATION OF PLANS 1-1
102.1 BRIDGE DESIGN, CHECK AND REVIEW REQUIREMENTS 1-3
102.2 MANUAL DRAFTING STANDARDS 1-4
102.2.1 GENERAL 1-4
102.2.2 LETTERING STANDARDS 1-4
102.2.3 MANUAL DRAFTING LINE STANDARDS 1-4
102.3 COMPUTER AIDED DRAFTING STANDARDS 1-4
102.4 DESIGNER, CHECKER, REVIEWER INITIALS BLOCK 1-4
102.5 TITLE BLOCK 1-4
102.6 ESTIMATED QUANTITIES 1-10
102.7 STANDARD BRIDGE DRAWINGS 1-11
102.8 SUPPLEMENTAL SPECIFICATIONS 1-12
102.9 PROPOSAL NOTES 1-12
103 COMPUTER PROGRAMS 1-12
103.1 GEOMETRIC PROGRAMS 1-13
103.2 DESIGN PROGRAMS 1-13
103.3 HYDRAULIC ENGINEERING PROGRAMS 1-13
103.4 GEOTECHNICAL ENGINEERING PROGRAMS 1-13
103.5 BRIDGE RATING PROGRAM 1-14
104 OHIO REVISED CODE SUBMITTALS 1-14
105 BRIDGE PLAN SHEET ORDER 1-14

SECTION 200 - PRELIMINARY DESIGN 2-1
201 STRUCTURE TYPE STUDY 2-1
201.1 GENERAL 2-1
201.2 STRUCTURE TYPE STUDY SUBMISSION REQUIREMENTS 2-1
201.2.1 PROFILE FOR EACH BRIDGE ALTERNATIVE 2-2
201.2.2 PRELIMINARY STRUCTURE SITE PLAN 2-2
201.2.3 HYDRAULIC REPORT 2-4
201.2.4 NARRATIVE OF BRIDGE ALTERNATIVES 2-6
201.2.5 COST ANALYSIS 2-7
201.2.6 FOUNDATION RECOMMENDATION 2-7
201.2.7 PRELIMINARY MAINTENANCE OF TRAFFIC PLAN 2-7
201.3 UTILITIES 2-8
202 BRIDGE PRELIMINARY DESIGN REPORT 2-9
202.1 GENERAL 2-9
202.2 BRIDGE PRELIMINARY DESIGN REPORT SUBMISSION REQUIREMENTS 2-9
202.2.1 FINAL STRUCTURE SITE PLAN 2-9
202.2.2 FINAL MAINTENANCE OF TRAFFIC PLAN 2-10
202.2.3 FOUNDATION REPORT 2-11
202.2.3.1 SPREAD FOOTINGS 2-11
202.2.3.2 PILE FOUNDATIONS 2-12
202.2.3.2.a STEEL 'H' PILES 2-12
202.2.3.2.b CAST-IN-PLACE REINFORCED CONCRETE PILES 2-13
202.2.3.2.c DOWN DRAG FORCES ON PILES 2-14
202.2.3.2.d PILE WALL THICKNESS 2-15
202.2.3.2.e PILE HAMMER SIZE 2-15
202.2.3.2.f CONSTRUCTION CONSTRAINTS 2-15
202.2.3.2.g PREBORED HOLES 2-15
202.2.3.3 DRILLED SHAFTS 2-15
202.2.4 SUPPLEMENTAL SITE PLAN FOR RAILWAY CROSSINGS 2-16
203 BRIDGE WATERWAY 2-17
203.1 HYDROLOGY 2-17
203.2 HYDRAULIC ANALYSIS 2-18
203.3 SCOUR 2-20
204 SUBSTRUCTURE INFORMATION 2-21
204.1 FOOTING ELEVATIONS 2-21
204.2 EARTH BENCHES AND SLOPES 2-22
204.3 ABUTMENT TYPES 2-22
204.4 ABUTMENTS SUPPORTED ON MSE WALLS 2-22
204.5 PIER TYPES 2-23
204.6 RETAINING WALLS 2-23
204.6.1 DESIGN CONSTRAINTS 2-25
204.6.2 STAGE 1 DETAIL DESIGN SUBMISSION FOR RETAINING WALLS 2-26
204.6.2.1 PROPRIETARY WALLS 2-26
204.6.2.2 CAST-IN-PLACE WALLS 2-27.1
204.6.2.3 OTHER WALLS 2-27.1
205 SUPERSTRUCTURE INFORMATION 2-27.1
205.1 TYPE OF STRUCTURES 2-27.1
205.2 SPAN ARRANGEMENTS 2-28
205.3 CONCRETE SLABS 2-28
205.4 PRESTRESSED CONCRETE BOX BEAMS 2-29
205.5 PRESTRESSED CONCRETE I-BEAMS 2-29
205.6 STEEL BEAMS AND GIRDERS 2-30
205.7 COMPOSITE DESIGN 2-31
205.8 INTEGRAL DESIGN 2-32
205.9 SEMI-INTEGRAL DESIGN 2-32

206 MINIMAL BRIDGE PROJECTS 2-34
207 BRIDGE GEOMETRICS 2-34
207.1 VERTICAL CLEARANCE 2-34
207.2 BRIDGE SUPERSTRUCTURE 2-34
207.3 LATERAL CLEARANCE 2-34
207.4 INTERFERENCE DUE TO EXISTING SUBSTRUCTURE 2-35
207.5 BRIDGE STRUCTURE, SKEW, CURVATURE AND SUPERELEVATION 2-35
208 TEMPORARY SHORING 2-35
209 MISCELLANEOUS 2-37
209.1 TRANSVERSE DECK SECTION WITH SUPERELEVATION 2-37
209.1.1 SUPERELEVATION TRANSITIONS 2-37
209.2 BRIDGE RAILINGS 2-38
209.3 BRIDGE DECK DRAINAGE 2-38
209.4 SLOPE PROTECTION 2-39
209.5 APPROACH SLABS 2-39
209.6 PRESSURE RELIEF JOINTS 2-40
209.7 AESTHETICS 2-40
209.8 RAILWAY BRIDGES 2-41
209.9 BICYCLE BRIDGES 2-43
209.10 PEDESTRIAN BRIDGES 2-43
209.11 SIDEWALKS ON BRIDGES 2-43
209.12 MAINTENANCE AND INSPECTION ACCESS 2-44

SECTION 300 – DETAIL DESIGN 3-1
301 GENERAL 3-1
301.1 DESIGN PHILOSOPHY 3-1
301.2 DETAIL DESIGN REVIEW SUBMISSIONS 3-1
301.3 DESIGN METHODS 3-1
301.4 LOADING REQUIREMENTS 3-2
301.4.1 PEDESTRIAN AND BIKEWAY BRIDGES 3-2
301.4.2 RAILROAD BRIDGES 3-2
301.4.3 SEISMIC DESIGN 3-3
301.5 REINFORCING STEEL 3-4
301.5.1 MAXIMUM LENGTH 3-4
301.5.2 BAR MARKS 3-4
301.5.3 LAP SPLICES 3-4
301.5.4 CALCULATING LENGTHS AND WEIGHTS OF REINFORCING 3-5
301.5.5 BAR LIST 3-6
301.5.6 USE OF EPOXY COATED REINFORCING STEEL 3-7
301.5.7 MINIMUM CONCRETE COVER FOR REINFORCING 3-7
301.5.8 MINIMUM REINFORCING STEEL 3-7
301.6 REFERENCE LINE 3-7
301.7 UTILITIES 3-8
301.7.1 UTILITIES ATTACHED TO BEAMS AND GIRDERS 3-8
301.8 CONSTRUCTION JOINTS, NEW CONSTRUCTION 3-8
302 SUPERSTRUCTURE 3-9
302.1 GENERAL CONCRETE REQUIREMENTS 3-9
302.1.1 CONCRETE DESIGN ALLOWABLES 3-9
302.1.2 SUPERSTRUCTURE CONCRETE TYPES 3-9
302.1.2.1 CLASS S & HP CONCRETE, QC/QA CONCRETE FOR STRUCTURES & CONCRETE WITH WARRANTY 3-9
302.1.2.2 SELECTION OF CONCRETE FOR BRIDGE STRUCTURES 3-10
302.1.3 WEARING SURFACE 3-10
302.1.3.1 TYPES 3-10
302.1.3.2 FUTURE WEARING SURFACE 3-11
302.1.4 CONCRETE DECK PROTECTION 3-11
302.1.4.1 TYPES 3-11
302.1.4.2 WHEN TO USE 3-11
302.1.4.3 SEALING OF CONCRETE SURFACES SUPERSTRUCTURE 3-12
302.2 REINFORCED CONCRETE DECK ON STRINGERS 3-13
302.2.1 DECK THICKNESS 3-13
302.2.2 CONCRETE DECK DESIGN 3-14
302.2.3 SCREED ELEVATIONS 3-14
302.2.4 REINFORCEMENT 3-15
302.2.4.1 LONGITUDINAL 3-15
302.2.4.2 TRANSVERSE 3-16
302.2.5 HAUNCHED DECK REQUIREMENTS 3-16
302.2.6 STAY IN PLACE FORMS 3-16
302.2.7 CONCRETE PLACEMENT SEQUENCE 3-16
302.2.8 SLAB DEPTH OF CURVED BRIDGES 3-17
302.2.9 STAGED CONSTRUCTION 3-17
302.3 CONTINUOUS OR SINGLE SPAN CONCRETE SLAB BRIDGES 3-18
302.3.1 DESIGN REQUIRMENTS 3-18
302.4 STRUCTURAL STEEL 3-18
302.4.1 GENERAL 3-18
302.4.1.1 MATERIAL REQUIREMENTS 3-19
302.4.1.2 ATTACHMENTS 3-19
302.4.1.3 STEEL FABRICATION QUALIFICATION 3-19
302.4.1.4 MAXIMUM AVAILABLE LENGTH OF STEEL MEMBER 3-20

302.4.1.5 STRUCTURAL STEEL COATINGS 3-20
302.4.1.5.a PRIMARY COATING SYSTEMS 3-20
302.4.1.5.b ALTERNATIVE COATING SYSTEMS 3-21
302.4.1.5.c EXISTING STEEL COATING SYSTEMS 3-22
302.4.1.6 STEEL PIER CAP 3-23
302.4.1.7 OUTSIDE MEMBER CONSIDERATIONS 3-23
302.4.1.8 CAMBER AND DEFLECTIONS 3-23
302.4.1.9 FATIGUE 3-24
302.4.1.9.a LOADING 3-24
302.4.1.9.b STRESS CATEGORY 3-25
302.4.1.10 TOUGHNESS TESTS 3-25
302.4.1.11 STANDARD END CROSS FRAMES 3-25
302.4.1.12 BASELINE REQUIREMETNS FOR CURVED AND DOG-LEGGED STEEL STRUCTURES 3-25
302.4.1.13 INTERMEDIATE EXPANSION DEVICES 3-25
302.4.1.14 BOLTED SPLICES 3-26
302.4.1.14.a BOLTS 3-27
302.4.1.14.b EDGE DISTANCES 3-27
302.4.1.14.c LOCATION OF FIELD SPLICES 3-27
302.4.1.15 SHEAR CONNECTORS 3-27
302.4.2 ROLLED BEAMS 3-28
302.4.2.1 GALVANIZED BEAM STRUCTURES 3-28
302.4.2.2 STIFFENERS 3-28
302.4.2.3 INTERMEDIATE CROSS FRAMES 3-29
302.4.2.4 WELDS 3-31
302.4.2.4.a MINIMUM SIZE OF FILLET WELD 3-31
302.4.2.4.b NON-DESTRUCTIVE INSPECTION OF WELDS 3-31
302.4.2.5 MOMENT PLATES 3-31
302.4.3 GIRDERS 3-32
302.4.3.1 GENERAL 3-32
302.4.3.2 FRACTURE CRITICAL 3-32
302.4.3.3 WIDTH & THICKNESS REQUIREMENTS 3-33
302.4.3.3.a FLANGES 3-33
302.4.3.3.b WEBS 3-34
302.4.3.4 INTERMEDIATE STIFFENERS 3-34
302.4.3.5 INTERMEDIATE CROSS FRAMES 3-34
302.4.3.6 WELDS 3-35
302.4.3.6.a TYPES 3-35
302.4.3.6.b MINIMUM SIZE OF FILLET AND COMPLETE PENETRATION WELDS, PLAN REQUIREMENTS 3-35
302.4.3.6.c INSPECTION OF WELDS, WHAT TO SHOW ON PLANS 3-36
302.4.3.7 CURVED GIRDER DESIGN REQUIREMENTS 3-36
302.5 PRESTRESSED CONCRETE BEAMS 3-37
302.5.1 BOX BEAMS 3-37
302.5.1.1 DESIGN REQUIREMENTS 3-38
302.5.1.2 STRANDS 3-39
302.5.1.2.a TYPE, SIZE OF STRANDS 3-39
302.5.1.2.b SPACING 3-39
302.5.1.2.c STRESSES 3-40
302.5.1.3 COMPOSITE 3-40
302.5.1.4 NON-COMPOSITE WEARING SURFACE 3-41
302.5.1.5 CAMBER 3-41
302.5.1.6 ANCHORAGE 3-42
302.5.1.7 CONCRETE MATERIALS FOR BOX BEAMS 3-42
302.5.1.8 REINFORCING 3-43
302.5.1.9 TIE RODS 3-43

302.5.2 I-BEAMS ... 3-43
302.5.2.1 DESIGN REQUIREMENTS ... 3-44
302.5.2.2 STRANDS ... 3-44
302.5.2.2.a TYPE, SIZE ... 3-44
302.5.2.2.b SPACING ... 3-45
302.5.2.2.c STRESSES ... 3-45
302.5.2.2.d DEBONDING ... 3-46
302.5.2.2.e DRAPING ... 3-46
302.5.2.3 CAMBER ... 3-47
302.5.2.4 ANCHORAGE ... 3-48
302.5.2.5 DECK SUPERSTRUCTURE AND PRECAST DECK PANEL ... 3-49
302.5.2.6 DIAPHRAGMS ... 3-49
302.5.2.7 DECK POURING SEQUENCE ... 3-49
302.5.2.8 CONCRETE MATERIALS FOR I-BEAMS ... 3-50
302.5.2.9 REINFORCING ... 3-50
302.5.2.10 TRANSPORTATION & HANDLING CONSIDERATIONS ... 3-50
303 SUBSTRUCTURE ... 3-51
303.1 GENERAL ... 3-51
303.1.1 SEALING OF CONCRETE SURFACES, SUBSTRUCTURE ... 3-51
303.2 ABUTMENTS ... 3-52
303.2.1 GENERAL ... 3-52
303.2.1.1 PRESSURE RELIEF JOINTS FOR RIGID PAVEMENT ... 3-52
303.2.1.2 BEARING SEAT WIDTH ... 3-53
303.2.1.3 BEARING SEAT REINFORCEMENT ... 3-53
303.2.1.4 PHASED CONSTRUCTION JOINTS ... 3-53
303.2.2 TYPES OF ABUTMENTS ... 3-54
303.2.2.1 FULL HEIGHT ABUTMENTS ... 3-54
303.2.2.1.a COUNTERFORTS FOR FULL HEIGHT ABUTMENTS ... 3-55
303.2.2.1.b SEALING STRIP FOR FULL HEIGHT ABUTMENTS ... 3-55
303.2.2.2 CONCRETE SLAB BRIDGES ON RIGID ABUTMENTS ... 3-55
303.2.2.3 STUB ABUTMENTS WITH SPILL THRU SLOPES ... 3-55
303.2.2.4 CAPPED PILE STUB ABUTMENTS ... 3-56
303.2.2.5 SPREAD FOOTING TYPE ABUTMENTS ... 3-56
303.2.2.6 INTEGRAL ABUTMENTS ... 3-56
303.2.2.7 SEMI-INTEGRAL ABUTMENTS ... 3-57
303.2.3 ABUTMENT DRAINAGE ... 3-58
303.2.3.1 BACKWALL DRAINAGE ... 3-58
303.2.3.2 BRIDGE SEAT DRAINAGE ... 3-59
303.2.3.3 WEEP HOLES IN WALL TYPE ABUTMENTS AND RETAINING WALLS ... 3-59
303.2.4 WINGWALLS ... 3-59
303.2.5 EXPANSION AND CONTRACTION JOINTS ... 3-60
303.2.6 REINFORCEMENT, “U” AND CANTILEVER WINGS ... 3-60
303.2.7 FILLS AT ABUTMENTS ... 3-60
303.3 PIERS ... 3-61
303.3.1 GENERAL ... 3-61
303.3.1.1 BEARING SEAT WIDTHS ... 3-61
303.3.1.2 PIER PROTECTION IN WATERWAYS ... 3-62
303.3.2 TYPES OF PIERS ... 3-62
303.3.2.1 CAP AND COLUMN PIERS ... 3-62
303.3.2.2 CAP AND COLUMN PIERS ON PILES ... 3-63
303.3.2.3 CAP AND COLUMN PIERS ON DRILLED SHAFTS ... 3-63
303.3.2.4 CAP AND COLUMN PIERS ON SPREAD FOOTINGS ... 3-63
303.3.2.5 CAPPED PILE PIERS ... 3-64
303.3.2.6 STEEL CAP PIERS ... 3-64
303.3.2.7 POST-TENSIONED CONCRETE PIER CAPS ... 3-65
303.3.2.8 T-TYPE PIERS ... 3-65

303.3.2.9 PIER USE ON RAILWAY STRUCTURES 3-66
303.3.2.10 PIERS ON NAVIGABLE WATERWAYS 3-66
303.3.2.11 PIER CAP REINFORCING STEEL STIRRUPS 3-66
303.3.3 FOOTING ON PILES 3-66
303.4 FOUNDATIONS 3-66
303.4.1 MINIMUM DEPTH OF FOOTINGS 3-66
303.4.1.1 FOOTING, RESISTANCE TO HORIZONTAL FORCES 3-67
303.4.1.2 LOCATION OF RESULTANT FORCES ON FOOTINGS 3-69
303.4.1.3 REINFORCING STEEL IN FOOTINGS 3-70
303.4.2 PILE FOUNDATIONS 3-70
303.4.2.1 PILES, PLAN SHEET REQUIREMENTS 3-70
303.4.2.2 PILES, NUMBER & SPACING 3-71
303.4.2.3 PILES BATTERED 3-71
303.4.2.4 PILES, DESIGN LOADS 3-71
303.4.2.5 PILES, STATIC LOAD TEST 3-72
303.4.2.6 PILES, DYNAMIC LOAD TEST 3-73
303.4.2.7 PILE FOUNDATION – DESIGN EXAMPLE 3-73
303.4.3 DRILLED SHAFTS 3-75
303.5 DETAIL DESIGN REQUIREMENTS FOR PROPRIETARY RETAINING WALLS 3-76
303.5.1 WORK PERFORMED BY THE DESIGN AGENCY 3-76
303.5.2 WORK PERFORMED BY THE PROPRIETARY WALL COMPANIES 3-79
304 RAILING 3-82
304.1 GENERAL 3-82
304.2 STANDARD RAILING TYPES 3-84
304.3 WHEN TO USE 3-84
304.3.1 PARAPET TYPE (BR-1 & SBR-1-99) 3-84
304.3.2 DEEP BEAM BRIDGE GUARDRAIL (DBR-2-73) 3-85
304.3.3 TWIN STEL TUBE BRIDGE RAILING (TST-1-99) 3-86
304.3.4 BRIDGE RETRO-FIT RAILING, THRIE BEAM BRIDGE RAILING FOR BRIDGES WITH SAFETY CURBS (TBR-91) 3-86
304.3.5 PORTABLE CONCRETE BARRIER (PCB-91) 3-86
304.3.6 BRIDGE SIDEWALK RAILING WITH CONCRETE PARAPETS (BR-2-98) 3-87
305 FENCING 3-88
305.1 GENERAL 3-88
305.2 WHEN TO USE 3-88
305.3 FENCING CONFIGURATIONS 3-89
305.4 SPECIAL DESIGNS 3-90
305.5 FENCE DESIGN GENERAL REQUIREMENTS 3-90
305.5.1 WIND LOADS 3-91
306 EXPANSION DEVICES 3-92
306.1 GENERAL 3-92
306.1.1 PAY ITEM 3-92
306.1.2 EXPANSION DEVICES WITH SIDEWALKS 3-92
306.1.3 EXPANSION DEVICES WITH STAGE CONSTRUCTION 3-93
306.2 EXPANSION DEVICE TYPES 3-93
306.2.1 ABUTMENT JOINTS IN BITUMINOUS CONCRETE, BOX BEAM BRIDGES 3-93
306.2.2 ABUTMENT JOINTS AS PER AS-1-81 3-93
306.2.3 EXPANSION JOINTS USING POLYMER MODIFIED ASPHALT BINDER 3-93
306.2.4 STRIP SEAL EXPANSION DEVICES 3-94
306.2.5 COMPRESSION SEAL EXPANSION DEVICES 3-94
306.2.6 STEEL SLIDING PLATE ENDDAMS, RETIRED STANDARD DRAWING SD-1-69 3-94
306.2.7 MODULAR EXPANSION DEVICES 3-94
306.2.8 TOOTH TYPE, FINGER TYPE OR NON-STANDARD SLIDING PLATE EXPANSION DEVICES 3-95
306.3 EXPANSION DEVICE USES – BRIDGE OR ABUTMENT TYPE 3-96
306.3.1 INTEGRAL OR SEMI-INTEGRAL TYPE ABUTMENTS 3-96

306.3.2 REINFORCED CONCRETE SLAB BRIDGES 3-96
306.3.3 STEEL STRINGER BRIDGES 3-96
306.3.4 PRESTRESSED CONCRETE I-BEAM BRIDGES 3-97
306.3.5 NON-COMPOSITE PRESTRESSED BOX BEAM BRIDGES 3-97
306.3.6 COMPOSITE PRESTRESSED CONCRETE BOX BEAM BRIDGES 3-98
306.3.7 ALL TIMBER STRUCTURES 3-98
307 BEARINGS 3-99
307.1 GENERAL 3-99
307.2 BEARING TYPES 3-99
307.2.1 ELASTOMERIC BEARINGS 3-99
307.2.2 STEEL ROCKER & BOLSTER BEARINGS, RB-1-55 3-100
307.2.3 SLIDING BRONZE TYPE & FIXED TYPE STEEL BEARINGS 3-100
307.2.4 SPECIALIZED BEARINGS 3-101
307.2.4.1 POT TYPE BEARINGS 3-101
307.2.4.2 DISC TYPE BEARINGS 3-102
307.2.4.3 SPHERICAL TYPE BEARINGS 3-102
307.3 GUIDELINES FOR USE 3-103
307.3.1 FIXED BEARINGS 3-103
307.3.1.1 FIXED TYPE STEEL BEARINGS (RB-1-55 OR FB-1-82) 3-103
307.3.1.2 FIXED LAMINATED ELASTOMERIC BEARINGS FOR STEEL BEAM BRIDGES . 3-103
307.3.1.3 FIXED LAMINATED ELASTOMERIC BEARINGS FOR PRESTRESSED BOX BEAMS 3-104
307.3.1.4 FIXED LAMINATED ELASTOMERIC BEARINGS FOR PRESTRESSED I-BEAMS 3-104
307.3.2 EXPANSION BEARINGS 3-105
307.3.2.1 ROCKER BEARINGS (RB-1-55) 3-105
307.3.2.2 BRONZE TYPE STEEL EXPANSION BEARINGS 3-105
307.3.2.3 EXPANSION ELASTOMERIC BEARINGS FOR BEAM AND GIRDGER BRIDGES 3-105
307.3.2.4 EXPANSION ELASTOMERIC BEARINGS FOR PRESTRESSED BOX BEAMS. 3-106
307.3.2.5 EXPANSION ELASTOMERIC BEARINGS FOR PRESTRESSED I-BEAMS 3-106
307.3.3 SPECIALIZED BEARINGS 3-106
307.3.3.1 POT BEARINGS 3-107
307.3.3.2 DISC TYPE BEARINGS 3-107
307.3.3.3 SPHERICAL BEARINGS 3-107

SECTION 400 – REHABILITATION & REPAIR 4-1
401 GENERAL 4-1
401.1 DESIGN CONSIDERATIONS 4-1
401.2 STRENGTH ANALYSIS 4-2
402 STRUCTURAL STEEL 4-2
402.1 DAMAGE OR SECTION LOSS 4-2
402.2 FATIGUE ANALYSIS 4-2
402.3 FATIGUE RETROFIT 4-3
402.3.1 END BOLTED COVER PLATES 4-3
402.3.2 BOX GIRDER PIER CAPS 4-4
402.3.3 MISCELLANEOUS FATIGUE RETROFITS 4-4
402.4 STRENGTHENING OF STRUCTURAL STEEL MEMBERS 4-4
402.5 TRIMMING BEAM ENDS 4-5
402.6 HEAT STRAIGHTENING 4-5
402.7 HINGE ASSEMBLIES 4-5
402.8 BOLTS 4-5
403 CONCRETE REPAIR/RESTORATION (OTHER THAN DECK REPAIR) 4-6
403.1 GENERAL 4-6
403.2 PATCHING 4-6
403.3 CRACK REPAIR 4-7
404 BRIDGE DECK REPAIR 4-7
404.1 OVERLAYS ON AN OVERLAY 4-7
404.2 OVERLAYS 4-7
404.3 UNDER DECK REPAIR 4-8
405 BRIDGE DECK REPLACEMENT 4-9
405.1 ELIMINATION OF LONGITUDINAL DECK JOINT 4-9
405.2 DECK HAUNCH 4-9
405.3 CLOSURE POUR 4-10
405.4 CONCRETE PLACEMENT SEQUENCE 4-10
405.4.1 STANDARD BRIDGES 4-10
405.4.2 STRUCTURES WITH INTERMEDIATE HINGES 4-10
406 EXPANSION JOINT RETROFIT 4-11
407 RAISING AND JACKING BRIDGES 4-12
408 BRIDGE DRAINAGE 4-13
409 WIDENING 4-13
409.1 CLOSURE POUR 4-13
409.2 SUPERSTRUCTURE DEFLECTIONS 4-14
409.3 FOUNDATIONS 4-15
409.3.1 WIDENED STRUCTURES 4-15
409.3.2 SCOUR CONSIDERATIONS 4-15
409.4 CONCRETE SLAB BRIDGES 4-15
409.5 PIER COLUMNS 4-16
410 RAILING 4-16
410.1 FACING 4-16
410.2 REMOVAL FLUSH WITH THE TOP OF THE DECK 4-16
410.3 THRIE BEAM RETROFIT 4-17
411 BEARINGS 4-17
412 CONCRETE BRIDGE DECK REPAIR QUANTITY ESTIMATING 4-17
412.1 SPECIAL REQUIREMENTS FOR QUANTITY ESTIMATING FOR BRIDGES 500 FEET [150 m] OR GREATER IN LENGTH 4-19
412.2 ACTUAL QUANTITIES, ESTIMATING FACTORS 4-19
413 REFERENCES 4-21

SECTION 500 – TEMPORARY STRUCTURES 5-1
501 GENERAL 5-1
502 PRELIMINARY DESIGN 5-1
502.1 HYDRAULICS 5-1
503 DETAIL DESIGN 5-1
504 GENERAL NOTES 5-3

SECTION 600 – TYPICAL GENERAL NOTES 6-1
601 DESIGN REFERENCES 6-1
601.1 GENERAL 6-1
601.2 STANDARD DRAWINGS AND SUPPLEMENTAL SPECIFICATIONS 6-1
601.3 DESIGN SPECIFICATIONS 6-1
602 DESIGN DATA 6-2
602.1 DESIGN LOADING 6-2
602.2 DESIGN STRESSES 6-3
602.3 FOR RAILWAY PROJECTS 6-7
602.4 DECK PROTECTION METHOD 6-8
602.5 MONOLITHIC WEARING SURFACE 6-9
602.6 SEALING OF CONCRETE SURFACES 6-9
603 EXISTING STRUCTURE REMOVAL NOTES 6-9
603.1 CONCRETE DECK REMOVAL PROJECTS 6-10
604 TEMPORARY STRUCTURE CONSTRUCTION 6-13
605 EMBANKMENT CONSTRUCTION 6-13
605.1 FOUNDATIONS ON PILES IN NEW EMBANKMENTS 6-13
605.2 FOUNDATIONS ON SPREAD FOOTINGS IN NEW EMBANKMENTS 6-14
605.3 EMBANKMENT CONSTRUCTION NOTE 6-15
605.4 UNCLASSIFIED EXCAVATION 6-15
605.5 PROPRIETARY RETAINING WALLS 6-16
606 FOUNDATIONS 6-16.1
606.1 PILES DRIVEN TO BEDROCK 6-16.1
606.2 FRICTION TYPE PILES 6-17
606.3 STEEL PILE POINTS 6-19
606.4 PILE WALL THICKNESS 6-20
606.5 MINIMUM HAMMER SIZE 6-20
606.6 PILE ENCASEMENT 6-20
606.7 FOUNDATION BEARING PRESSURE 6-20
606.7.1 SPREAD FOOTINGS NOT ON BEDROCK 6-21
606.8 FOOTINGS 6-22
606.9 DRILLED SHAFTS 6-22
607 MAINTENANCE OF TRAFFIC 6-23
608 RAILROAD GRADE SEPARATION PROJECTS 6-23
608.1 CONSTRUCTION CLEARANCE 6-23
608.2 RAILROAD AERIAL LINES 6-23
608.3 RAILROAD STRUCTURAL STEEL 6-24
609 UTILITY LINES 6-24
610 REHABILITATION OF EXISTING STRUCTURES 6-24
610.1 EXISTING STRUCTURE VERIFICATION 6-24
610.2 REINFORCING STEEL REPLACEMENT 6-25
610.3 REHABILITATION – STRUCTURAL STEEL 6-25
610.4 REFURBISHED BEARINGS 6-26
610.5 JACKING BRIDGE SUPERSTRUCTURES 6-26
610.6 FATIGUE MEMBER INSPECTION 6-27
610.7 RAILING 6-29
611 MISCELLANEOUS GENERAL NOTES 6-30
611.1 DOWEL HOLES 6-30
611.2 APPROACH SLABS 6-30
611.3 INTEGRAL AND SEMI-INTEGRAL ABUTMENT EXPANSION JOINT SEALS 6-31
611.4 BACKWALL DRAINAGE 6-32
611.5 CONCRETE PARAPET SAWCUT JOINTS 6-32
611.6 BEARING PAD SHIMS, PRESTRESSED 6-32
611.7 CLEANING STEEL IN PATCHES 6-33
611.8 CONVERSION OF STANDARD BRIDGE DRAWINGS 6-33

SECTION 700 – TYPICAL DETAIL NOTES 7-1
701 SUBSTRUCTURE DETAILS 7-1
701.1 STEEL SHEET PILING 7-1
701.2 POROUS BACKFILL 7-1
701.3 BRIDGE SEAT REINFORCING 7-1
701.4 BRIDGE SEAT ELEVATIONS FOR ELASTOMERIC BEARINGS 7-2
701.5 PROPER SEATING OF STEEL BEAMS AT ABUTMENTS 7-2
701.6 BACKWALL CONCRETE PLACEMENT FOR PRESTRESSED BOX BEAMS 7-2
701.7 SEALING OF BEAM SEATS 7-3
702 SUPERSTRUCTURE DETAILS 7-3
702.1 STEEL BEAM DEFLECTION AND CAMBER 7-3
702.2 STEEL NOTCH TOUGHNESS REQUIREMENT (CHARPY V-NOTCH) 7-3
702.3 HIGH STRENGTH BOLTS 7-4
702.4 SCUPPERS 7-4
702.5 ELASTOMERIC BEARING LOAD PLATE 7-4
702.6 BEARING REPOSITIONING 7-4
702.7 CONCRETE PLACEMENT SEQUENCE NOTES 7-4
702.7.1 CONCRETE INTERMEDIATE DIAPHRAGM FOR PRESTRESSED CONCRETE I-BEAMS 7-4
702.7.2 SEMI-INTEGRAL OR INTEGRAL ABUTMENT CONCRETE PLACEMENT FOR STEEL MEMBERS 7-5
702.8 CONCRETE DECK SLAB DEPTH AND PAY QUANTITIES 7-6
702.9 CONCRETE DECK HAUNCH WIDTHS 7-7
702.10 PRESTRESSED CONCRETE I-BEAM BRIDGES 7-7
702.11 PRESTRESSED CONCRETE BOX BEAM BRIDGE 7-8
702.12 ASPHALT CONCRETE SURFACE COURSE 7-10
702.13 PAINTING OF A588/A709 GRADE 50 STEEL 7-11
702.14 ERECTION BOLTS 7-11
702.15 WELDED ATTACHMENTS 7-12
702.16 SCREED ELEVATION TABLES 7-12
702.16.1 SCREED ELEVATION TABLES – STRUCTURAL STEEL MEMBERS 7-12
702.16.2 SCREED ELEVATION TABLES – PRESTRESSED I-BEAM MEMBERS 7-12
702.16.3 SCREED ELEVATION TABLES – COMPOSITE BOX BEAM MEMBERS 7-12
702.17 STEEL DRIP STRIP 7-13
702.18 REINFORCING STEEL FOR REHABILITATION 7-13
702.19 ELASTOMERIC BEARING MATERIAL REQUIREMENTS 7-13
702.20 BEARING SEAT ADJUSTMENTS FOR SPECIAL BEARINGS 7-13
702.21 HAUNCHED GIRDER FABRICATION NOTE 7-14
702.22 FRACTURE CRITICAL FABRICATION NOTE 7-14
702.23 WELDED SHEAR CONNECTORS ON GALVANIZED STRUCTURES 7-14
703 SITE PLAN REQUIREMENTS FOR SECTION 401 AND 404 OF THE CLEAN WATER ACT 7-14

SECTION 800 – NOISE BARRIERS 8-1
801 INTRODUCTION 8-1
802 DESIGN CONSIDERATIONS 8-1
802.1 NOISE BARRIER FOUNDATIONS 8-1
802.2 NOISE BARRIER AESTHETICS 8-1
803 DETAIL DESIGN SUBMISSION REQUIREMENTS 8-2
804 NOISE BARRIERS – APPROVAL OF WALL DESIGNS 8-3
805 NOISE BARRIER SUBMISSION REQUIREMENTS 8-4
805.1 ENVIRONMENTAL DESIGN REQUIREMENTS 8-4
805.2 STRUCTURAL DESIGN REQUIREMENTS 8-5
805.3 MATERIAL DESIGN REQUIREMENTS 8-5

SECTION 900 – BRIDGE LOAD RATING 9-1
901 INTRODUCTION 9-1
902 LOADS TO BE USED FOR LOAD RATING 9-1
903 UNIT WEIGHTS & DENSITIES 9-1
904 LOAD RATING OF BURIED STRUCTURES 9-2
904.1 GENERAL 9-2
904.2 LOAD RATING OF NEW BURIED BRIDGES 9-2
904.2.1 CAST-IN-PLACE BOX & FRAME STRUCTURES 9-2
904.2.2 PRECAST BOXES 9-2
904.2.2.1 PRECAST BOXES OF SPAN GREATER THAN 12’ [3.6 m] 9-2
904.2.2.2 PRECAST BOXES OF SPAN EQUAL TO OR LESS THAN 12’ [3.6 m] 9-3
904.2.3 PRECAST FRAMES, ARCHES, AND CONSPANS & BEBO TYPE STRUCTURES 9-3
904.3 LOAD RATING OF BURIED BRIDGES TO BE REHABILITATED 9-3
904.3.1 CAST-IN-PLACE STRUCTURES 9-3
904.3.2 PRECAST BOXES 9-3
904.3.2.1 PRECAST BOXES OF SPAN GREATER THAN 12’ [3.6 m] 9-3
904.3.2.2 PRECAST BOXES OF SPAN EQUAL TO OR LESS THAN 12’ [3.6 m] 9-3
904.3.3 PRECAST FRAMES, ARCHES, AND CONSPANS & BEBO TYPE STRUCTURES 9-3
904.4 LOAD RATING OF EXISTING BURIED BRIDGES 9-4
904.5 LOAD RATING REPORT SUBMISSION 9-4
905 LOAD RATING OF NON-BURIED STRUCTURES 9-4
905.1 GENERAL 9-4
905.2 SOFTWARE TO BE USED FOR LOAD RATING 9-5
905.3 ANALYSIS OF CONCRETE BOX SECTIONS & FRAMES 9-5
905.4 LOAD RATING OF NEW BRIDGES 9-6
905.4.1 HOW THE LOAD RATING SHALL BE DONE 9-6
905.4.2 WHEN THE BRIDGE LOAD RATING SHALL BE DONE 9-7
905.4.2.1 BRIDGES DESIGNED UNDER MAJOR OR MINOR PLAN DEVELOPMENT PROCESS 9-7
905.4.2.2 BRIDGES DESIGNED UNDER MINIMAL PLAN DEVELOPMENT PROCESS 9-7
905.4.2.3 BRIDGES DESIGNED UNDER MINOR DESIGN-BUILD PROCESS 9-7
905.4.2.4 BRIDGES DESIGNED UNDER MINIMAL DESIGN-BUILD PROCESS 9-7
905.4.2.5 BRIDGES DESIGNED UNDER VALUE ENGINEERING CHANGE PROPOSAL 9-8
905.5 LOAD RATING OF BRIDGES TO BE REHABILITATED 9-8
905.5.1 HOW THE LOAD RATING SHALL BE DONE 9-8
905.5.2 WHEN THE BRIDGE LOAD RATING SHALL BE DONE 9-9
905.5.2.1 BRIDGES DESIGNED UNDER MAJOR OR MINOR PLAN DEVELOPMENT PROCESS 9-10
905.5.2.2 BRIDGES DESIGNED UNDER MINIMAL PLAN DEVELOPMENT PROCESS 9-10
905.5.2.3 BRIDGES DESIGNED UNDER MINOR DESIGN-BUILD PROCESS 9-10
905.5.2.4 BRIDGES DESIGNED UNDER MINIMAL DESIGN-BUILD PROCESS 9-10
905.5.2.5 BRIDGES DESIGNED UNDER VALUE ENGINEERING CHANGE PROPOSAL 9-10
905.6 LOAD RATING OF EXISTING BRIDGES 9-11
905.6.1 HOW THE LOAD RATING SHALL BE DONE 9-11
905.6.2 WHEN THE BRIDGE LOAD RATING SHALL BE DONE 9-12
906 ANALYSIS OF BRIDGES WITH SIDEWALKS 9-12
907 ANALYSIS OF MULTILANE LOADING 9-12
908 ANALYSIS FOR SPECIAL OR SUPERLOAD 9-12
909 LOAD RATING ANALYSIS USING BARS-PC 9-12
909.1 GENERAL 9-12
909.2 SYSTEM REQUIREMENTS 9-13
909.3 BARS-PC ANALYSIS – GENERAL GUIDELINES 9-14
909.4 BARS-PC LOAD RATING REPORT SUBMISSION 9-15
909.5 BARS-PC COMPUTER INPUT AND OUTPUT FILES 9-15
910 LOAD ANALYSIS USING BRASS-CULVERT PROGRAM 9-16
910.1 GENERAL 9-16

910.2 BRASS CAPABILITIES 9-16
910.3 BRASS LOAD RATING REPORT SUBMISSION 9-16
910.4 BRASS COMPUTER INPUT AND OUTPUT FILES 9-17
911 REFERENCES 9-17

102.1 BRIDGE DESIGN, CHECK AND REVIEW REQUIREMENTS

The Department requires bridge design computations and bridge plans be made and prepared by an experienced bridge design engineer, the designer; all bridge computations be independently verified by an experienced engineer, the checker; and all bridge plans be reviewed by an experienced engineer, the reviewer. The design agency shall perform the required checks and reviews prior to submitting prints to the Department for review.

All outside agencies performing bridge design work for the Department shall be pre-qualified according to the requirements contained in the Departmental document "Consultant Prequalification Requirements and Procedures" which is on file with the Office of Contracts. Those individuals upon whose experience the classification level of the design agency is based shall complete work. The initials of these same individuals shall be placed in the appropriate spaces in the title block signifying that they performed the work.

The designer shall be responsible for preparing a design that follows sound engineering practice and conforms to AASHTO, ODOT and other specifications and manuals. The designer shall also be responsible for preparing an accurate and complete set of final bridge construction plans.

The checker shall be responsible for ensuring correctness, constructability and completeness of the plans and calculations and adherence to pertinent specifications and manuals. The checker shall perform and prepare a set of separate, independent calculations verifying all stations, dimensions, elevations and estimated quantities.

The checker shall independently check all structural calculations to assure that the structural theory, design formulae and mathematics used by the designer are correct. The intent is not to produce two separate sets of structural calculations. However, for atypical designs, fracture critical components, and situations where the designer's theory is unclear or questionable, the checker shall perform and prepare a set of separate, independent calculations. The checker and designer shall resolve all discrepancies and the final product shall reflect mutual agreement that the design is correct.

The checker shall verify all structural calculations performed by computer analysis by preparing independent input for comparison with the designer's input. The checker shall perform an independent analysis of the output and agree with the designer on the final design.

The design agency's reviewer is responsible for the overall evaluation of the plans for completeness, consistency, continuity, constructability, general design logic and quality.

Design and check computations shall be kept neat and orderly so they may be easily followed and understood by a person other than the preparer.

102.2 MANUAL DRAFTING STANDARDS

102.2.1 GENERAL

A. All lines and lettering shall be dark and opaque. All lines and lettering shall be on the front face of the drawing, whether original or reproduced.
B. Plan sheets submitted to the Department shall be of extremely good quality on reproducible mylar.

102.2.2 LETTERING STANDARDS

A. All lettering shall be Braddock No. 5 size (upper case 5/32" [4 mm] in height), or larger.
B. Lettering within lined areas, such as quantity box, should at no time come in contact with any of these lines.
C. Letters should be properly spaced so that a crowded condition does not exist.

102.2.3 MANUAL DRAFTING LINE STANDARDS

A. "0" (Rapidograph pen size) (decimal width of 0.4 mm) is minimum and can only be used for dimension lines, X-hatching and index map.
B. All other lines and lettering shall be a minimum of "1" (Rapidograph pen size) (decimal width of 0.5 mm).
C. Individual lines shall be of uniform weight and density.
D. 1/16" [1.5 mm] is the minimum distance between two or more adjacent lines, even though an out of scale condition might exist.

102.3 COMPUTER AIDED DRAFTING STANDARDS

Refer to the *Ohio Department of Transportation CADD – Engineering Standards* for all CADD drafting standards.

102.4 DESIGNER, CHECKER, REVIEWER INITIALS BLOCK

The design agency's designer, checker and reviewer's initials and the date of the final review shall be shown in the title block of each sheet.

102.5 TITLE BLOCK

See Figure 109 for example title blocks for 22" x 34" [559 mm x 864 mm] sheets.

Straight Line Mileage (SLM) shall be shown to the nearest 1/100 of a mile. (Example: MER-707-16.92)

Straight Line Kilometers (SLK) shall be shown to the nearest 1/1000 of a kilometer (nearest 10 meters). (Example: MER-707-27.310)

A bridge number is the SLM of the structure written without the decimal point. (Example: MER-707-1692)

(THIS PAGE INTENTIONALLY LEFT BLANK)

(THIS PAGE INTENTIONALLY LEFT BLANK)

(THIS PAGE INTENTIONALLY LEFT BLANK)

(THIS PAGE INTENTIONALLY LEFT BLANK)

A bridge number is SLK of the structure written without the decimal point. (Example: MER-707-27310)

A Station is defined as 100 feet. Stations shall be shown to the nearest 1/100 of a foot. (Example: Sta 895+08.75)

A Station is a kilometer. Roadway stations are shown to the nearest 1/1000 of a meter. (Example: Sta 8+282.273)

The correct Structure File Number (SFN) shall be shown in the Existing Structure Block and Title blocks for the existing and proposed structures respectively. The SFN for the existing structure should be included in the Scope of Services. If not, it may be obtained from the responsible office.

If a new SFN is required for a proposed structure, contact the appropriate office as follows:

A. Contact the Office of Structural Engineering, Inventory Section, for structures on the State System or special systems statewide.
B. Contact County Bridge Engineers for SFN's to structures within their jurisdiction.
C. Contact the responsible District Office for SFN's to structures in municipalities within the District's jurisdiction.

It is the Designer's responsibility to contact and confirm the correct SFN with the appropriate office. For more information on the Structure File Number, refer to the Structure Inventory website at http://www.dot.state.oh.us/sfn/inventory.

Provide the Project Identification Number (PID) below the project County, Route and Section number in the Title Block.

The wording "State of Ohio, Department of Transportation", "Office of Structural Engineering" is used on plans prepared by the Office of Structural Engineering. The name and address of the consulting firm should replace "State of Ohio, Department of Transportation, Office of Structural Engineering" in the title block.

102.6 ESTIMATED QUANTITIES

Plan quantities shall be listed separately for each bridge structure. Incorporating common bid items between multiple bridge structures in a project is not acceptable. Summation of common items cannot be done due to computer tracking of quantities based on Structural File Number .

In order to avoid the re-calculating of pay quantities by the construction forces, a copy of the quantity calculations made, as the basis for the quantities shown on the plans, shall be furnished to the District Production Office. Therefore, it is important that the quantity calculations be

accurate and complete and prepared neatly on standard computation sheets. They should be arranged in an orderly fashion so that a person examining them will be able to follow the calculation sequence. Someone other than the original designer should independently check the calculations. The designer and checker shall each prepare separate sets of figures to minimize risk of error. The two sets of calculations then shall be reconciled, and one set (either the designer's or the checker's) shall be selected as the official set. The calculations shall be initialed and dated on each sheet by both the designer and checker. The results of this official set shall correspond to the quantities shown on the plans.

Each sheet of computations, notes, estimated quantities and steel list shall be marked with the Bridge Number, Structure File Number, the date, the writer's initials, and subject. Sheets that are accidentally misplaced are sometimes very difficult to identify if they are unmarked.

102.7 STANDARD BRIDGE DRAWINGS

Current standard bridge drawings should be followed and used whenever practicable. Reference to standard bridge drawings should be made by stating the Drawing Number and latest date of revision, or the approval date if there has been no revision. If reference is made to a standard drawing, details shown on such standard drawing generally should not be duplicated on the project plans. The designer shall be familiar with the standards and know if they are adequate for the particular design situation being addressed. If they are not, then standards shall be modified as necessary by supplying pertinent details, dimensions or material specifications in the plans.

The designer shall assure that standard drawings referenced on the General Notes sheet are also transferred to the Project Plans Title Sheet.

A standard drawing should not be referenced if only one or two small details on the standard are applicable. Details should be copied on the project plans. In general the call out of more than one standard drawing for a particular bridge component should be avoided.

Where possible, English standard bridge drawings should be referenced to English design plans and vice versa. Refer to Section 600 for unit conversion information and related plan note. Design Data drawings are not Standard Drawings and should not be referenced in the plans.

The quantities if shown on standard drawings are based upon average conditions and are only approximate. The quantities shall be computed from the actual plan dimensions.

In accordance with ODOT Policy 16-004(P), effective July 1, 2005, Standard Drawings will no longer be available for purchase through the Department’s Office of Contracts. Standard Drawings can be downloaded through the Office of Structural Engineering’s web page:

http://www.dot.state.oh.us/se/

102.8 SUPPLEMENTAL SPECIFICATIONS

The Department has many Supplemental Specifications that the designer needs to be familiar with and should use rather than developing their own individual specifications in the form of plan notes or Special bid items.

Supplemental Specifications may be obtained on the internet by accessing the Design Reference Resource Center (DRRC) home page from the Department website .
The designer shall not modify Supplemental Specifications.

Supplemental Specifications, like standard bridge drawings are to be listed on the General Notes plan sheet. (See Section 600). The designer shall assure that standard drawings referenced on the General Notes sheet are also transferred to the Project Plans Title Sheet.

102.9 PROPOSAL NOTES

Proposal notes are similar to Supplemental Specifications. The Department's numbered Proposal Notes were developed to assure uniform specifications for specific items that may not be required on every project or are either experimental or of an interim status. Proposal Notes, like Supplemental Specifications, are not to be revised by the designer.

The designer not only needs to know what bid item the Proposal Note applies to but also understand the Proposal Note so it is only applied where applicable.

Proposal Notes can also be obtained at the DRRC from the Department website.
Proposal Notes are referenced on the bridge plan by adding a note to the end of the applicable bid item (See Proposal Note). If multiple Proposal Notes are being used with different bridge plan bid items a footnote method may be used at the end of each bid item with the footnote saying - "See Proposal Note". Do not refer to Proposal Notes by number.

103 COMPUTER PROGRAMS

The following is a list of computer programs used by the Department. The Design Agency may want to consider these programs or other programs not listed. The Design Agency is responsible for obtaining any programs. It is the choice of the Design Agency as to which computer programs it uses.

Note: (MF) denotes a mainframe program
(PC) denotes a personal computer program

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-17-03)

Figure 101

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 102

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 103

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 104

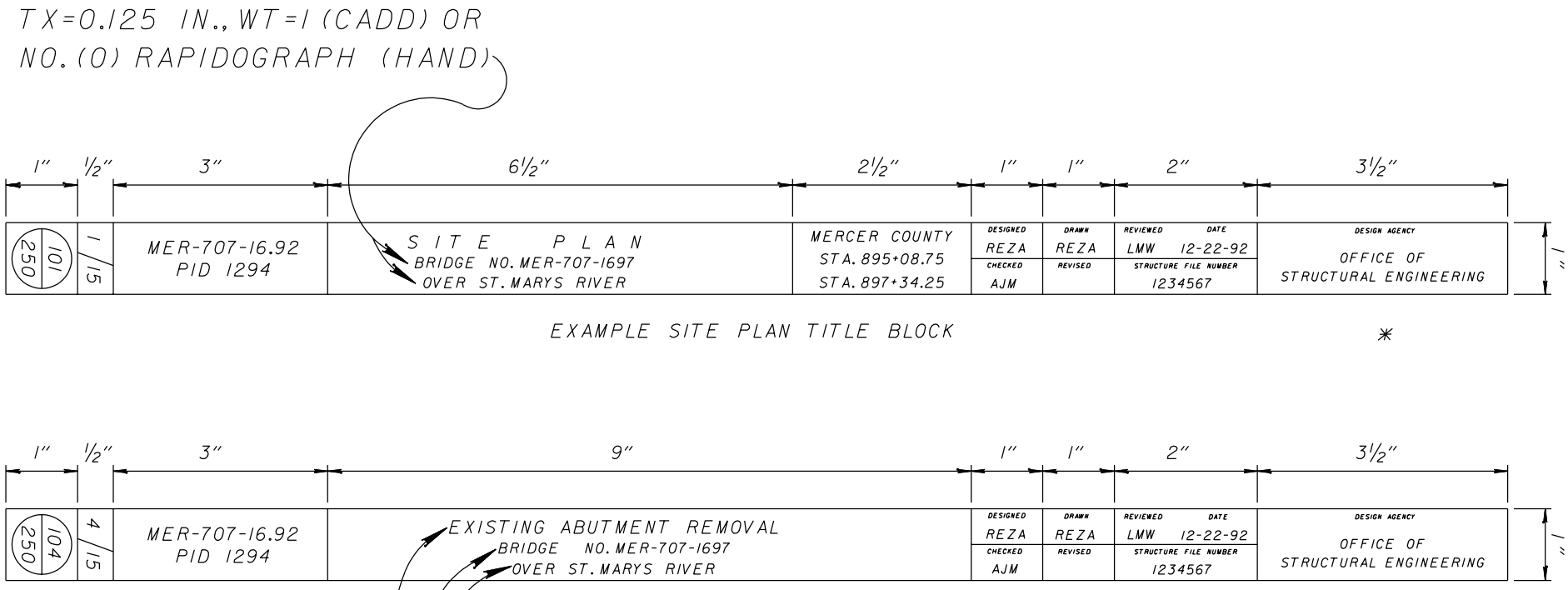
THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 105

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 106

STANDARD TITLE BLOCKS



* THIS BLOCK SHOULD BE FILLED IN WITH THE NAME OF THE ACTUAL DESIGN AGENCY.

Figure 109

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-17-03)

Figure 101M

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 102M

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 103M

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 104M

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 105M

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 106M

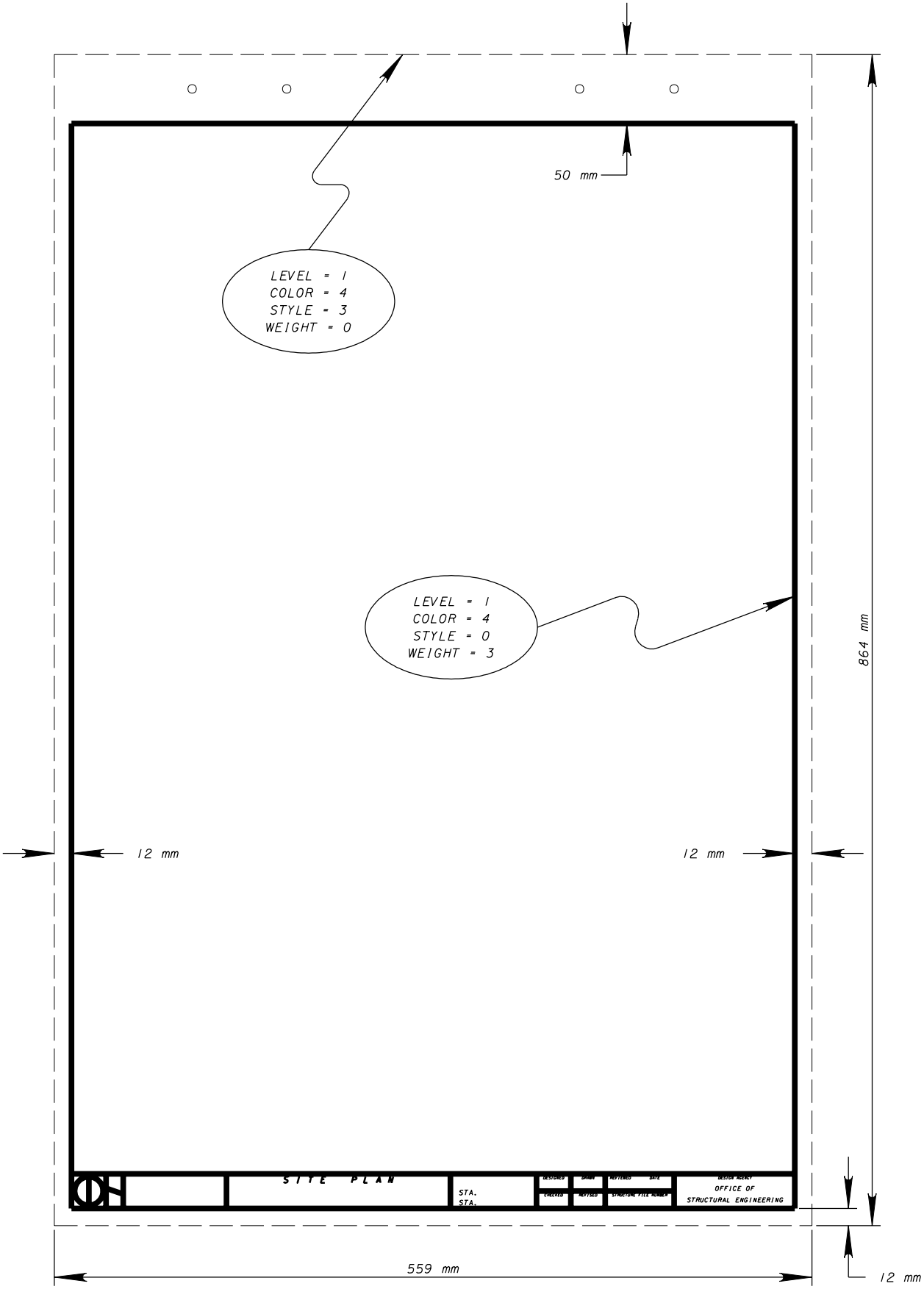

50 mm
LEVEL = 1
COLOR = 4
STYLE = 3
WEIGHT = 0
LEVEL = 1
COLOR = 4
STYLE = 0
WEIGHT = 3
12 mm
12 mm
864 mm
SITE PLAN
STA.
STA.
DESIGNED
DRAWN
REVIEWED
DATE
CHECKED
REVISED
STRUCTURE FILE NUMBER
DESIGN AGENCY
OFFICE OF
STRUCTURAL ENGINEERING
559 mm
12 mm

Figure 107M

G. T-Wall
Wall type - Cellular Bin

Contact Information:
Hydro-Conduit
620 Liberty Road
Delaware, Ohio 43015
(800) 395-8383

H. MSE Wall Plus
Wall type - MSE

Contact Information:
SSL, LLC
4740 Scotts Valley Dr. Ste. E
Scotts Valley, CA 95066
(831)430-9300

I. Genesis Wall
Wall type - Modular Block

Contact Information:
Contech Construction Products Inc.
3360 Tremont Rd.
Columbus, Ohio 43221
(614)457-7450

J. Pyramid Earth Wall
Wall type - Modular Block

Contact Information:
The Reinforced Earth Company
3884 Penbrook Lane
Lafayette, IN. 47905
(765) 449-1200

The use of the Genesis and T-Wall retaining walls is limited to non-critical locations with a wall design height not more than 25 ft [7.6 m]. MSE wall types that are approved for supporting abutments on are Reinforced Earth, Retained Earth, Tensar Ares and SSL LLC. However, the Tensar Ares wall shall be limited to pile supported abutments only. The Tensar Ares wall is limited to a maximum height of 30 ft [9.15 m] for all applications. The Hilfiker company furnishes a variety of wall types, but only their wall design referred to as "Reinforced Soil Embankment" with precast reinforced concrete face panels is approved.

204.6.1 DESIGN CONSTRAINTS

Below are some design constraints to consider in the wall justification study to establish acceptable wall types:

A. Future use of the site (future excavations can not be made in Mechanically Stabilized Embankments)

B. Deflection and/or differential settlements

C. Accessibility to the construction site

D. Aesthetics, including wall textures

E. Right-of-way (or other physical constraints)

F. Cost (approximate cost analysis)

G. Stage construction

H. Stability (long-term and during construction)

I. Railroad policies

204.6.2 STAGE 1 DETAIL DESIGN SUBMISSION FOR RETAINING WALLS

When a justification study has determined that a retaining wall is required, generally the wall will be a cast-in-place reinforced concrete wall or some type of proprietary wall system. The use of proprietary wall systems should be considered when the wall quantity for the project exceeds 5000 ft^2 [450 m^2].

204.6.2.1 PROPRIETARY WALLS

If a proprietary wall is justified, the Design Agency shall include the following information in the Stage 1 Detailed Design Submission: footing elevations; allowable bearing pressure at the leveling pad elevation; a global stability analysis; settlement calculations; and any construction constraints, such as soil improvement methods, that may be required. Refer to Section 303.5 for plan requirements for Detail Design.

The design of the wall shall be in conformance with the 17th Edition of the "AASHTO Standard Specifications for Highway Bridges" and the following:

A. Determine the height of the wall (h) for minimum soil reinforcement lengths as follows:

   1. When the surface of the retained soil is level, measure (h) from the top of the concrete leveling pad to the top of the concrete coping.

   2. When the surface of the retained soil is sloping, measure (h) as shown in AASHTO Figure 5.8.2B.

   3. When the surface of the retained soil is supporting an abutment, measure (h) from the top of the concrete leveling pad to the profile grade elevation at the face of the wall.

B. Determine the minimum soil reinforcement length as the larger of 70 % of the wall height (h) or 8'-0" [2.5 m].

C. The thickness of the unreinforced concrete leveling pad shall not be less than 6 inches [150 mm]. The minimum distance from the top of the leveling pad the ground surface at a point located 4'-0" [1.2 m] from the face of the wall shall be the larger of 3'-0" [900 mm] or the frost depth. Refer to Figure 202 for more information.

D. The minimum thickness of the precast reinforced concrete face panels may be assumed to be 5½ inches [140 mm].

E. The maximum allowable differential settlement in the longitudinal direction (regardless of the size of panels) is one (1) percent.

F. The following factors of safety shall apply:

Factor of Safety	
Sliding	> 1.5
Overturning	> 2.0
Bearing Capacity	>2.5
Overall Stability	>1.5 (for walls supporting spread footing abutments)
	>1.30 (for all other walls)
Factor of safety for settlement will be site specific.	

G. Use the following soil parameters for design:

Fill Zone	Type of Soil	Soil Unit Weight	Friction Angle	Cohesion
Reinforced Zone	Select Granular Embankment Material	120 lb/ft^3 [18.9 kN/m^3]	34º	0
Retained Soil	On-site soil varying from sandy lean clay to silty sand	120 lb/ft^3 [18.9 kN/m^3]	30º	0
Foundation Soil	Variable – ranging from existing uncontrolled fill to natural silty sand	120 lb/ft^3 [18.9 kN/m^3]	**	**

** When calculating sliding resistance, refer to BDM Section 303.4.1.1. For all other design calculations, use soil parameters determined from soil borings.

H. Compute the coefficient of lateral earth pressure, k_a, using the Coulomb equation.

I. MSE walls located within 25'-0" [7.6 m] of the centerline of tracks, or other distance as specified by an individual railroad, shall be protected by a crash wall as specified in Section 209.8 and the AREMA Manual for Railway Engineering. The MSE wall system does not meet the definition of a crash wall as defined by the AREMA Manual for Railway Engineering.

J. The minimum distance between the back face of the MSE wall panels and the toe of the bridge abutment footing shall be 1'-0" [305 mm].

K. The minimum distance between the front face of the MSE wall panels and the centerline of the

abutment bearings shall be 5'-0" [1525 mm].

L. Integral abutment designs placed on MSE wall embankments are prohibited. Semi-integral abutment designs are allowed.

M. The maximum allowable bearing pressure for a spread footing abutment placed on an MSE wall embankment shall be 4 ksf [190 kPa].

N. When detailing the pile layout and the design of the abutments and/or wingwalls, consider that 100% of the ground reinforcement shall be connect to the facing elements and the Department will not allow field cutting of reinforcement systems to avoid piles or other obstacles.

204.6.2.2 CAST-IN-PLACE WALLS

If a cast-in-place wall is justified, the design agency will be responsible for providing the complete wall design in the detail plans. The Stage 1 Detailed Design Submission shall include: footing elevations; allowable bearing pressures; a global stability analysis; settlement calculations, if necessary; and any construction constraints that may be required.

204.6.2.3 OTHER WALLS

The other wall types listed in Section 204.6 are for use with special project conditions such as top-down construction and other excavation methods. Contact the Office of Structural Engineering for recommendations when considering these other wall types. Typically only one wall type design shall be prepared for these methods.

205 SUPERSTRUCTURE INFORMATION

205.1 TYPE OF STRUCTURES

The types of superstructure generally used in Ohio consist of cast-in-place concrete slabs, prestressed concrete box or I-beams, and steel beams or welded plate girders. Normally shallow abutments and spill-thru slopes will be used. The type of superstructure used should be selected on the basis of economy as well as appearance. For special conditions where other types of super-structures may be considered, consult the Office of Structural Engineering for recommendations prior to initiating the design.

(THIS PAGE INTENTIONALLY LEFT BLANK)

205.2 SPAN ARRANGEMENTS

The length of a bridge will be determined by the requirements for horizontal clearance at grade (highway or railway) separations or by the requirements for waterway opening at stream crossings. Typically for any given bridge, there are a number of combinations of spans and lengths of spans that can be utilized. Generally a preferred span arrangement that minimizes the number of sub-structure units should be used (i.e. fewer piers with longer spans).

For grade separation structures spanning any divided highway a two-span bridge with spill-thru slopes is preferred.

For waterway crossings, one or three span bridges are typically used. This span arrangement is preferred so that a pier is not located in the middle of the waterway. If a series of precast, three-sided structures are used to produce a multiple span structure over a waterway, spread footings on soil shall not be used to support any of the precast structures.

When a multiple span arrangement (4 spans or more) is required, the Cost Analysis should examine the most economical number of spans required based on total bridge costs, including a substructure and superstructure cost optimization study. Site conditions will govern the location of substructure units with respect to required horizontal clearances, foundation conditions and appearance.

On structures with steep grades, the designer should account for the load effects of the grade on the substructure units.

205.3 CONCRETE SLABS

Cast-in-place concrete slabs are normally used where site geometry dictates a curved alignment or variable superelevation and the use of prestressed concrete box beams is impractical. Since concrete slabs will generally yield the least superstructure depth they should be considered when vertical clearance is limited. For stream crossings where flood waters often inundate the structure, a concrete slab should be considered. When using cast-in-place concrete slabs the construction clearance requirements of the falsework should be considered.

Standard bridge drawings are available for the design of single span and three span continuous concrete slabs. The Standard Bridge Drawing for single span concrete slab bridges is SB-1-03. The spans range from 11 to 38 feet [3350 to 11 580 mm] with a maximum skew angle of 30 degrees. The Standard Bridge Drawing for three span continuous concrete slabs is CS-1-03. The spans range from 14’ - 17.5’ - 14’ [4260 mm - 5334 mm - 4260 mm] to 46’ - 57.5’ - 46’ [14 020 mm - 17 530 mm - 14 020 mm] with a maximum skew angle of 30 degrees. The drawings are based on a 60 lb/ft^2 future wearing surface and a live load of an HS25 truck and the alternate military vehicle. The edge beam is designed to support live load according to AASHTO 3.24.8 and the weight of the 42” BR-1 deflector parapet.

205.4 PRESTRESSED CONCRETE BOX BEAMS

The span limits for prestressed, side by side, concrete box beams generally range from 15 to 100 feet [5 to 30 meters]. These span limits are based on the current design data sheets with 0.167 in^2 [108 mm^2] low relaxation strands, a concrete 28-day compressive strength of 7000 psi [48.3 MPa], a release strength of 5000 psi [34.5 MPa] and an HS25 truck. Prestressed box beams of up to 120 foot spans [36 meters] have been designed using 10,000 psi [68.9 MPa] concrete and larger diameter strands. Concrete compressive strengths should be limited to 5000 psi [34.5 Mpa] at release and 7000 psi [48.3 Mpa] at 28-days. Consult the Office of Structural Engineering for recommendations prior to designing a structure with higher compressive strengths.

The skew angle should be limited to a maximum of 30 degrees. Consult the Office of Structural Engineering for recommendations prior to designing a box beam structure with a higher degree of skew. For all four lane divided highways or where the design ADTT (one way) is greater than 2500, prestressed box beam superstructures shall not be used. Box beams may be used on curved alignment where the mid-ordinate is 6 inches [150 mm] or less, as long as the required bridge width is provided. The maximum asphalt wearing surface thickness for a non-composite designed box beam bridge shall be 8 inches [200 mm]. For multiple span bridges, individual span lengths may vary but the proposed box beam depth should be constant.

The Designer shall consider the site limitations for practical hauling. While weight of a precast bridge member is not typically a limiting factor, its length and ability to reach the jobsite may be a restriction. Maximum lengths are normally dictated by the smallest turning radius enroute to the project site. For beams 100 ft [30 m] long or more, the Designer should contact at least two approved fabricators of precast bridge members to obtain a written agreement stating that the member can be shipped to the project site. The agreements should be included in the Structure Type Study, Narrative of Bridge Alternatives.

Non-composite boxbeam designs should be used where over the side drainage is provided and where the combined deck grade is less than 4 percent. The combined deck grade, Cg, should be computed by the following equation:

$$Cg = [\text{transverse deck grade}^2 + \text{roadway grade}^2]^{1/2}$$

For a normal transverse deck grade horizontal to vertical of 3/16 inch per foot [1 to 64 (1.56 percent)], the maximum roadway grade would be 3.68 percent or less for non-composite design. Where the combined deck grade is greater than 4 percent or the deck drainage is confined to the bridge deck by a parapet, curb, etc., a composite design should be used.

205.5 PRESTRESSED CONCRETE I-BEAMS

The span limits for prestressed concrete I-beams (AASHTO Type II, III, IV, and Modified Type IV) generally range from 60 to 125 feet [18 to 38 meters]. The shapes are to conform to Standard Bridge

Drawing PSID-1-99. Consult the Office of Structural Engineering for recommendations prior to designing a structure with a non-standard shape. Cast-in-place concrete decks compositely designed shall be used. The transportation and weight requirements listed for box beams will also apply for I-beams.

Standard Bridge Drawing PSID-1-99 allows 28-day concrete strengths up to 7000 psi [48.3 MPa] and release strengths up to 5000 psi [34.5 MPa]. Consult the Office of Structural Engineering for recommendations prior to designing a structure with higher compressive strengths. Straight strand and draped strand designs are allowed. Refer to Section 300 of this Manual for the preferred methods to relieve excessive tensile stresses.

Prestressed I-beam highway bridges should have a minimum of 4 stringer lines.

Prestressed I-beam bridges that meet the vertical clearance specified in Section 207 are acceptable over highway crossings.

205.6 STEEL BEAMS AND GIRDERS

For spans greater than 60 feet [18 meters], rolled beams, up to and including the 40 inch [1000 mm] depth, or welded plate girders should be considered. Continuous spans shall be used for multiple span bridges. The ratio of the length of the end spans to the intermediate spans usually should be 0.7 to 0.8. The latter ratio is preferred because it nearly equalizes the maximum positive moment of all spans. Integrally designed structures may have end span ratios of as low as 0.6 if prevention of uplift is considered. For multi-span, composite designed, rolled beams, the maximum intermediate span is generally around 115 feet [35 meters]. For single span, composite designed, rolled beams, the maximum span is generally around 100 feet [30 meters].

While constant depth plate girders can be used in the same range as rolled beams, they are generally not as cost effective as rolled beams for the same span lengths. Haunched girders over the intermediate substructure units should be considered for spans greater than 350’-0” [105 meters] or where economics warrant their use. Selections of any steel members should be based on an overall cost analysis of the structure.

Stringer type	**Span length**
Rolled beam	up to 115’ [35 m]
Constant Depth Girder	100’ - 350’ [30 - 105 m]
Haunched Girder	> 350’ [105 m]

Generally the minimum economical beam spacing for rolled beams is 8’-0” [2450 mm]. For plate girders a minimum spacing of 9’-0” [2750 mm] is generally recommended.

[125 meters] total length, assuming 2/3 movement could occur in one direction). Generally there are no skew limitations. The foundation for these designs must be stable and fixed in position. These designs are not applicable when a single row of piles is used. The expansion and contraction movement of the bridge superstructure is accommodated between the end of the approach slab and the roadway. This design should be used for uncurved (straight beams) structures and at sites where there are no concerns about settlement or differential settlement. An example of a semi-integral design can be found in the figures portion of Section 300 of this Manual.

Spread footings may be appropriate for semi-integral abutments but settlement should be evaluated. Consult the Office of Structural Engineering for recommendations during preliminary design.

To utilize a semi-integral design, the geometry of the approach slab, the design of the wingwalls, and the transition parapets if any must be compatible with the freedom required for the integral (beams, deck, backwall and approach slab) connection to translate longitudinally. The expansion and contraction movements of the bridge superstructure will be transferred to the end of the approach slabs, see Section 209.6, Pressure Relief Joints.

There is a standard bridge drawing available that establishes details for semi-integral abutment designs.

The limitations previously discussed are basically for steel superstructures. If a concrete superstructure is being proposed, longer structure lengths may be investigated. During preliminary design, consult the Office of Structural Engineering for recommendations on a specific site that exceeds the prescribed limits.

The expansion length, at the abutment, is considered to be two-thirds (2/3) of the total length of the structure. On new structures, all pier bearings should be expansion bearings. The abutment bearings shall always be expansion bearings and be designed for the assumption that the 2/3 movement could occur at one of the abutments. The pier expansion bearings are designed proportionally (by distance) to the abutment design length.

If unsymmetrical spans (from a thermal neutral point viewpoint) are used, either all pier bearings are to be expansion or piers with fixed bearings are to be designed for the forces induced by unbalanced thermal movements.

The use of a fixed pier (i.e. fixed bearings), regardless of structural rigidity, does not allow an increase in bridge length nor does it reduce the 2/3 movement assumption. Depending on its distance from the abutments, the pier will need to be designed for a portion of the movement from the superstructure.

On rehabilitation projects, preference should be given to using expansion bearings at all substructure units. However, this is not meant to be used as a blanket statement to automatically and blindly replace the existing bearings. If an existing pier has a fixed bearing, the pier will need to be analyzed for the new, additional loading that results from the 2/3 movement assumption. The load will be proportional to the distance from the pier to an abutment. The fixed bearing will not be the thermal

neutral point as was assumed in the original design.

206 MINIMAL BRIDGE PROJECTS

Minimal projects are defined in Section 1400 of the ODOT Location and Design Manual, Volume Three, as projects that do not alter the basic highway cross section or geometry, require no additional right-of-way, are exempt from Categorical Exclusion documentation, and require little or no public involvement. Minimal project types include: bridge painting, deck overlays, scupper installations, barrier facings, concrete sealing, partial depth concrete repairs, etc. Minimal projects do not require a preliminary design submission.

Minimal bridge projects shall have a General Plan. A Site Plan is not required. The General Plan should define all necessary information.

For all rehabilitation projects an "Existing Structure" data block and a "Proposed Structure" data block shall be provided. These standard data blocks provide a quick reference and documentation of proposed design changes. The "Existing Structure" data block shall include the Structural File Number (SFN). The first item in the "Proposed Structure" data block should be "Proposed Work" followed by a brief description of the type of work to be done (for example: Bridge deck repair using Microsilica Concrete Overlay, Concrete parapet refacing, etc.). Provide a relatively thorough description (list of work) of the type of work to be done within a plan note entitled "Proposed Work" and include this note on the sheet containing the General Plan.

207 BRIDGE GEOMETRICS

207.1 VERTICAL CLEARANCE

Vertical Clearances for all grade separation structures shall meet the preferred clearances specified in ODOT's Location and Design Manual, Section 302.

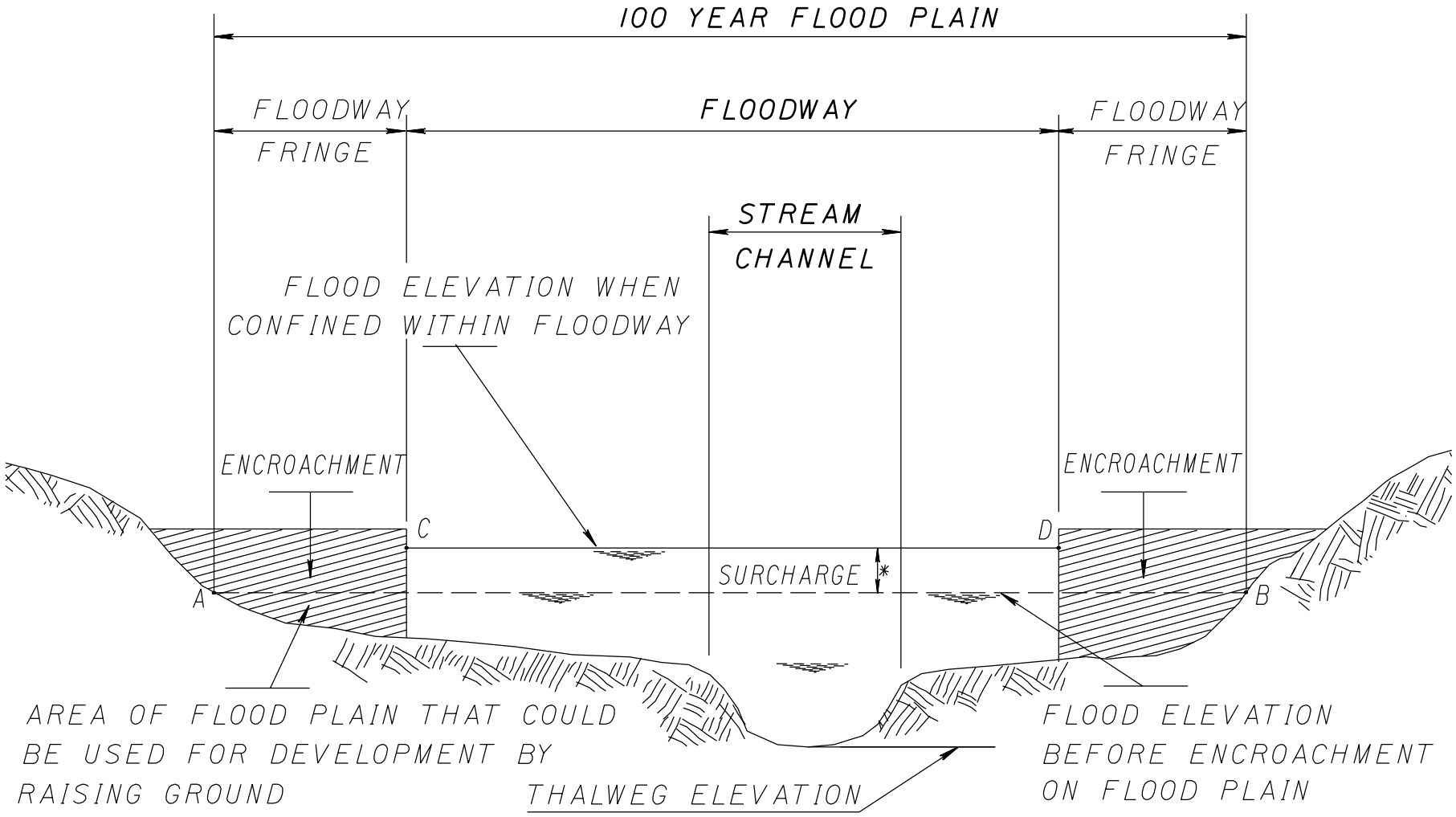
207.2 BRIDGE SUPERSTRUCTURE

Bridge superstructure widths shall be established in accordance with ODOT's Location and Design Manual, Section 302, unless specified in the scope of services or other contract criteria.

207.3 LATERAL CLEARANCE

Divided highways having four or more lanes crossing under an intersecting highway shall be provided with a minimum lateral clearance of 30 feet [9000 mm] from the edge of traveled lane to the point where the 2:1 back slope intersects the radius at the toe of the 2:1 slope. Refer to ODOT's

Figure 201



LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
* SURCHARGE IS NOT TO EXCEED 1.0 FOOT OR THAT ALLOWED BY OTHER REGULATORY AGENCIES IF MORE RESTRICTIVE.

FLOODWAY SCHEMATIC

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 202

THIS FIGURE HAS BEEN RETIRED
(EFFECTIVE 01-21-05)

Figure 202M

SEMI-INTEGRAL/INTEGRAL ABUTMENT TYPE

SKEW VS. BRIDGE LENGTH LIMITATIONS (mm)

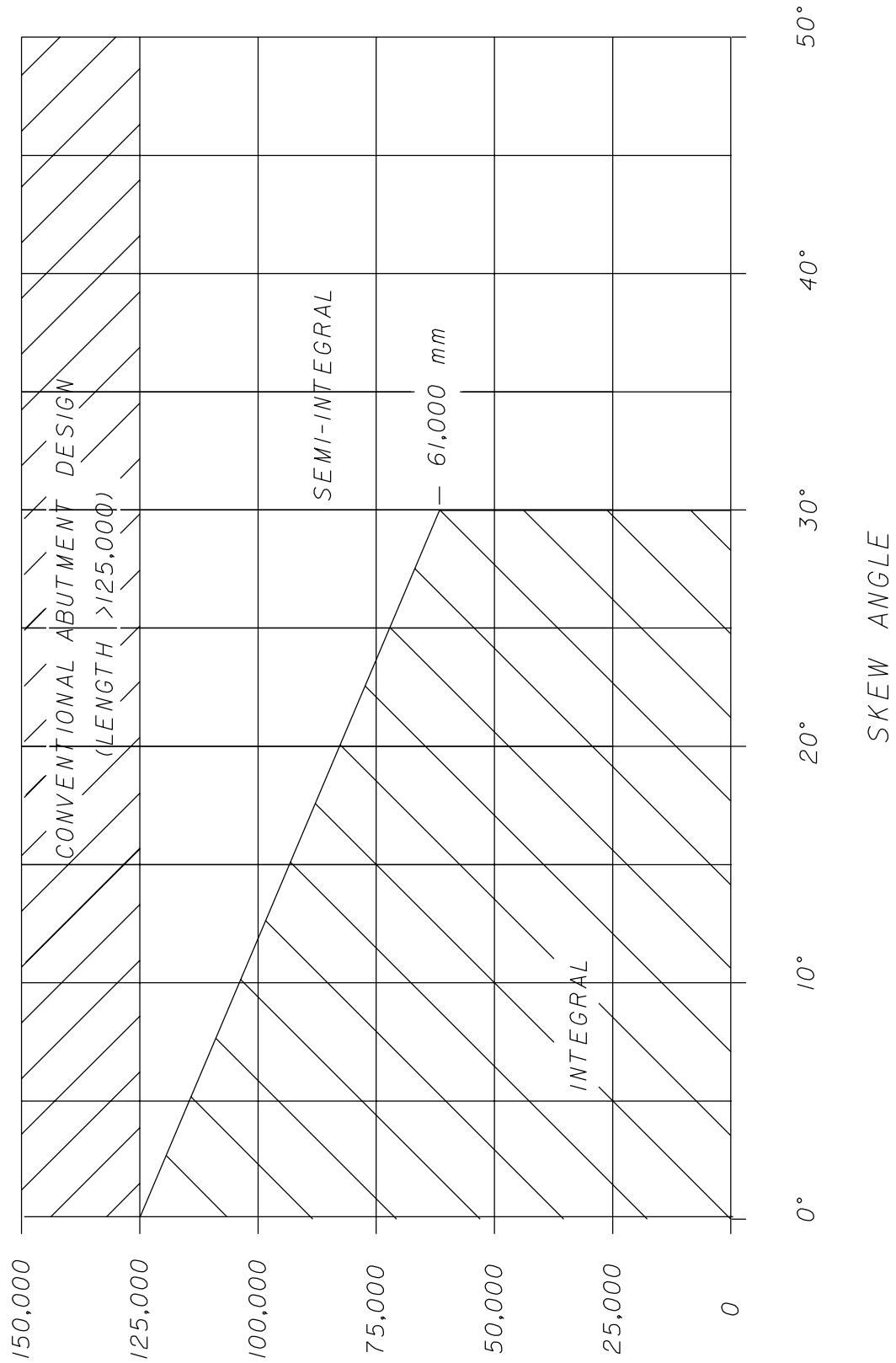


Figure 203M

wearing surface shall be composed as follows:

1. 1½ inches [38 mm] of Item 448 Asphalt Concrete Surface Course, Type 1H.

2. 1½ inches [38 mm] minimum thickness of Item 448 Asphalt Concrete Intermediate Course, Type 2, PG64-28.

3. Two applications of Item 407 Tack Coat - one prior to placement of the intermediate course and one prior to placement of the surface course.

C. 6 inches [155 mm] cast-in-place composite deck - defined as the minimum thickness of concrete slab for composite prestressed box beams. The top 1 inch [25 mm] shall be considered monolithic as defined above. Also see Section 302.5.1.3.

302.1.3.2 FUTURE WEARING SURFACE

All bridges shall be designed for a future wearing surface (FWS) of 60 psf [2.87 kPa].

The future wearing surface is considered non-structural and shall not be used in design to increase the strength of the superstructure. The presence of a future wearing surface does not exclude the use of the 1 inch [25 mm] monolithic wearing surface as defined above.

302.1.4 CONCRETE DECK PROTECTION

302.1.4.1 TYPES

A. Epoxy Coated Reinforcing Steel - CMS 709.00

B. Minimum concrete cover of 2½ inches [65 mm]

C. Class S Concrete

D. Class HP Concrete

E. Drip Strips

F. CMS 512, Type D, Waterproofing or CMS 512 Type 3 Waterproofing

G. Asphaltic concrete wearing surface

302.1.4.2 WHEN TO USE

All reinforcing steel shall be epoxy coated.

All cast-in-place concrete decks shall have minimum concrete top cover of 2½ inches [65 mm].

A drip strip may be used on decks with over the side drainage.

Non-composite box beam bridges, with over the side drainage, shall have an asphalt concrete overlay. The overlay shall be placed over either Type D Waterproofing, CMS 512 or Type 3 Waterproofing, CMS 512. Minimum thickness of overlay is 3 inches [75 mm] - See Section 302.1.3.1.

302.1.4.3 SEALING OF CONCRETE SURFACES SUPERSTRUCTURE

Specifications for sealing material are defined in CMS 512. Concrete surfaces shall be sealed with an approved concrete sealer as follows: (See Figures 310 & 311)

A. Concrete slabs or concrete decks on steel superstructures with over-the-side drainage:

   The exterior 9 inch [230 mm] width on the top of the deck, the deck fascia and a 6 inch [150 mm] (minimum) width under the deck shall be sealed with either an epoxy-urethane or non-epoxy sealer.

B. Concrete slabs, composite prestressed box beam superstructures or concrete decks on steel superstructures with sidewalks:

   A 9 inch [230 mm] width of the roadway along the curbline; the vertical face of curb; the top of the curb/sidewalk; the inside face, top and outside face of the parapet; the deck fascia; and a 6 inch [150 mm] (minimum) width under the deck shall be sealed with either an epoxy - urethane or non-epoxy sealer.

C. Concrete slabs, composite prestressed box beam superstructures or concrete decks on steel superstructures with deflector parapets:

   A 9 inch [230 mm] width of the roadway along the face of parapet; the inside face, top and outside face of parapet; the deck fascia; and a 6 inch [150 mm] (minimum) width under the deck shall be sealed with either an epoxy-urethane, or non-epoxy sealer.

D. Non-composite prestressed concrete box beam decks with over-the-side drainage:

   The fascia of the outside beams and a minimum 6 inch [150 mm] width under the beam shall be sealed with an epoxy-urethane or a non-epoxy sealer.

E. Concrete decks on prestressed I-beam superstructures with over-the-side drainage:

   The exterior 9 inch [230 mm] width on the top of the deck; the deck fascia; the underside of the deck to the edge of the top flange; the exterior fascia of the beam; the underside of the

The Designer shall supply basic erection data on the contract plans. As a minimum, include the following information:

A. If temporary supports are required, provide the location of the assumed temporary support points, reactions and deflections for each construction stage and loading condition.
B. Instructions to the Contractor as to when and how to fasten connections for cross frames or diaphragms to assure stability during all temporary conditions.

Further design information for curved structures is contained in the "Guide Specifications for Horizontally Curved Highway Bridges", published by the American Association of State Highway and Transportation Officials.

302.5 PRESTRESSED CONCRETE BEAMS

Model multi-span, non-composite members as simple-span for all loading conditions. The live load and future wearing surface shall be as defined in Section 301.4.

Model multi-span, composite members using the two loading conditions that follow. The loading condition that produces the largest load effects shall govern.

1. Simple-span for non-composite dead loads; continuous span for live load and composite dead loads. The live load and future wearing surface shall be as defined in Section 301.4.

2. Simple-span for all loading conditions. Do not include future wearing surface. The live load shall be as defined in Section 301.4.

302.5.1 BOX BEAMS

Physical dimensions and section properties of box beam cross sections shall be as shown on the Prestressed Concrete Box Beam Bridge Details, Standard Bridge Drawing.

Box beams should be limited to a maximum skew of 30 degrees.

Multiple span box beam bridges shall be joined over the piers with a T-joint as shown in the Standard Bridge Drawing. Structurally, non-composite beams shall be designed as simple spans. Composite beams shall be designed as simple span for non-composite dead loads and continuous for live loads and composite dead loads.

Expansion at the piers shall be accommodated by elastomeric expansion bearings or by flexibility of the piers for integral designs.

The length of abutment seats of prestressed concrete box beam bridges should be long enough to accommodate the total width out-to-out of all beams including a fit-up allowance of ½ inch [12 mm] per joint between beams.

In order to keep the beam seat from extending beyond the fascia of any pier of a box beam bridge, the length of the pier seat should only include a fit-up allowance for the joints between the beams of 1/4 inch [6 mm] per joint.

For box beam bridges that have skew combined with grade or which have variable superelevation, beam seats shall be designed and dimensioned to provide support for the full width of the box beams.

If a bridge structure's geometry causes a bridge deck in an individual span to have a different cross slope at one bearing than at the other bearing, the difference should be evenly divided so that the box beam seat cross slopes at both bearings are made to be the same. This adjustment gives the box beam full support at the seat without creating any twist or torsion on the box beam. Any elevation differences created by this beam seat adjustment should be adjusted for in the overlay, whether asphaltic or concrete.

Prestressed box beam members shall be supported by two bearings at each support.

Abutment wingwalls above the bridge seat and backwalls should not be cast until after box beams have been erected. The cast in place wingwall and box beam should normally be separated by one inch [25 mm] joint filler, CMS 705.03. The designer should show both requirements in the plans. Casting the backwall and wingwalls after the box beams are erected eliminates installation problems associated with the actual physical dimensions of the box beam and the joint filler. Cracking and spalling of backwall and wingwall concrete due to movements of the elastomeric bearings is also alleviated.

For box beam bridges with steel railing, the post spacing and position of post anchorage shall be detailed on the plans. The designer shall check that the post anchor spacing does not interfere with tierod locations or the "T" joint over the pier. The designer should confirm that post anchors at the ends of skewed box beams have both adequate concrete cover and do not interfere with the tierods. If the designer finds that no post spacing option can comply with the above requirements, the option of relocating the tie rods may be chosen. See standard drawings for maximum allowable spacing of tie rods.

When the box beam ends are not completely encased in concrete, the Standard Bridge Drawing requires Type B waterproofing on the ends. When required, Designers shall include a pay item for Item 512, Type B Waterproofing, in the estimated quantities.

302.5.1.1 DESIGN REQUIREMENTS

For box beam members, the live load distribution factors of AASHTO Section 3.23.4.3 shall be used.

Prestressed box beam design data sheets for non-composite designs are available on the Office of Structural Engineering website. The sheets are designed for TST-1-99 railing, a 60 lb/ft^2 future

wearing surface and an HS25 or alternate military loading.

In order to prevent fabrication mistakes for beam length, the effect that the longitudinal grade has on dimensions measured along a beam's length should be addressed in the plans. When the beam length measured along the grade differs from the beam length measured horizontally by more than 3/8" [10 mm], all affected dimensions measured along the length of the beam should be clearly labeled so that the fabricator can make the necessary allowances in the shop drawings. A Typical Detail note is available in Section 700.

(THIS PAGE INTENTIONALLY LEFT BLANK)

303 SUBSTRUCTURE

303.1 GENERAL

If a pier column, wall or other structural member is located in the sloped portion of an embankment, the design active earth pressure shall be applied to an effective width (S) of the member as defined in the following table. The effective width accounts for the earth pressure due to the embankment directly in back of the member and the earth pressure due to the adjacent embankment on each side.

Type of Member		S
Single Column or Wall		a + H
Interior Columns	c $ H	a + H
	c < H	$a+H-(H-c)^2/H$
Exterior Columns	c $ H	a + H
	c < H	$a+H-(H-c)^2/2H$

Where: c = One-half of the distance between adjacent members measured face to face.
H = Height of the active earth fill measured at the face of the footing.
a = Width of the member.

The minimum design earth pressure shall be 40 psf [2.0 kPa] unless granular backfill is provided.

303.1.1 SEALING OF CONCRETE SURFACES, SUBSTRUCTURE

Specifications for the sealer are defined in CMS 512. Concrete surfaces shall be sealed with a concrete sealer as follows:

A. The front face of abutment backwalls, from top to bridge seat, the bridge seat and the breastwall down to the groundline shall be sealed with an epoxy-urethane or non-epoxy sealer. (Note: Sealing of the backwall shall not be required on prestressed box beam bridges because the beams are installed before the backwall is placed.)

B. The exposed surfaces of all wingwalls and retaining walls, exclusive of abutment type, that are within 30 feet [10 000 mm] of any pavement edge shall be sealed with an epoxy-urethane sealer.

C. Ends and sides of piers exposed to traffic-induced deicer spray, from any direction, shall be sealed with either an epoxy-urethane or non-epoxy sealer. Top of pier caps need only be sealed if there is an expansion joint or the tops are subject to exposure to deicer-laden water.

D. The total vertical surface of piers which are adjacent to traffic lanes shall be sealed with either an epoxy-urethane or non-epoxy sealer. Structures with A588[M] weathering steel superstructures shall also have their piers sealed as stated above with either an epoxy-urethane or non-epoxy sealer.

The designer should include in the plans actual details showing the position, location and area required to be sealed. A plan note to describe the position should not be used as there can be both description and interpretation problems.

The designer has the option to select a specific type of sealer, epoxy-urethane or non-epoxy. The designer also has the alternative to just use a bid item for sealer, with no preference, and allows the contractor to choose based on cost.

See Figures 321, 322 & 323.

303.2 ABUTMENTS

303.2.1 GENERAL

Abutments should be provided with backwalls to protect the superstructure from contact with the approach fill and to assist in preventing water from reaching the bridge seat.

For members designed to retain earth embankments and restrained from deflecting freely at their tops, the computed backfill pressure shall be determined by using at-rest pressure. Examples include: rigid frame bridges, abutment walls keyed to the superstructure, and some types of U-abutments.

For abutment walls of structures designed without provision for expansion between superstructure and substructure and where an appreciable amount of superstructure expansion is anticipated, passive earth pressure should be considered in the design.

To allow for slight tilting of wall type abutments after the backfill has been placed, batter the front face 1/16" for each foot [5 mm for each 1000 mm] of abutment height. Height is measured from bottom of footing to the roadway surface.

303.2.1.1 PRESSURE RELIEF JOINTS FOR RIGID PAVEMENT

If rigid concrete pavement or base is to be used adjacent to the structure, the designer shall confirm that the roadway plans require installation of type A pressure relief joints, as per Standard Construction Drawing BP-2.3.

Pressure relief joints are required to alleviate backwall pressures on abutments with expansion devices and to allow freedom of movement for integral and semi-integral abutments.

Pier 5 Piles:
52 piles 90 ft long, order length
1 dynamic load testing item

The Designer should provide the following items in the Estimated Quantities:

Item	Extension	Total	Unit	Description
506	11100	Lump	Sum	Static Load Test
506	12200	1	Each	Subsequent Static Load Test
507	00500	4200	ft	12" Cast-In-Place Reinforced Concrete Piles, Driven
507	00550	4500	ft	12" Cast-In-Place Reinforced Concrete Piles, Furnished
507	00600	26,820	ft	14" Cast-In-Place Reinforced Concrete Piles, Driven
507	00650	28,680	ft	14" Cast-In-Place Reinforced Concrete Piles, Furnished
523	20000	4	Each	Dynamic Load Testing
523	20500	6	Each	Restriking

303.4.3 DRILLED SHAFTS

3'-6" [1065 mm] diameter drilled shafts for piers and 3'-0" [915 mm] diameter shafts for abutments are normally used.

The diameter of bedrock sockets of a drilled shaft are generally 6 inches [150 mm] less in diameter than the diameter of the drilled shaft above the bedrock elevation. The 6 inch [150 mm] downsize can be eliminated for abutment shafts. Reinforcing steel cages should be based on the bedrock socket diameter.

The drilled shaft diameter for the abutment shafts can be shown as one constant diameter for the full length of the drilled shaft (through bedrock and through soil).

Spiral reinforcement used in the drilled shaft is normally a #4 [#13M] bar at a 4½ inch [115 mm] pitch with a spiral diameter of 6 inches [150 mm] less, out to out of spiral cage than the drilled shaft diameter. (Note AASHTO specifications do not recognize a 4½ inch [115 mm] pitch as meeting spiral requirements definition 8.18.2.2.3) When steel casing is left in place, a pitch of 12 inches [300 mm] should be used for the spiral reinforcing.

Drilled shafts with diameter s of less than 3'-0" [915 mm] are not recommended.

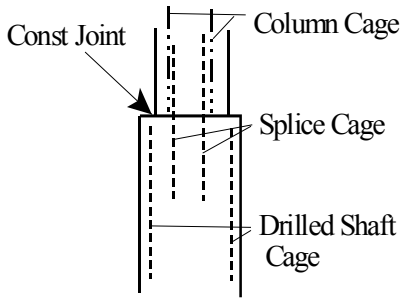
The diameter of the drilled shafts should be 6 inches [150 mm] larger than the pier column diameter so that if the drilled shaft is slightly misaligned, the pier column can still be placed at plan location, although the pier column would not be exactly centered on a misaligned-drilled shaft.

For record and project use, each drilled shaft for a structure shall be individually identified by a unique number. The designer may choose to number the drilled shafts on the individual

substructure plan sheet or on a separate drilled shaft foundation layout sheet.

A construction joint between the drilled shaft and any column will be required. Therefore the designer will need to specify reinforcing steel, incorporating the required lap splices, at the construction joint.

The designer should develop a lap splice that will allow both for required lap and minimum cover due to mis-alignment of the drilled shaft versus the column. Possible alternatives are two cages, one for the drilled shaft diameter and a second splice cage for the lap to the column.



When the exposed length of the pier columns is relatively short, one full length reinforcing steel cage, from the bottom of the drilled shaft up into the pier cap, should be designed. The steel cage should be designed to provide a 3 inch [75 mm] concrete cover within the pier column.

When the drilled shaft is socketed into bedrock, the quantity of the reinforcing steel in the drilled shaft, including the portion extending into the rock socket, should be included with Item 524 "Drilled Shaft, Above Bedrock" for payment. For drilled shafts with friction type design where the tip elevation is known, the reinforcing steel should be paid under Item 524, Drilled Shafts. The Designer shall also specify the reinforcing steel to be epoxy coated according to 709.00.

A general note as listed in Section 600 will be required.

The top of the drilled shaft is defined as 1 foot [0.3 meter] above normal water elevation, for piers in water, and 1 foot [0.3 meter] below the ground surface for piers not in water.

303.5 DETAIL DESIGN REQUIREMENTS FOR PROPRIETARY RETAINING WALLS

303.5.1 WORK PERFORMED BY THE DESIGN AGENCY

The Design Agency is responsible for providing sufficient information in the plans such that, prior to submitting a bid, the Contractor can select a proprietary company to design the internal stability of the wall after the project is awarded. Detail each wall on a project separately. As a minimum, the project plans for each wall location shall provide the following:

A. Plan View of the wall showing: (Refer to Figure 329)

1. Wall location with station and offset with respect to the centerline of construction for each critical point

2. All complex geometry information

3. Limits of proprietary wall embankment

4. North Arrow

5. Locations of typical sections for (C.) below

6. Utility Locations

7. Parapet/barrier locations

8. Limits of proposed undercut and backfill

9. Locations of sheeting and bracing

   If sheeting and bracing is required to support an excavation for undercut and backfill, show the location and provide a pay item for Item 503 – Cofferdams, Cribs and Sheeting. Refer to BDM Section 208 for more information.

10. Backfill drainage locations

    A plastic pipe, CMS 707.33, shall be located below the bottom row of soil reinforcement at the back side of the leveling pad and at the free end of the soil reinforcement. The pipe shall be continuous and sloped to provide a positive gravity flow in a direction away from the facing elements. If the proprietary wall supports an abutment, provide backfill drainage in accordance with Section 303.2.3.1.

B. Elevation of the wall showing: (Refer to Figure 329)

1. Station and elevation for each critical point on the wall

2. Finished ground surface elevations for each critical point on the wall

3. Leveling pad showing the minimum dimension from the finished ground line to the top of the pad.

4. Utility Locations

5. Backfill drainage

C. Typical Sections showing: (Refer to Figures 330, 331, 332 & 333)

1. Coping details (Refer to Appendix Figure App-1 for more information)

2. Parapet and sleeper slab details

3. Abutment footing details including the dimensions from the front of the proprietary wall to the centerline of bearing at the abutment and from the back of the proprietary wall to the toe of the abutment footing.

4. Minimum clearance between the bottom of the footing/sleeper slab and the uppermost wall reinforcement strap.

5. Utility locations

6. Backfill drainage

7. Soil reinforcements attached to abutment (where required)

   Show soil reinforcements attached to the backside of abutments regardless of foundation types according to the following:

   a. For jointed structures, the soil reinforcement should be attached up to the level of the approach slab seat.

   b. For semi-integral structures, the soil reinforcement should be attached up to the level of the beam seat.

8. Limits of select granular material

9. Limits of unclassified excavation

10. Pay limits of proprietary wall

11. Limits of undercut and backfill

    The backfill material shall be select granular embankment material compacted according to CMS 503.09.

12. Location of sheeting and bracing (if required)

13. Limits of concrete sealer

D. Requirements for wall surface textures or other aesthetic treatments (i.e. show panel size and shape restrictions specific to the project in the plans)

E. Wall design criteria including:

1. Allowable bearing capacity at the base of the reinforced soil mass

2. Vertical dead and live loads, horizontal loads and actual bearing pressure applied to the reinforced soil mass

Plan notes are provided in Section 600.

F. Final copy of the Special Provision for each design.

See Appendix A of this manual for Special Provisions. A master copy of the Special Provisions for each wall design can be obtained from the Office of Structural Engineering.

G. Estimated Quantities Table (list each wall on a project separately)

1. Include pay items for each wall manufacturer labeled as "Option A, B, etc." Unless otherwise directed, the unit of measure shall be "Square Foot" ["Square Meter"].

2. Include one pay item per wall, as necessary, for: Item Special - Concrete Coping; Item Special - Concrete Coping including Sleeper Slab; Item Special - Undercut and Backfill; and Item 503 - Cofferdams, Cribs and Sheeting.

303.5.2 WORK PERFORMED BY THE PROPRIETARY WALL COMPANIES

The proprietary wall companies will be responsible for designing the internal stability of the wall in accordance with the project plans and special provisions.

(THIS PAGE INTENTIONALLY LEFT BLANK)

(THIS PAGE INTENTIONALLY LEFT BLANK)

304 RAILING

304.1 GENERAL

Bridge railing on all projects, NHS or otherwise, shall meet acceptance criteria contained in NCHRP Report 350 or its successor. The minimum acceptance level shall be TL-3 unless supported by a rational selection procedure described herein. Projects, for the purpose of railing installations, shall include new construction, complete deck replacements, replacement of deteriorated concrete deck edges, superstructure widenings and rigid concrete overlays. For other work types, including roadway railing upgrade projects, a railing upgrade is not warranted, but a positive connection between the approach railing and the existing bridge railing is required.

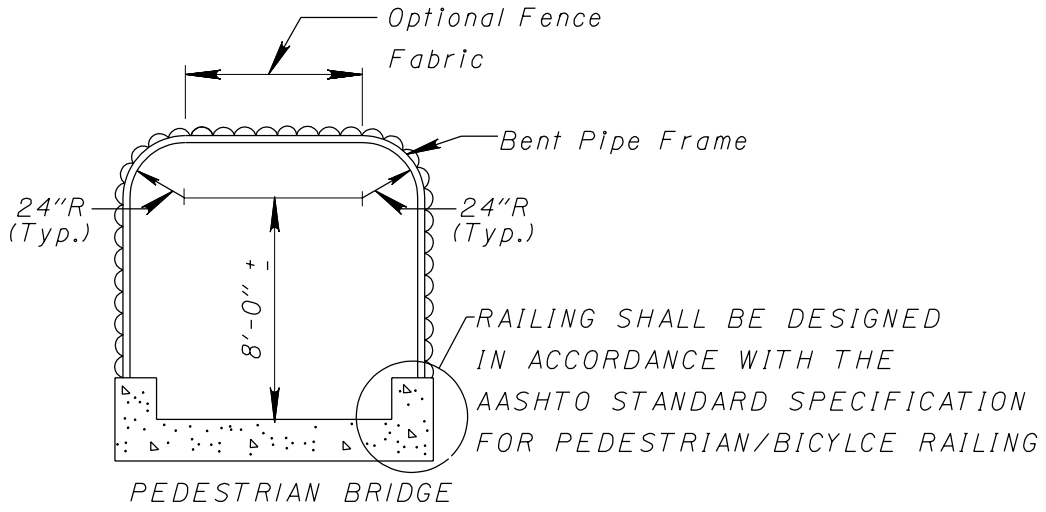
Bridge railings that have been found acceptable under the crash testing acceptance criteria defined in NCHRP Report 230 and the AASHTO Guide Specification for Bridge Railing, 1989 including all interims, will be considered as meeting the requirements of NCHRP Report 350 without further testing as indicated in the following table.

Bridge Railing Testing Criteria	Acceptance Equivalencies					
NCHRP 350	TL-1	TL-2	TL-3	TL-4	TL-5	TL-6
NCHRP 230		MSL-1 MSL-2		MSL-3		
AASHTO Guide Specification		PL-1		PL-2	PL-3	

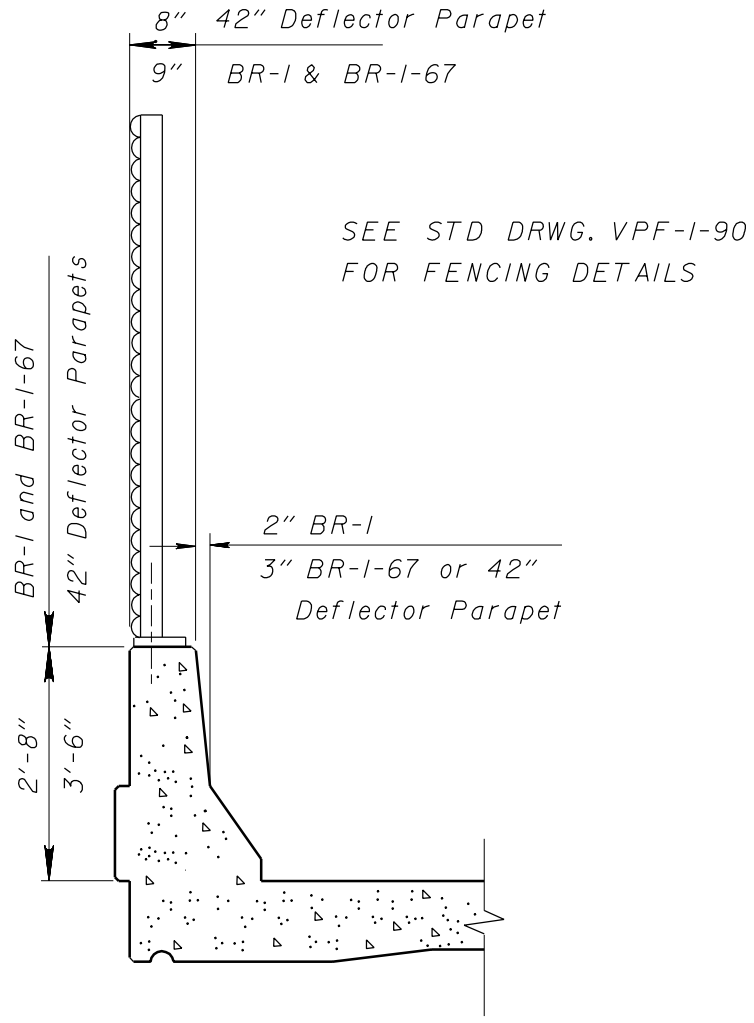
The AASHTO Guide Specification provides a Performance Level Selection Criteria for bridge railings that is considered an acceptable alternative to NCHRP Report 350 and may be used for railing designs on any project defined above.

Section 304.2 of this Manual lists standard ODOT bridge railing types available along with the corresponding NCHRP 350 level of acceptability. For non-standard railing designs, a review submission, concurrent with the Structure Type Study, shall be made to the Office of Structural Engineering as stated in Section 201 of this Manual. The design of all non-standard railing systems shall be based on the NCHRP 350 level of acceptability. Designers may be required to submit actual crash test report data to verify the level of acceptability of a proposed design.

Modifications to the ODOT standard railing types or other NCHRP 350 approved railing system should be avoided. Additional structural steel tubing added to satisfy pedestrian concerns does not require additional crash testing provided these elements do not protrude nearer to the roadway than the rail elements on the tested design and they do not present any type of snagging potential to an impacting vehicle. If an accepted crash tested railing system is modified, the face geometry (i.e. offset, rail height, spacing, etc.) shall match the tested design and the static

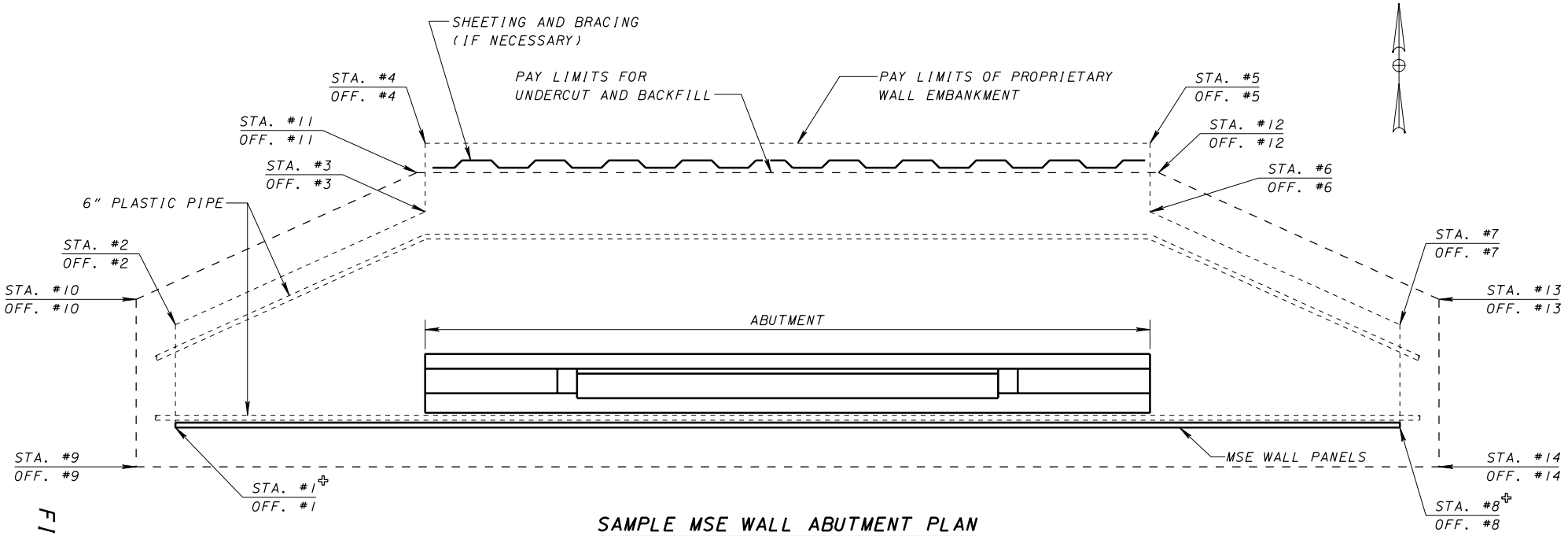


PEDESTRIAN FENCING ON STRUCTURES



DEFLECTOR PARAPET WITH FENCING

Figure 328

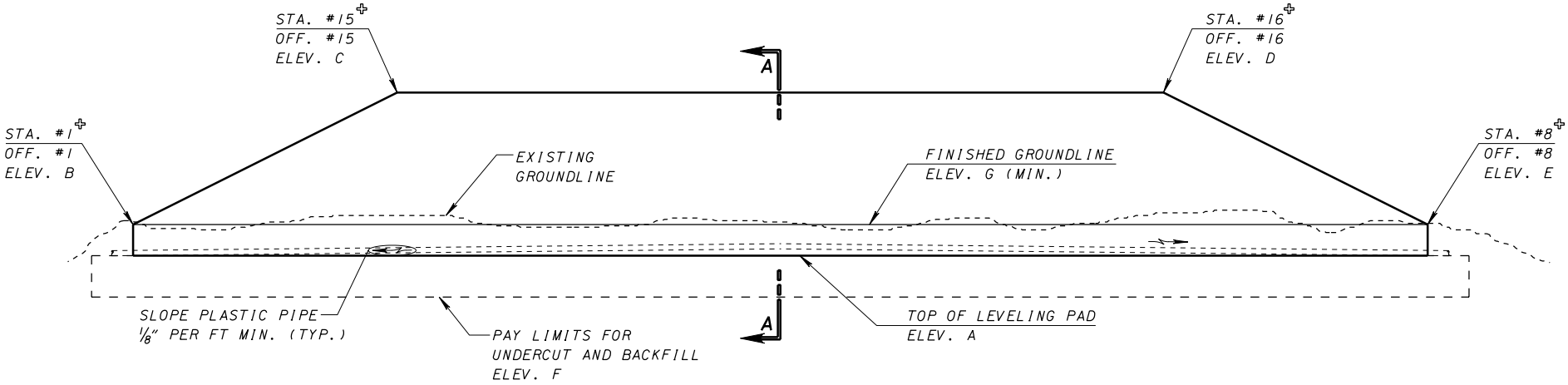


SAMPLE MSE WALL ABUTMENT PLAN

✣ - MEASURED TO EXPOSED FACE OF MSE WALL

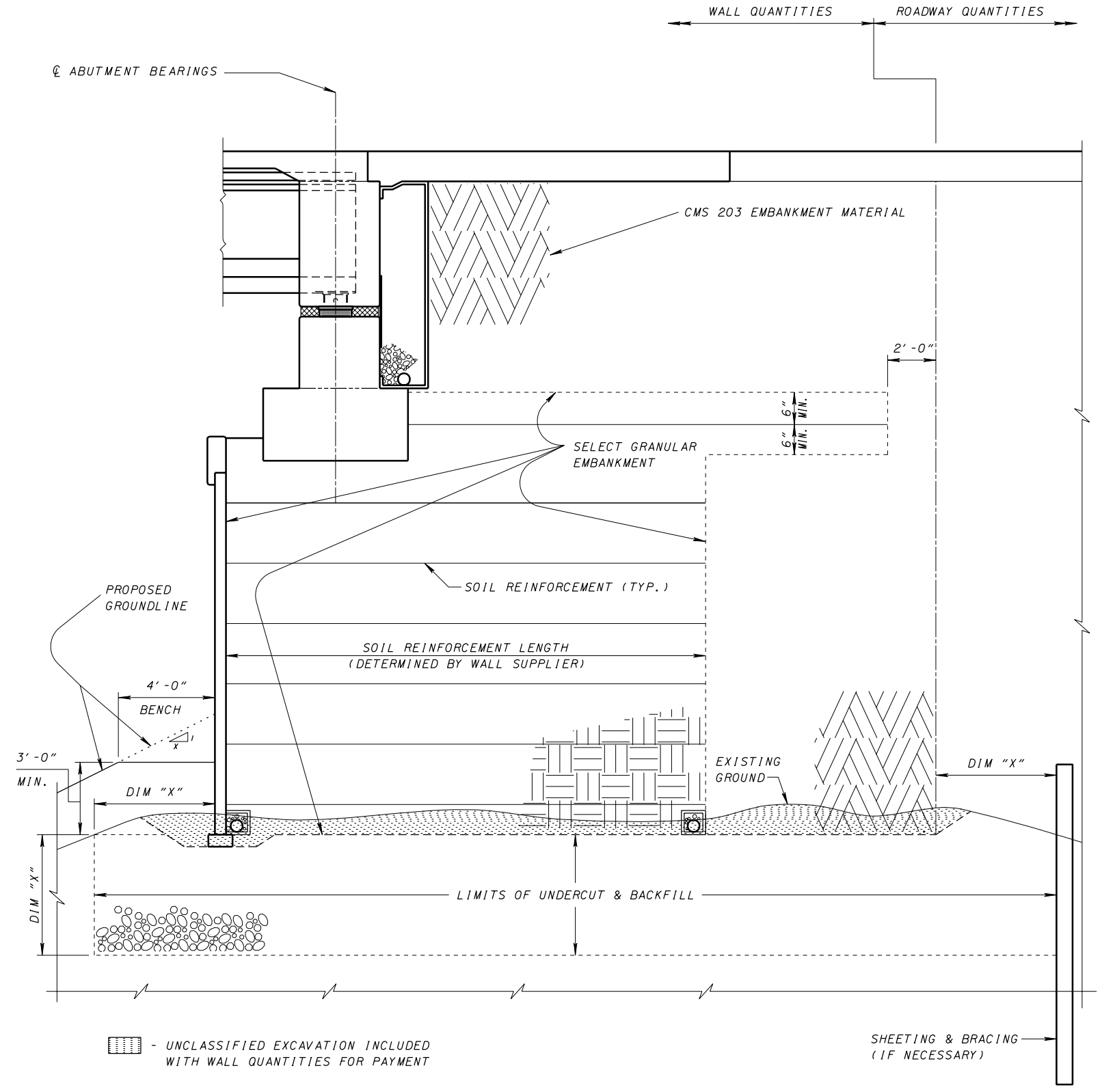
FIGURE 329

SEE FIGURE 330 FOR SECTION A-A (WITH UNDERCUT AND BACKFILL)
SEE FIGURE 331 FOR SECTION A-A (WITHOUT UNDERCUT AND BACKFILL)



SAMPLE MSE WALL ABUTMENT ELEVATION

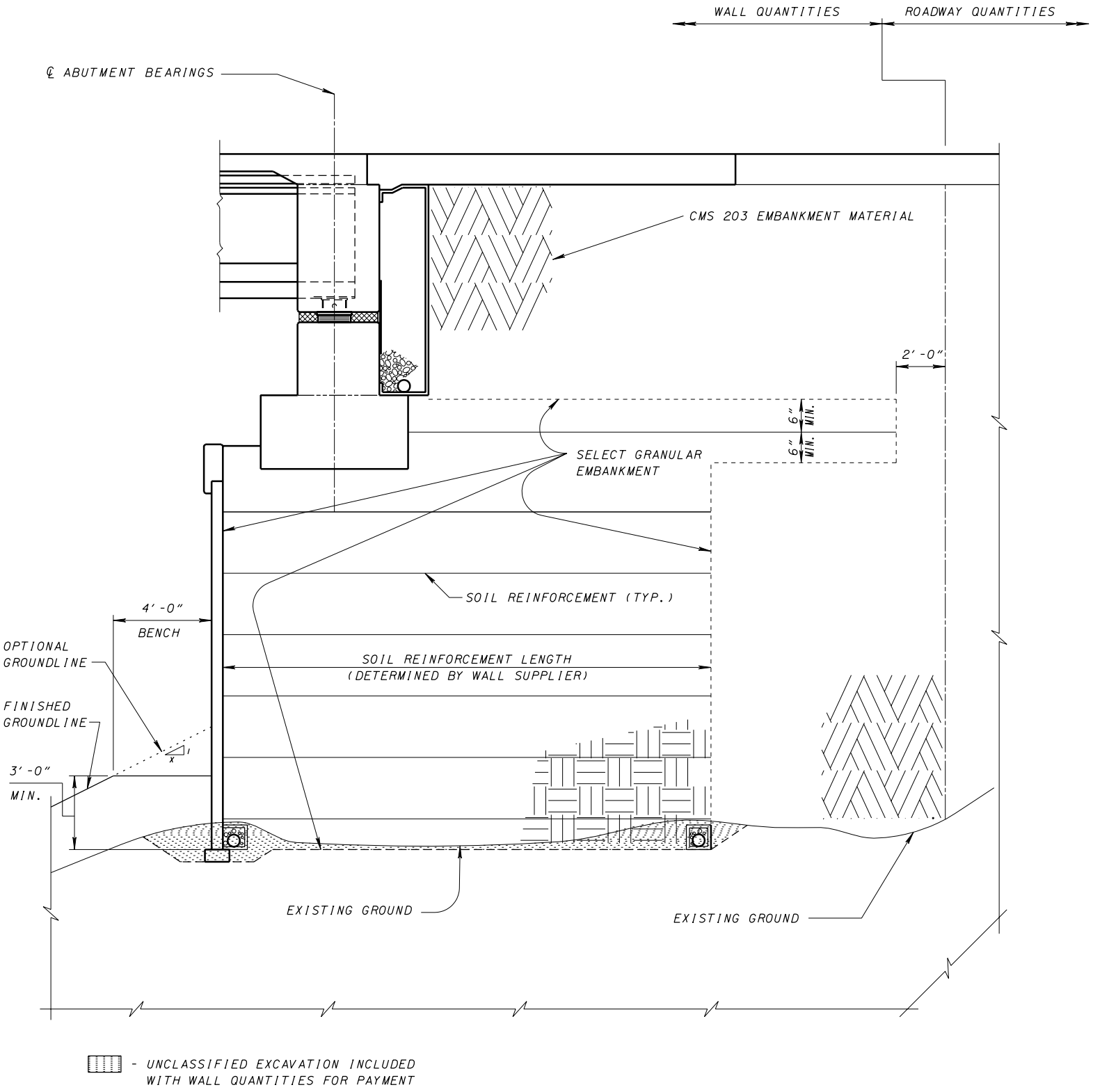
✣ - MEASURED TO EXPOSED FACE OF MSE WALL



SECTION A-A

(ALL DIMENSIONS PERPENDICULAR TO MSE WALL)

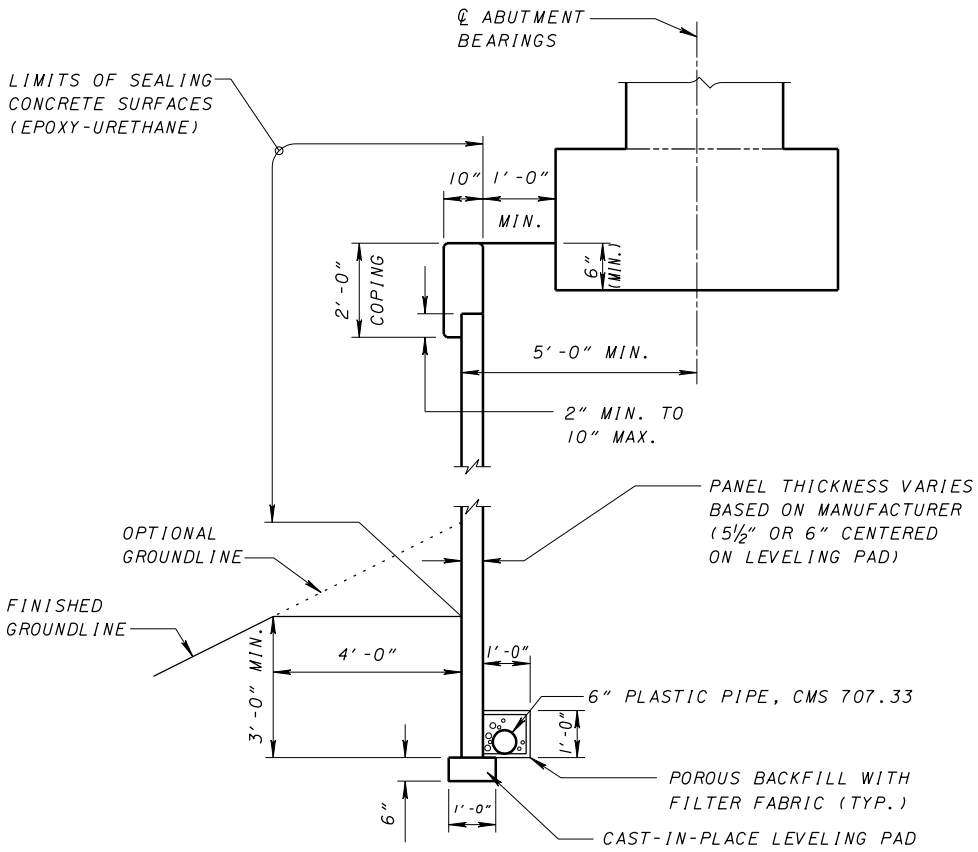
FIGURE 330



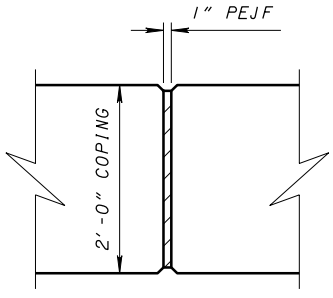
SECTION A-A

(ALL DIMENSIONS PERPENDICULAR TO MSE WALL)

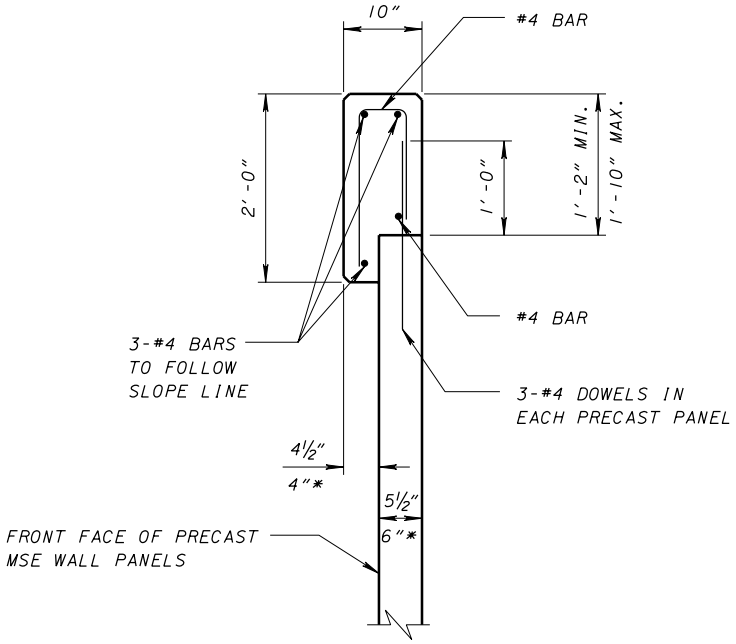
FIGURE 331



MSE WALL AND COPING DETAIL



COPING EXPANSION JOINTS



MSE WALL COPING

ALL REINFORCING STEEL TO BE EPOXY COATED

* DEPENDS ON THE APPROVED WALL SYSTEM

FIGURE 332

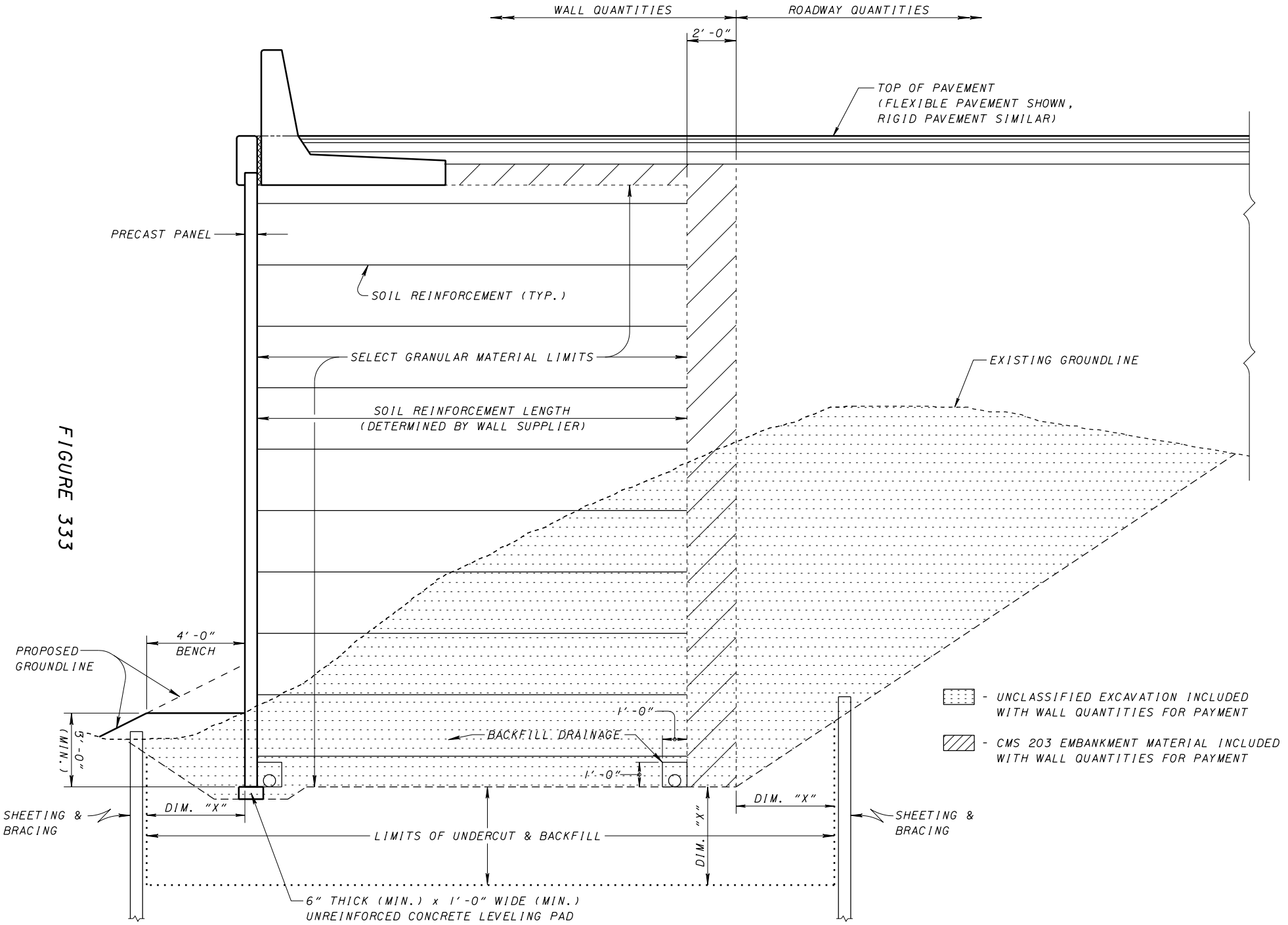

WALL QUANTITIES
ROADWAY QUANTITIES
2'-0"
TOP OF PAVEMENT
(FLEXIBLE PAVEMENT SHOWN,
RIGID PAVEMENT SIMILAR)
PRECAST PANEL
SOIL REINFORCEMENT (TYP.)
SELECT GRANULAR MATERIAL LIMITS
EXISTING GROUNDLINE
SOIL REINFORCEMENT LENGTH
(DETERMINED BY WALL SUPPLIER)
4'-0"
BENCH
PROPOSED
GROUNDLINE
3'-0"
(MIN.)
1'-0"
BACKFILL DRAINAGE
1'-0"
- UNCLASSIFIED EXCAVATION INCLUDED
WITH WALL QUANTITIES FOR PAYMENT
- CMS 203 EMBANKMENT MATERIAL INCLUDED
WITH WALL QUANTITIES FOR PAYMENT
SHEETING &
BRACING
DIM. "X"
DIM. "X"
SHEETING &
BRACING
LIMITS OF UNDERCUT & BACKFILL
DIM. "X"
6" THICK (MIN.) x 1'-0" WIDE (MIN.)
UNREINFORCED CONCRETE LEVELING PAD

FIGURE 333

410.3 THRIE BEAM RETROFIT

If it is determined that upgrading of the parapet to the deflector shape is not prudent, there is a standard bridge drawing available that can be applied.

411 BEARINGS

Notes may be provided to rehabilitate the bearings if that is the chosen course of action. It is customary to split the jacking of the superstructure into one pay item (see Section 407 of this Manual) and the actual bearing restoration work into another. The contractor should be given the option of totally replacing the bearings with like bearings in lieu of rehabilitating the existing.

If elastomeric bearings are used at abutments where the existing expansion joint is built according to Standard Bridge Drawing SD-1-69, the joint shall be modified. The retired Standard Bridge Drawing SD-1-69 end dam consists of an angle, attached to the superstructure, which angle overlaps the abutment backwall. If compressible type bearings are used with this arrangement, the reaction will be transferred to the end dam angle causing distress to the end of the deck.

All bearings at an individual substructure unit shall be the same type. The bearings at any one substructure unit shall be compatible with all the bearings at the other substructure units.

When rehabilitation of existing bearings is being considered, the designer should make a cost comparison between rehabilitating the existing bearings and replacing them with all new bearings and any additional costs associated with modifying the existing structure to accommodate the new bearings. For new bearings, preference should be given to using elastomeric bearings. See Section 300 of this Manual for additional guidance. The cost comparison is to be submitted (included) as part of the Structure Type Study.

412 CONCRETE BRIDGE DECK REPAIR QUANTITY ESTIMATING

A deck condition survey shall be conducted and a report prepared for each existing concrete deck. The survey shall be performed as near as practicable to the plan preparation stage and shall be completed before beginning detail design work for the deck rehabilitation since it is to be used as a design tool toward that end. If the survey will be two winters or more old at the scheduled time of sale, a new survey shall be performed. The new survey will include recoring of the deck as deemed necessary.

The top surface of bare concrete decks shall be both visually inspected and sounded for obvious signs of deterioration. The top surface of decks with an asphalt overlay shall be visually inspected for signs of obvious and suspected deterioration.

The underside of all decks shall be inspected. Where there are indications of delamination, water

intrusion, discoloration, spalls, efflorescence or other signs of distress, the underside shall be sounded. The decks shall then be cored in suspicious areas to verify and further define areas of unsoundness. If it is suspected that full depth repair may be required, cores shall be taken full depth or at least to the bottom mat of reinforcing steel in those areas. A description of the core results shall accompany the deck condition survey report.

See Figure 411 for an example of the survey report form.

A sketched plan of the deck area, both top surface and underside, shall be included with the bridge deck condition survey. The unsound areas should be plotted on the sketch indicating the approximate dimensions that were used to estimate the percentage of total unsound deck area.

The minimum number of cores to be taken for a bare concrete deck shall be determined by the following criteria:

A. A minimum of two (2) per bridge for bridges with a deck area less than 2500 square feet [225 square meters].

B. A minimum of three (3) per bridge for bridges with a deck area between 2500 to 5000 square feet [225 to 450 square meters].

C. A minimum of four (4) per bridge for bridges with a deck area between 5000 to 10,000 square feet [450 to 900 square meters] with one additional core for each additional 10,000 square feet [900 square meters] or part thereof.

For bridge decks with an asphalt overlay the minimum number of cores listed above is required but it is further recommended that additional cores be taken due to the variability of unknowns hidden under the overlay.

Core locations shall be determined from conditions detected primarily from the bottom side of the deck; however, the top surface may also indicate areas to be cored. At least one core shall be taken from an apparently sound area and the others from questionable areas for comparison.

The cores shall be submitted to the District Bridge Engineer with proper identification. They shall be retained for a minimum period of six months following the award of the actual construction contract.

Cores shall be inspected for:

A. Obvious crumbling
B. Stratification or delamination zones
C. Soundness of aggregate
D. Depth and condition of reinforcing steel

A description of the core results shall accompany the deck condition survey report.

An estimate of the unsound deck area as a percentage of total deck area shall be made from all of the information gathered from the survey and testing.

412.1 SPECIAL REQUIREMENTS FOR QUANTITY ESTIMATING FOR BRIDGES 500 FEET [150 m] OR GREATER IN LENGTH

In addition to the requirements of Section 412 above, additional requirements are added for structures with a length of greater than 500 feet [150 meters].

An electrical potential survey shall be performed. The area of active corrosion shall be compared with the delaminated area to determine a more accurate repair area.

Consideration should be given to engaging a company or agency specializing in bridge deck condition surveys that include thermographic acoustic and radar techniques, electromagnetic sounding and nuclear magnetic resonance.

Deck cores shall be analyzed for chloride content.

It should be noted that active corrosion is assumed to be taking place if a chloride ion content greater than 2.0 lbs. per cubic yard [1.2 kg/m^3] is present and/or if there is an observed rebar electrical potential reading of greater than -0.35 volts compared to a copper-copper sulfate reference half cell.

It is not the intent to remove chloride contaminated or electrically active concrete but rather the results of the chloride ion content tests are to be used as a support tool for determining the type and extent of rehabilitation to be recommended.

412.2 ACTUAL QUANTITIES, ESTIMATING FACTORS

The following table gives estimating factors. The estimating factors are related on a sliding scale in order to project the quantities based upon measured areas to plan quantities 6 to 9 months beyond the actual date of the deck condition survey, including one winter.

Measured % Unsound Area	Estimating Factor	Project % Plan Area
0-10	0-3	30
15	2.33	35
20	2	40
25	1.9	47.5
30	1.87	55
35	1.79	62.5
40	1.69	67.5
45	1.56	70
50	1.50	75
60	1.33	80
70	1.21	85
80	1.09	87.5
90	1.00	90

The plan quantity shall be increased by a factor of 15% when the survey is one winter old.

Life cycle cost comparisons indicate that the benefits derived from replacement versus rehabilitation are approximately equal when the amount of unsound and delaminated concrete area is 50% to 60% of the total deck area. Therefore, unless there are overriding circumstances, the decks shall be replaced rather than rehabilitated when this area equals or exceeds 60% of the total deck area.

Do not include a pay item for full depth repair when such work is not indicated. The unit price established by this practice is worthless.

For any overlay project establishing accurate quantities are difficult. The difficulty is only increased if the bridge has an existing asphaltic or rigid concrete overlay. As asphaltic concrete overlays do not allow conventional sounding methods, additional coring and/or evaluation methods listed in Section 412.1 are recommended.

Required removal thicknesses of existing overlays should be established by coring of the deck to establish the true thickness of the existing overlay. Do not use the original design plans specified overlay thickness.

Variable thickness quantities should be established based on unsound areas of deck and assuming a depth to the bottom of the top layer of reinforcing steel + ¾ inch [19 mm]. Coring should be used to verify delamination depth

.

Hand chipping bid items for overlay projects requiring hydrodemolition removal are associated with variable thickness quantities. Using 10% of the variable thickness surface area for quantities is one alternative, but other methods may be acceptable. Take note that this percentage is based on the variable thickness surface area and not the entire deck surface area. Another method would be to get local experience from the District Maintenance and Construction personnel as to what percentage would be best to use. A separate hand chipping bid item is not required if the method of removal is mechanical scarification as this is included in the overlay variable thickness quantity.

Accurate records of actual quantities shall be maintained for each bridge.

It is recommended that the Districts review any criteria for selecting rehabilitation and replacement projects with the Offices of Maintenance Administration and Structural Engineering to help assure statewide consistency on rehabilitation or replacement deck projects.

It should be noted that in all cases, maintaining the structural integrity of the structure is of prime importance. The effects of exposing large areas of the top mat of reinforcing in areas such as cantilevered parapets, negative moment reinforcing over beams on stringer bridges and over piers on continuous slab bridges and in other areas of a critical nature shall be clearly understood from a design standpoint.

413 REFERENCES

A. FHWA-RD-78-133, “Extending the Service Life of Existing Bridges by Increasing Their Load Carrying Capacity,” 1978

B. NCHRP Report 206, “Detection and Repair of Fatigue Damage in Welded Highway Bridges,” 1978

C. NCHRP Report 222, “Bridges on Secondary Highways and Local Roads -- Rehabilitation and Replacement,” 1980

D. NCHRP Project 12-17 Final Report, “Evaluation of Repair Techniques for Damaged Steel Bridge Members: Phase l,” 1981

E. NCHRP Report 243, “Rehabilitation and Replacement of Bridges on Secondary Highways and Local Roads,” 1981

F. NCHRP Report 271, “Guidelines for Evaluation and Repair of Damaged Steel Bridge Members,” 1984

G. NCHRP Report 293, “Methods of Strengthening Existing Highway Bridges,” 1987

H. NCHRP Report 333, “Guidelines for Evaluating Corrosion Effects in Existing Steel

Bridges," 1990

I. Park, Sung H., "Bridge Rehabilitation and Replacement (Bridge Repair Practice)," S. H. Park, P.O. Box 7474, Trenton, N.J., 08628- 0474, 1984

For wall type abutments on spread footings with no new embankment provide note **[26]** or **[27]** and the following note:

[25] CONSTRUCTION CONSTRAINTS: Fill the void created by excavating for the abutment footings with Type B granular material, 703.16.C. After the footing and the breastwall have been constructed, fill the void behind each abutment up to the beam seat elevation and from the beam seat up on a 1:1 slope to the subgrade elevation prior to constructing the backwall and setting the beams on the abutment.

605.3 EMBANKMENT CONSTRUCTION NOTE

In an attempt to reduce settlements of the roadway approaches, specify the placement of embankment materials in 6 inch [150 mm] lifts. Include one of the following plan notes in the Project General Notes and make reference to the work defined below at the appropriate locations within the plans.

Note that Item 203 is a roadway quantity and coordination with the roadway plans is necessary.

To define the limits of measured pay quantities for bridges with wall-type abutments, provide excavation, backfill, and embankment diagrams (or a composite diagram, where suitable), using schematic abutment cross-sections, showing the boundaries between structure and roadway excavation, and between structure backfill and roadway embankment.

[26] ITEM 203 EMBANKMENT, AS PER PLAN: Place and compact embankment material in 6 inch [150 mm] lifts for the construction of the approach embankment between stations _**_ to _**_.

** The approximate limits should be 100 feet behind each abutment

[27] ITEM 203 EMBANKMENT, AS PER PLAN: Place and compact embankment material in 6 inch [150 mm] lifts for the construction of the approach embankment.

605.4 UNCLASSIFIED EXCAVATION

Compute and use pay items for Item 503 as follows:

When an excavation includes 10 yd^3 [m^3] or more of rock (or shale), itemize the quantity of rock excavation separately under:

Item 503 - Rock (or Shale) Excavation

When the rock (or shale) excavation is under 10 yd^3 [m^3], do not itemize the rock (or shale) excavation separately. Provide the following pay item:

Item 503 - Unclassified excavation, including rock (and/or shale)

When excavation includes no rock (or shale), provide the following pay item:

Item 503 - Unclassified excavation

In computing the quantity of Item 503 excavation, the designer should confirm that all removals under items 201, 202 or 203 have been excluded, according to CMS 503.01. Generally, the basis of payment for Item 503 should be yd^3 [m^3]. Lump sum quantities may be used if authorized by the District and with the understanding that cost may be higher than when specific quantities are used.

605.5 PROPRIETARY RETAINING WALLS

For projects with proprietary retaining wall systems supporting bridge abutments on spread footings, provide the following note and table:

[98] PROPRIETARY RETAINING WALL DATA:
The proprietary wall supplier shall design the internal stability of a mechanically stabilized earth (MSE) wall in accordance with the special provisions to support the abutment loads provided in the table below. All loads in the table represent unfactored service loads applied to the reinforced soil mass at the base of the concrete footing. DL represents a vertical spread footing strip load that includes the dead load of the approach slab; the dead load of the abutment; and the dead load from the superstructure. LL represents a vertical spread footing strip load that includes only the live load from the superstructure. H represents a horizontal strip load from the superstructure applied perpendicular to the face of wall. Ecc. represents the distance between the geometrical center of the strip footing and the resultant of all loads applied to the footing.

Wall Location	DL (k/ft)	LL (k/ft)	H (k/ft)	Ecc. (ft)	Bearing Pressure (k/ft^2)
#1					
#2					
#3					

For projects with proprietary retaining wall systems supporting bridge abutments on pile foundations, provide the following note:

[99] PROPRIETARY RETAINING WALL DATA:
The proprietary wall supplier shall design the internal stability of a mechanically stabilized earth (MSE) wall in accordance with the special provisions to support the

abutment. The design for internal stability shall include an unfactored horizontal strip load from the superstructure of _____ k/ft [kN/m] applied perpendicular to the face of wall at the base of the concrete footing.

606 FOUNDATIONS

606.1 PILES DRIVEN TO BEDROCK

The following note generally will apply where steel-H piles are to be driven to bedrock:

[29] PILES TO BEDROCK: Drive piles to refusal on bedrock. The Department will consider refusal to be obtained by penetrating soft bedrock for several inches to a minimum resistance of 20 blows per inch [25 mm] or by contacting hard bedrock and the pile receiving at least 20 blows. Select the hammer size to achieve the required depth to bedrock and refusal.

The Ultimate Bearing Value is _#_ tons [kN] per pile for the ____ abutment piles. The Ultimate Bearing Value is _#_ tons [kN] per pile for the ____ pier piles.

Abutment piles:
____ piles ____ feet [meters] long, order length

Pier piles:
____ piles ____ feet [meters] long, order length

(THIS PAGE INTENTIONALLY LEFT BLANK)

702.13 PAINTING OF A588/A709 GRADE 50 STEEL

[78] Note retired - see appendix

Provide the following note for bridge superstructures using unpainted A588/A709 Grade 50W steel and having deck expansion joints at the abutments. Modify the note accordingly for structures with intermediate expansion joints. Bridges with an integral or semi-integral type abutment will not require painting of the beam ends.

[79] PARTIAL PAINTING OF A709 GRADE 50W STEEL : Paint the last 10 ft [3 m] of each beam/girder end adjacent to the abutments including all cross frames and other steel within these limits. The prime coat shall be 708.01. The top coat color shall closely approach Federal Standard No. 595B - 20045 or 20059 (the color of weathering steel).

702.14 ERECTION BOLTS

Where erection bolts are specified for attaching crossframes on steel girder or rolled beam bridges, and the expected dead load differential deflection at each end of the crossframes is less than or equal to ½" [13 mm] provide the following note. (Do not use the note if standard drawing GSD-1-96 is being referenced.)

[80] ERECTION BOLTS: The hole diameter in the cross frames and girder stiffeners shall be 3/16" [4 mm] larger than the diameter of the erection bolts. Erection bolts shall be high strength bolts and shall remain in place. Supply two hardened washers with each high strength bolt. Fully torque the bolts or use a lock washer in addition to the two hardened washers. Furnish erection bolts as part of Item 513.

If the differential dead load deflection at each end of the crossframes is greater than ½" [13 mm], provide the following note. (Note - if part of a structure's crossframes have a differential deflection of greater than ½" [13 mm] and part of the structure does not, use the following ERECTION BOLT note.)

[81] ERECTION BOLTS AND CROSS FRAME FIELD WELDING : The hole diameter in the girder stiffeners shall be 3/16" [4 mm] larger than the diameter of the erection bolts. The cross frame members shall have slotted holes, 3/4" [19 mm] longer than the bolt diameter and 1/16" [2 mm] wider than the erection bolt diameter. The slot shall be parallel to the longitudinal dimension of the cross frame member. Erection bolts shall be high strength bolts and shall remain in place. Supply two hardened washers with each high strength bolt. Fully torque the bolts or use a lock washer in addition to the two hardened washers. Furnish erection bolts as part of Item 513.

Do not weld the cross frame members to the stiffeners until the concrete deck has been placed.

702.15 WELDED ATTACHMENTS

Provide the following note on plans for steel beam or girder bridges:

[82] WELD ATTACHMENT of supports for concrete deck finishing machine to areas of the fascia stringer flanges designated "Compression". Do not weld attachments to areas designated "Tension". Fillet welds to compression flanges shall be at least 1" [25 mm] from edge of flange, be no more than 2" [50 mm] long, and be at least 1/4" [6 mm] for thicknesses up to 3/4" [19 mm] or 5/16" [8 mm] for greater than 3/4" [19 mm] thick.

702.16 SCREED ELEVATION TABLES

Screed elevation tables are required for concrete decks on structural steel beams, structural steel girders, prestressed I-beams and composite deck box beams. General criteria for screed elevation tables are defined in section 302.2.3. Refer to Figure 703 for an example screed table for structural steel members and Figure 704 for an example screed table for composite box beams.

702.16.1 SCREED ELEVATION TABLES – STRUCTURAL STEEL MEMBERS

In lieu of a table format, the designer may supply screed elevations through the use of a deck plan view showing elevations and stations of the points required in section 302.2.3.

In addition to the screed elevation table or diagram, provide a screed elevation note similar to the one below to describe the elevations that are given.

[83] SCREED ELEVATIONS shown are for the deck slab surface prior to concrete placement. Allowance has been made for anticipated calculated dead load deflections.

702.16.2 SCREED ELEVATION TABLES – PRESTRESSED I-BEAM MEMBERS

See the requirements of 702.16.1 for example tables, notes and format.

702.16.3 SCREED ELEVATION TABLES – COMPOSITE BOX BEAM MEMBERS

In lieu of a table format, the designer may supply screed elevations through the use of a deck plan view showing elevations and stations of the points required in section 302.2.3.

In addition to the screed elevation table or diagram, provide a screed elevation note similar to **[83]** to describe the elevations that are given.

D. Top elevation of barrier sound line. This elevation will normally be the same throughout the length of the wall. The Office of Environmental Services will specify the required elevation and elevation changes, if required.

E. The finished ground line and bottom of barrier elevations.

F. A noise barrier general summary containing all bid items and any required noise barrier material type alternate bids.

G. Plan notes and details to assure the aesthetic requirements of 802.2

H. Special plan details required to show features such as noise barriers on structures; locations of utilities, special access for fire hydrants, termination at structures, (such as bridges, culverts, overhead sign supports) and details not covered by the Department's "Noise Barrier Design" plan insert sheets,

I. Subsurface investigation plan sheets including borings

J. The Department's "Noise Barrier Design" plan insert sheets, revised as follows:

1. List only the approved suppliers for the material noise barrier types authorized for the project and any alternate bid noise barrier material types authorized for the project.

2. Clearly list the foundation depth for each drilled shaft throughout the total project length.

3. Because Plan Insert Sheets are not standard drawings, the sheets shall be numbered as normal plan sheets for incorporation into final set of contract plans.

K. A copy of the Office of Environmental Services requirements for location and height of noise barrier walls.

L. The District Production Administrator should be contacted for the approved noise barrier material types, suppliers, alternate bid requirements, and special features in accordance with the Department's Noise Wall Policy 417-001(P). A copy of the letter from the District Production Administrator stipulating the information in this paragraph should be part of the detailed design submission.

804 NOISE BARRIERS – APPROVAL OF WALL DESIGNS

The Department does not have a standard design for noise barrier panels. The Department's plan insert sheets do establish standard designs for posts and foundations.

Individual manufacturers submit panel designs and those designs, if approved, are added to the plan inserts sheets. A modification to an approved wall design requires a resubmission to the

Department for approval. The Department will not allow a modified design to be used on a construction project prior to its approval.

Environmental, structural and acoustic design for the walls shall meet the requirements of 805.1, 805.2 and 805.3 of this manual.

There are two types of noise barriers, reflective and absorptive. Noise barrier manufacturers interested in having their noise barrier wall approved should submit their proposed designs in accordance with 805.

805 NOISE BARRIER SUBMISSION REQUIREMENTS

Manufacturers interested in having their noise barrier design approved shall submit an approval package to the Office of Environmental Services.

As a minimum, the submission package shall show compliance with the following design requirements:

A. Environmental.....Section 805.1
B. Structural.....Section 805.2
C. Material.....Section 805.3

Submit three copies of the complete submission package to the Office of Environmental Services. Include the specific product trade name; company address; and name, phone number, and email address of a technical representative available to answer questions during the product review period. The Department will evaluate the submission and provide a written decision to the manufacturer no later than 20 working days after the submission package is received.

805.1 ENVIRONMENTAL DESIGN REQUIREMENTS

The Manufacturer's wall system shall show compliance with the Department's Aesthetic limitations provided in Section 802.2 and the following Acoustic requirements:

A. Reflective noise barriers - Minimum TL (Transmission Loss) = 22 dBA

B. Absorptive noise barriers:

1. Minimum TL (Transmission Loss) = 22 dBA
2. Minimum NRC (Noise Reduction Coefficient) = 0.70

All barrier material submitted shall be acoustically tested at an independent laboratory capable of performing the following tests:

A. ASTM Standard Test Method for Sound Absorption and Sound Absorption Coefficients by Reverberation Room Method

B. ASTM C423 and E795 (Latest editions)

C. ASTM E90 and E413 (Latest editions)

805.2 STRUCTURAL DESIGN REQUIREMENTS

As a minimum, the structural design of the Manufacturer's wall system shall conform to the 17th Edition of the AASTHO "Standard Specifications for Highway Bridges", 2002; the AASHTO "Guide Specifications for Structural Design of Noise Barriers", 1989, including all interims; the Department's "Noise Barrier Details" plan insert sheets; and this Manual.

The structural design submission shall also include:

A. All design assumptions including:
   1. Physical and mechanical strengths of the component raw materials
   2. Physical and mechanical strengths of the final composite material
   3. Design method(s) and governing specifications used
   4. Design safety factors used including information on why the factors were chosen and how the material's environmental and loading durability affect those factors.

B. Complete design calculations:
   1. Signed, sealed and dated by a registered professional engineer
   2. Using the following minimum wind pressures:
      a. Roadway barriers = 25 psf [1.2 kPa]
      b. Bridge barriers = 30 psf [1.4 kPa]
   3. Include all fabrication, shipping, handling and erection loads

C. Fabrication and construction drawings showing wall details, dimensions, connections and any other information required to define the wall system.

The following list provides the minimum design data for standard materials:

A. Reinforced Concrete ..... f'c = 4000 psi [27.5 MPa]
B. Prestressed Concrete ..... f'ci = 4000 psi [27.5 MPa]
   f'c = 5500 psi [34.5 MPa]
C. Structural Steel ..... fy = 50,000 psi [345 MPa]
D. Prestressing Strand (Low-relaxation) ..... f's = 270 ksi [1860 MPa]
E. Reinforcing Steel ..... fy = 60,000 psi [413 MPa]
F. Timber ..... fb = 1500 psi [10.3 MPa]

805.3 MATERIAL DESIGN REQUIREMENTS

The material design submission shall include:

A. Test data documenting the physical and mechanical properties used for structural design.
B. Test data documenting any long term decrease in physical and/or mechanical properties due to fatigue, creep, bond deterioration, etc.
C. Test data documenting material durability to environmental variables including: UV, temperature, moisture, freeze-thaw, fire, salt, petroleum, pH, etc.
D. Test data documenting material's performance to temperature changes expected under service conditions.
E. Test data documenting durability of any applied coatings used to protect material from environmental deterioration.

SECTION 900 – BRIDGE LOAD RATING

901 INTRODUCTION

For the purpose of this section following definitions shall be used:

Bridge: All structures under the pavement of a roadway that have a total length, measured along the centerline of the roadway, of 10 ft. [3.048 m] or more.

Pavement of a roadway: The pavement of a roadway includes all the paved or unpaved portions of a roadway including graded shoulders that may support vehicular traffic.

Buried bridges: All structures including flat slabs, arch structures, frames, box sections, etc., that have a fill or pavement material of 2'-0" [600 mm] or more on top of the structures.

Non-buried bridges: All structures including flat slabs, arch structures, frames, box sections, etc., that have a fill or pavement material of less than 2'-0" [600 mm] on top of the structures.

OSE: ODOT Office of Structural Engineering

For load rating of buried bridges, see Section 904.

For load rating of non-buried bridges, see Section 905.

For analysis for special or Superload see Section 908.

902 LOADS TO BE USED FOR LOAD RATING

The analysis shall be performed for AASHTO HS20-44 [MS 18] (truck & lane) loading for both inventory and operating levels, and for four Ohio Legal Loads (2F1, 3F1, 4F1, and 5C1) at operating level, according to Figure 901.

All trucks used for analysis shall have transverse spacing, between centerline of wheels or wheel groups, of 6 ft. [1.830 m].

903 UNIT WEIGHTS & DENSITIES

The following assumptions should be made while performing the load rating analysis, unless more accurate site information is available:

A. Unit weight of soil ..... 120 lb/ft^3 [18.9 kN/m^3]
B. Unit weight of asphalt..... 145 lb/ft^3 [22.8 kN/m^3]

C. Unit weight of concrete ..... 150 lb/ft^3 [23.6 kN/m^3]
D. Unit weight of latex modified concrete ..... 150 lb/ft^3 [23.6 kN/m^3]
E. Water density ..... 62.4 lb/ft^3 [9.8 kN/m^3]

904 LOAD RATING OF BURIED STRUCTURES

904.1 GENERAL

A. All bridges that have the pavement or the fill material of 2'-0" [600 mm] or more on top of the structure shall be load rated according to the provisions of this Section.

B. Complete structure shall be load rated for the Loads as per Section 902.

C. Exception List: Following types of buried structures shall not be load rated under the provisions of this Section.

1. Circular metal pipes
2. Circular plastic pipes
3. Circular concrete pipes
4. Buried metal boxes
5. Buried metal frames
6. Junction chambers
7. Manholes
8. Inlets

904.2 LOAD RATING OF NEW BURIED BRIDGES

904.2.1 CAST-IN-PLACE BOX & FRAME STRUCTURES

A. Cast-in-place bridges shall be load rated by the designer of the bridge.
B. BRASS-Culvert program shall be used to load rate the structure. For the BRASS-Culvert Analysis, see Section 910.

904.2.2 PRECAST BOXES

904.2.2.1 PRECAST BOXES OF SPAN GREATER THAN 12' [3.6 m]

A. The load rating analysis will be performed by the OSE.
B. BRASS-Culvert program shall be used to load rate the structure. For the BRASS-Culvert Analysis, see Section 910.

904.2.2.2 PRECAST BOXES OF SPAN EQUAL TO OR LESS THAN 12’ [3.6 m]

A. Manufacturer shall submit the actual information about the dimensions and reinforcing bars/cage to the OSE along with the shop drawings before the placement of structure.
B. The load rating analysis will be performed by the OSE.

904.2.3 PRECAST FRAMES, ARCHES, AND CONSPANS & BEBO TYPE STRUCTURES

A. The load rating analysis will be performed by the manufacturer.
B. Load rating report shall be submitted along with the shop drawings before the placement of the precast units.
C. Use the design software to load rate the structure.

904.3 LOAD RATING OF BURIED BRIDGES TO BE REHABILITATED

904.3.1 CAST-IN-PLACE STRUCTURES

A. Cast-in-place bridges shall be load rated by the designer of the bridge.
B. BRASS-Culvert program shall be used to load rate the structure. For the BRASS-Culvert Analysis, see Section 910.

904.3.2 PRECAST BOXES

904.3.2.1 PRECAST BOXES OF SPAN GREATER THAN 12’ [3.6 m]

A. The load rating analysis will be performed by the OSE.
B. BRASS-Culvert program shall be used to load rate the structure. For the BRASS-Culvert Analysis, see Section 910.

904.3.2.2 PRECAST BOXES OF SPAN EQUAL TO OR LESS THAN 12’ [3.6 m]

A. Manufacturer shall submit information about the actual thicknesses and reinforcing bars/cage to the OSE along with the shop drawings before the placement of precast structure.
B. The load rating analysis will be performed by the OSE.

904.3.3 PRECAST FRAMES, ARCHES, AND CONSPANS & BEBO TYPE STRUCTURES

A. The load rating analysis for any new or replacement precast sections will be performed by the manufacturer, otherwise the load rating analysis will be performed as per the scope of

services.

B. Load rating report shall be submitted along with the shop drawings before the placement of the units.
C. Use the design software to load rate the structure.

904.4 LOAD RATING OF EXISTING BURIED BRIDGES

A. The load rating analysis will be performed as per the Scope of Services.
B. Unless specified otherwise, structure shall be load rated for the Loads as per Section 902.

904.5 LOAD RATING REPORT SUBMISSION

The load rating report shall be submitted to the District office(s). The submission shall include two (2) printed copies and one electronic copy of the Load Rating Report. The Load Rating Reports shall be signed, sealed and dated by an Ohio Registered Engineer.

The District Bridge Engineer will send one printed copy, an electronic copy of the report, the electronic data files and a copy of the final bridge plans to the OSE. The electronic data files from the District may be sent together with a copy of the report on a PC compatible computer disk, CD-ROM or separate from the report as an attachment to an E-mail message.

The report must list final inventory and operating ratings of the buried structure summarized in a tabular form. The ratings of each member and the overall ratings of the structure shall be presented for each live load truck given in Figure 901.

An example of a Load Rating Report Summary is given as Figure 908.

The inventory and operating ratings shall be expressed in terms of the AASHTO HS20-44 loading (English Units), rounded off to the nearest single decimal point.

For existing bridges, the report shall state how the material properties were determined. Any specific details about the current conditions and bridge geometry shall be listed.

All hand calculations should be a part of the report.

905 LOAD RATING OF NON-BURIED STRUCTURES

905.1 GENERAL

All structures including flat slabs, arch structures, frames, box sections, etc., having a fill or pavement material of less than 2’-0” [600 mm] on top of the structures shall be load rated according to the provisions of this Section.

All main structural members of the superstructure affected by live load shall be analyzed.

Superstructure shall be load rated for the Loads as per Section 902.

905.2 SOFTWARE TO BE USED FOR LOAD RATING

Use only the AASHTO BARS-PC (BARS-PC) computer program to load rate all bridges listed in Figures 902 and 903. The Department will not accept load ratings performed using other rating software products for bridges listed in Figures 902 and 903.

For analysis requirements using BARS-PC see Section 909.

BRASS-Culvert software shall be used for the analysis of concrete box sections and three sided concrete frames. For analysis requirements using BRASS-Culvert see Section 910.

Contact the OSE prior to using any computer program other than AASHTO BARS-PC or BRASS-Culvert.

For the analysis of arches and other special structures that cannot be modeled using BARS-PC, the current version of one of the following computer programs shall be used. Contact the OSE prior to using any of these computer programs for load rating purpose.

A. AASHTO Virtis - A load rating and analysis product developed by AASHTO (www.aashto.org).

B. BRASS - A bridge rating and design analysis program developed by the Wyoming Department of Transportation: (http://wydotweb.state.wy.us/docs/brass/brass.html).

C. DESCUS I - Design and Analysis of Curved I-girder Bridge Systems, marketed by OPTI-MATE, Inc. (www.opti-mate.com)

D. SAP 90 / SAP 2000 - Finite element analysis programs by Computers & Structures, Inc., 1995, University Ave., Berkeley, CA 94704 (www.csiberkeley.com).

E. STAAD - III/Pro - Finite element analysis programs for structural analysis, marketed by Research Engineers, Inc., 22700 Savi Ranch, Yorba Linda, CA 92887. (www.reiworld.com).

905.3 ANALYSIS OF CONCRETE BOX SECTIONS & FRAMES

Unless more accurate soil data exits, calculate the rating based on a lateral pressure of 60 lb/ft^2 [2.9 kPa].

2 ft [600 mm] of earth fill shall be assumed as live load surcharge on all structures as per

AASHTO 3.20.3 unless the provisions of AASHTO 3.20.4 apply.

Effect of soil-structure interaction shall be taken into account as per AASHTO 16.6.4.2

Assume hinged connections between the walls and the top and bottom slabs unless there is adequate reinforcing steel continuous between the slab and the walls at the joint. In that case continuity between the slab and the walls can be assumed.

Perform load rating of new structures according to Section 904.2.

Perform load rating of structures to be rehabilitated according to Section 904.3.

Perform load rating of existing structures according to Section 904.4.

905.4 LOAD RATING OF NEW BRIDGES

905.4.1 HOW THE LOAD RATING SHALL BE DONE

The designer shall analyze and load rate all spans which are designed to carry vehicular traffic.

The load rating analysis shall be based on the final design plans. At the inventory level, the load rating shall be equal to or greater than the design loading.

All members shall have actual net section and current conditions incorporated into the member's analysis.

Bridge members designed as non-composite with the deck slab should be analyzed as non-composite.

All dead loads are to be calculated based on the actual field conditions. Future dead loads shall not be applied, unless directed otherwise.

Live load distribution factors, as defined in the current AASHTO Standard Specifications for Highway Bridges, shall be used.

Continuous reinforced concrete slabs shall be rated using the live load distribution factor for the shortest span.

All analyses shall be performed using the Load Factor or Strength Design (LF) method. The load factors as defined in AASHTO shall be applied.

All bridges shall be rated for Inventory and Operating conditions. The inventory load rating condition refers to the stresses at the design level and reflects the customary conditions under normal operation. The operating load rating condition generally defines the maximum

permissible live load to which the structure may be subjected (AASHTO Manual for Condition Evaluation of Bridges).

Refer to ODOT Procedure No.: 518-001 (P), "Rating of Bridges and Posting for Reduced Load Limits," in the Appendix (AP-1, Rating of Bridges and Posted Loads) and at Structure Rating web site (http://www.dot.state.oh.us/srg/) for rating procedures.

905.4.2 WHEN THE BRIDGE LOAD RATING SHALL BE DONE

The load rating of new bridges shall be done as per following:

905.4.2.1 BRIDGES DESIGNED UNDER MAJOR OR MINOR PLAN DEVELOPMENT PROCESS

For bridges designed under the Major or Minor Plan Development Process (PDP), perform the load rating and include the load rating report in the Stage 2 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 2 and prior to contract sale, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

905.4.2.2 BRIDGES DESIGNED UNDER MINIMAL PLAN DEVELOPMENT PROCESS

For bridges designed under the Minimal Plan Development Process (PDP), perform the load rating and include the load rating report in the Stage 3 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 3 and prior to contract sale, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

905.4.2.3 BRIDGES DESIGNED UNDER MINOR DESIGN-BUILD PROCESS

For bridges designed as part of a Minor Design-Build project, perform the load rating and include the load rating report in the Stage 2 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 2, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

905.4.2.4 BRIDGES DESIGNED UNDER MINIMAL DESIGN-BUILD PROCESS

For bridges designed as part of a Minimal Design-Build project, perform the load rating and

include the load rating report in the Stage 3 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 3, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

905.4.2.5 BRIDGES DESIGNED UNDER VALUE ENGINEERING CHANGE PROPOSAL

For bridges re-designed under a Value Engineering Change Proposal (VECP), perform a load rating of the altered bridge design and submit the load rating report to the District Construction Engineer (DCE) with the Final VECP submission. The DCE will supply this information to the District Bridge Engineer.

905.5 LOAD RATING OF BRIDGES TO BE REHABILITATED

905.5.1 HOW THE LOAD RATING SHALL BE DONE

The designer shall analyze and load rate all spans which are designed to carry vehicular traffic.

The load rating analysis shall be based on the final design plans. At the inventory level, the load rating shall be equal to or greater than the design loading.

All members shall have actual net section and current conditions incorporated into the member's analysis. Any known section losses, defects or damage to the existing structural members shall be considered in the rating analysis.

Bridge members designed as non-composite with the deck slab should be analyzed as non-composite.

Structures to be rehabilitated shall be analyzed using the original design plans, the actual field conditions, and all major changes in the final rehabilitation plans.

A complete review of all the available inspection information as well as a thorough site inspection of the existing bridge must be performed to establish the current conditions prior to proceeding with the analysis.

Future wearing surface dead loads shall not be applied, unless directed otherwise.

Live load distribution factors, as defined in the current AASHTO Standard Specifications for Highway Bridges, shall be used.

Continuous reinforced concrete slabs shall be rated using the live load distribution factor for the shortest span.

All analyses shall be performed using the Load Factor or Strength Design (LF) method. The load factors as defined in AASHTO shall be applied.

All bridges shall be rated for Inventory and Operating conditions. The inventory load rating condition refers to the stresses at the design level and reflects the customary conditions under normal operation. The operating load rating condition generally defines the maximum permissible live load to which the structure may be subjected (AASHTO Manual for Condition Evaluation of Bridges).

The analysis shall be performed for AASHTO HS20-44 [MS 18] loading for both inventory and operating conditions, and for four Ohio Legal Loads (2F1, 3F1, 4F1, and 5C1) at operating level according to Figure 901.

Allowable stresses for the working stress and the ultimate or yield strengths of materials for Load Factor ratings shall be as specified on the original design plans, unless it is required in the scope of services to conduct specific tests to determine the material strengths.

For existing bridges, the rater should review the original design plans as the first source of information for material strengths and stresses. If the material strengths are not explicitly stated on the design plans, ODOT Construction and Material Specifications (CMS) applicable at the time of the bridge construction shall be reviewed. This may require investigations into old ASTM or AASHTO Material Specifications active at the time of construction.

Figures 904 and 905 provide general information about ODOT Allowable Stresses in bending and shear and material strengths based on the year of construction. These material properties are different from those given in AASHTO BARS Manual 2, Appendix A. However, they are used as default values in the BARS-PC customization file prepared by ODOT, which is available from Structure Rating website. Any material stresses and specifications specified on the design plans shall supersede the values given in Figures 904 and 905.

The rater is cautioned to pay extra attention to the design plans and the year of construction, when determining material strengths for structures built during transition years of Figures 904 and 905 (e.g., for member type SS, years 1964-68, or 1988-93, etc.), as materials may have been substituted.

Refer to ODOT Procedure No.: 518-001 (P), “Rating of Bridges and Posting for Reduced Load Limits,” in the Appendix (AP-1, Rating of Bridges and Posted Loads) and at Structure Rating web site (http://www.dot.state.oh.us/srg/) for rating procedures.

905.5.2 WHEN THE BRIDGE LOAD RATING SHALL BE DONE

The load rating of bridges to be rehabilitated shall be done as per following:

905.5.2.1 BRIDGES DESIGNED UNDER MAJOR OR MINOR PLAN DEVELOPMENT PROCESS

For bridges designed under the Major or Minor Plan Development Process (PDP), perform the load rating and include the load rating report in the Stage 2 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 2 and prior to contract sale, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

905.5.2.2 BRIDGES DESIGNED UNDER MINIMAL PLAN DEVELOPMENT PROCESS

For bridges designed under the Minimal Plan Development Process (PDP), perform the load rating and include the load rating report in the Stage 3 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 3 and prior to contract sale, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

905.5.2.3 BRIDGES DESIGNED UNDER MINOR DESIGN-BUILD PROCESS

For bridges designed as part of a Minor Design-Build project, perform the load rating and include the load rating report in the Stage 2 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 2, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

905.5.2.4 BRIDGES DESIGNED UNDER MINIMAL DESIGN-BUILD PROCESS

For bridges designed as part of a Minimal Design-Build project, perform the load rating and include the load rating report in the Stage 3 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 3, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

905.5.2.5 BRIDGES DESIGNED UNDER VALUE ENGINEERING CHANGE PROPOSAL

For bridges re-designed under a Value Engineering Change Proposal (VECP), perform a load rating of the altered bridge design and submit the load rating report to the District Construction Engineer (DCE) with the Final VECP submission. The DCE will supply this information to the

District Bridge Engineer.

905.6 LOAD RATING OF EXISTING BRIDGES

905.6.1 HOW THE LOAD RATING SHALL BE DONE

The rater shall analyze and load rate all spans which are designed to carry vehicular traffic.

Existing structures shall be analyzed using the information from the original design plans and the actual field conditions.

A complete review of all the available inspection information as well as a thorough site inspection of the existing bridge must be performed to establish the current conditions prior to proceeding with the analysis.

The bridges rated using design plans shall be noted as such in the load rating report.

Allowable stresses for the working stress and the ultimate or yield strengths of materials for Load Factor ratings shall be as specified on the original design plans, unless it is required in the scope of services to conduct specific tests to determine the material strengths.

For existing bridges, the rater should review the original design plans as the first source of information for material strengths and stresses. If the material strengths are not explicitly stated on the design plans, ODOT Construction and Material Specifications (CMS) applicable at the time of the bridge construction shall be reviewed. This may require investigations into old ASTM or AASHTO Material Specifications active at the time of construction.

Figures 904 and 905 provide general information about ODOT Allowable Stresses in bending and shear and material strengths based on the year of construction.

The rater is cautioned to pay extra attention to the design plans and the year of construction, when determining material strengths for structures built during transition years of Figures 904 and 905 (e.g., for member type SS, years 1964-68, or 1988-93, etc.), as materials may have been substituted.

Any material stresses and specifications specified on the design plans shall supersede the values given in Figures 904 and 905.

Refer to ODOT Procedure No.: 518-001 (P), “Rating of Bridges and Posting for Reduced Load Limits,” in the Appendix (AP-1, Rating of Bridges and Posted Loads) and at Structure Rating web site (http://www.dot.state.oh.us/srg/) for rating procedures.

905.6.2 WHEN THE BRIDGE LOAD RATING SHALL BE DONE

The load rating of existing bridges shall be done as per the Scope of Services.

906 ANALYSIS OF BRIDGES WITH SIDEWALKS

Sidewalks shall have AASHTO live loads applied, but reduced by 50% to reflect the actual service conditions.

907 ANALYSIS OF MULTILANE LOADING

Traffic lanes to be used for rating purposes, shall be the actual marked travel lanes.

AASHTO reduction factors for multiple lane loadings shall be applied where appropriate.

For rating analysis of floor beams, trusses, non-redundant girders or other non-redundant main structural members, position identical rating vehicles in one or more of the through traffic lanes on the bridge, spaced and shifted laterally on the deck, within the traffic lanes, so as to produce the maximum stress in the member under consideration.

908 ANALYSIS FOR SPECIAL OR SUPERLOAD

When a structure is required, in the Scope of Services, to be analyzed for special or Superload vehicle, a second analysis shall be performed for a single lane loading of the special or Superload vehicle condition. The special or Superload vehicle shall be placed laterally on the structure to produce maximum stresses in the critical member under consideration.

The analysis for special or Superload vehicle shall be performed at the operating level only.

909 LOAD RATING ANALYSIS USING BARS-PC

909.1 GENERAL

The BARS-PC is the PC version of the AASHTO BARS (Bridge Analysis and Rating System) program that can analyze and load rate structures based on the AASHTO Specifications.

BARS-PC program installation disks and User Manuals are available for use on ODOT Projects, from the OSE.

The OSE will provide limited technical support to install and execute the program.

The types of material, methods of construction and types of section that can be handled by BARS-PC are provided in Figure 902.

The types of bridge member that can be analyzed and rated by the BARS-PC are provided in Figure 903.

The BARS-PC program operates using English units. Input values taken from metric plans will have to be converted to English units.

Figures 904 and 905 provide general information about ODOT Allowable Stresses in bending and shear and material strengths based on the year of construction. These material properties are different from those given in AASHTO BARS Manual 2, Appendix A. However, they are used as default values in the BARS-PC customization file prepared by ODOT, which is available from Structure Rating website. Any material stresses and specifications specified on the design plans shall supersede the values given in Figures 904 and 905.

The rater is cautioned to pay extra attention to the design plans and the year of construction, when determining material strengths for structures built during transition years of Figures 904 and 905 (e.g., for member type SS, years 1964-68, or 1988-93, etc.), as materials may have been substituted.

909.2 SYSTEM REQUIREMENTS

Hardware Requirements:

A. Minimum Configuration
   386 - 12 MHz with math co-processor
   6 MB RAM
   60MB disk drive (uncompressed)
   3.5" high-density diskette drive
   EGA display adapter
   Keyboard
   Mouse

B. Optimum Configuration
   Pentium or compatible CPU
   32 MB RAM
   150 MB free space on hard drive (uncompressed)
   3.5" disk drive & CD-ROM Drive
   VGA or SVGA display adapter
   Keyboard
   Mouse

Software Requirements: (any of the following)

A. Windows 3.11 (with MS-DOS 5.0 or higher)

B. Windows 9X
C. Windows NT 3.51 and NT 4.0
D. Windows 2000
E. Windows XP PRO

909.3 BARS-PC ANALYSIS – GENERAL GUIDELINES

All information in a BARS-PC input data file shall be entered in uppercase with "Caps Lock ON."

The first six digits from left of the Structural File Number (SFN) of the bridge with prefix "R" and extension "dat" shall be used as the input data file name. The same first six digits of the SFN shall be used as Structure Group ID No. on all BARS-PC data input cards. For example, if the SFN of a bridge is 4729854, the input file name should be named as "R472985.DAT" and the Structure Group ID No. will be "472985."

If a SFN has not been assigned to a new structure, contact Structure Inventory Section in the OSE to get a SFN for the structure.

All BARS-PC input files shall have the word "NEW" in columns 9-11 and the letter "X" in column 17 of card type AA.

All BARS-PC input files shall have the bridge rater's initials and company/office abbreviations in the columns 15-22 of card type 01 and columns 9-16 of card type 02.

All structures rated by BARS-PC using LF method shall have letter "L" in column 65 of card type 05.

All structures rated by BARS-PC shall have letter "F" in column 66 of card type 05.

All structures rated using BARS program shall have a three-digit Structure Type Code in columns 41-46 of card type 02. The three-digit code shall be selected based on the material, type and the description of the main members according to Figure 906. For example, Concrete Slab Continuous shall be coded as "112" and Steel Beam Simple Span shall be coded as "321."

The complete seven digit SFN shall be entered in columns 9-16 of card type 05.

The original loading used for the design of the bridge shall be stated on card type 06.

The assumptions made to model a structural member or unit for computer analysis shall also be stated on card type 06.

The live load distribution factors for the single lane loading shall be given on the card type 6.

If space on card type 06 (maximum of six cards of type 06) is not sufficient, additional information can be included with the load rating report for ODOT review.

BARS (mainframe) and BARS-PC programs do not recognize standard steel rolled beams, Prestressed I-girder or Prestressed box beam sections. Standard rolled beams shall be coded on card type 12 in terms of flange and web plates. Prestressed I-girders and box beams shall be coded on card type 15 with special attention given to the type, area and strength of the prestressing strands.

When using BARS-PC to load rate multi-span prestressed structures, each member shall be analyzed as a simply supported member.

909.4 BARS-PC LOAD RATING REPORT SUBMISSION

The load rating report shall be submitted to the District office(s). The submission shall include two (2) printed copies and one electronic copy of the Load Rating Report and one copy of the electronic input data files. The Load Rating Reports shall be signed, sealed and dated by an Ohio Registered Engineer.

The District Bridge Engineer will send one printed copy, an electronic copy of the report, the electronic data files and a copy of the final bridge plans to the OSE. The electronic data files from the District may be sent together with a copy of the report on a PC compatible computer disk, CD-ROM or separate from the report as an attachment to an E-mail message.

The report must list final inventory and operating ratings of each main bridge member, overall ratings of each structure unit (mainline, ramps, etc.), and the final ratings of the entire bridge summarized in a tabular form. The ratings of each member and the overall ratings of the structure shall be presented for each live load truck given in Figure 901.

An example of a Load Rating Report Summary is given as Figure 908.

The inventory and operating ratings shall be expressed in terms of the AASHTO HS20-44 loading (English Units), rounded off to the nearest single decimal point.

For existing bridges, the report shall state how the material properties were determined. Any specific details about the current conditions and bridge geometry shall be listed.

All hand calculations should be a part of the report.

909.5 BARS-PC COMPUTER INPUT AND OUTPUT FILES

In addition to the electronic input data file, each copy of the rating report shall also include hard (printed) copies of the computer input and output files.

Some computer programs generate several output files during the process of analysis. Include those files that contain information. For example, the load rating analysis report of a steel beam bridge using BARS-PC shall contain printed copies of the following files:

A. lista.lis
B. rate2.lis
C. summary.lis
D. flex.lis

910 LOAD ANALYSIS USING BRASS-CULVERT PROGRAM

910.1 GENERAL

BRASS (Bridge Rating and Analysis System) is a family of several structural analysis modules, such as BRASS-Culvert, BRASS-Girder, BRASS-Pole, etc. BRASS-Culvert program can be used to analyze reinforced concrete three-sided flat-topped frames and four-sided box sections.

If haunch dimensions are different, use the smallest dimension in the analysis.

BRASS can run on any Microsoft Windows compatible machine.

BRASS data files should use the same naming convention as the BARS-PC data files.

BRASS Vehicle library can be customized to include ODOT Legal Loads (See Figure 909).

910.2 BRASS CAPABILITIES

BRASS program can analyze single-cell and multi-cell reinforced concrete box structures and frames.

Technical support on BRASS program is available to the BRASS licensed users from the Wyoming Department of Transportation.

910.3 BRASS LOAD RATING REPORT SUBMISSION

The load rating report shall be submitted to the District office. The submission shall include two (2) printed copies and one electronic copy of the Load Rating Report and one copy of the electronic input data files. The Load Rating Reports shall be signed, sealed and dated by an Ohio Registered Engineer.

The District Bridge Engineer will send one printed copy, an electronic copy of the report, the electronic data files and a copy of the final bridge plans to the OSE. The electronic data files

from the District may be sent together with a copy of the report on a PC compatible computer disk, CD-ROM or separate from the report as an attachment to an E-mail message.

The report must list final inventory and operating ratings of each main bridge member, overall ratings of each structure unit (mainline, ramps, etc.), and the final ratings of the entire bridge summarized in a tabular form. The ratings of each member and the overall ratings of the structure shall be presented for each live load vehicle according to Figure 901.

An example of a Load Rating Report Summary is given as Figure 908.

The inventory and operating ratings shall be expressed in terms of the AASHTO HS20-44 loading (English Units), rounded off to the nearest single decimal point.

For existing bridges, the report shall state how the material properties were determined. Any specific details about the current conditions and bridge geometry shall be listed.

All hand calculations should be a part of the report.

910.4 BRASS COMPUTER INPUT AND OUTPUT FILES

Submit electronic copies of the input & output files with extensions “dat,” “cus” and “xml.”

In addition to the electronic input data file, each copy of the rating report shall also include hard (printed) copies of the computer input and output files.

911 REFERENCES

A. AASHTO, 1978, “Guide Specifications for Fracture Critical Non-Redundant Steel Bridge Members,” and all subsequent Interims.

B. AASHTO, 1983, “Manual for Maintenance Inspection of Bridges.”

C. AASHTO, 1989, “Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges.”

D. AASHTO, 1990, “Guide Specifications for Fatigue Evaluation of Existing Steel Bridges,” and all subsequent Interims.

E. AASHTO, 2000, “Manual for Condition Evaluation of Bridges,” and all subsequent Interims.

F. BRASS-Culvert software developed by the Wyoming Department of Transportation (PO Box 1708, Cheyenne, WY 82003).

G. Duncan, J.M., 1979, “Design Studies For Aluminum Structural Plate Box Culverts,” Kaiser Aluminum and Chemical Sales, Inc.

H. NCSPA, “Load Rating & Structural Evaluation of In-Service Corrugated Steel Structures,” & Design Data Sheet No. 19, National Corrugated Steel Pipe Association (NCSPA, 202-452-1700).

I. SRG, Structure Rating Group Website http://www.dot.state.oh.us/srg/

APPENDIX – MISC. BRIDGE INFORMATION

APPENDIX PURPOSE

The Bridge Design Manual's appendix serves three purposes.

A. One is to serve as a repository for special plan notes that are infrequently used or subject to frequent revision. These notes are generally large and detailed documents. When a bridge design requires the use of appendix notes one of two methods should be used to incorporate the notes into the project plans. One, the designer transfers the notes to plan sheets for inclusion into the bridge plans. The second method is to treat the note as un-numbered proposal note. This method requires the designer to include with the bid item(s) a reference to the proposal and supply electronic versions, or typed hard copies, of the note with the final plan submission. If the proposal note method is used, the designer shall ensure the notes are presentable, that it is clear what notes are to be used as proposal notes, and that the agency receiving the completed plans understands the notes must be included in the project's actual proposal. The choice of methods is the option of the owner.

B. The second purpose is to serve as a historical archive for old plan notes, old general notes or old proposal notes which are no longer active or not recommended for use.

C. The third purpose is to serve a repository for special bridge policy criteria and other items of similar concept.

AN-1 ARES RETAINING WALLS BY TENSAR

The following un-numbered note should be part of any project allowing the use of the Ares Retaining Wall System. The designer shall revise this note to meet project conditions and forward the revised note for inclusion into the project as Special Provisions.

Included on Figure APP-1 [APP-1M] are standard details for the MSE wall coping and MSE wall mounted deflector parapet. The designer is required to include these details in the plans along with all additional details required to define: location, reinforcing, contraction and expansion joints, and other details specific to the project to construct the copings on the top of the MSE walls.

1.0 GENERAL

This work consists of designing the internal stability of the wall; preparing shop drawings; and fabricating and constructing Tensar Ares precast panel retaining walls. This work also includes excavation for the wall; the construction of the wall leveling pad, engineered backfill, backfill drainage and concrete traffic barrier; and placement of concrete sealer. In this specification, the subject, "the Bidder" or "the Contractor" is understood.

2.0 MATERIALS

Furnish the Tensar Ares Retaining Wall System, including the soil reinforcement, precast facing panels, joint materials and all necessary incidentals from:

Tensar Earth Technologies, Inc.
5775-B Glenridge Drive, Suite 450
Atlanta, GA 30328
Phone (404)250-1290.

The Department will not accept precast concrete elements from manufacturers that are not certified by the Office of Material Management according to Supplement 1073.

2.1 REINFORCED CONCRETE FACING PANELS

The materials shall conform to the following:

Portland cement 701.02, 701.04, 701.05
Reinforcing steel 709.00
Microsilica 701.10
Ground granulated blast furnace slag (GGBFS) 701.11
Fly ash 701.13
Fine aggregate 703.02
Coarse aggregate 703.02

Air-entraining admixture 705.10
Chemical admixtures 705.12

2.1.1 CONCRETE PROPORTIONING

Mix the concrete according to CMS 499. Proportion the concrete materials to provide a minimum compressive strength of 5000 psi [34.5 Mpa]. The air content shall be 6 ± 2 percent. Add an approved corrosion inhibiting admixture at the approved dosage.

2.1.2 CONCRETE TESTING

During the production of the concrete panels, the Manufacturer shall randomly sample the concrete in accordance with ASTM C 172. A single compressive strength sample shall consist of a minimum of four test cylinders for each production lot. A production lot consists of either 40 panels or a single day's production, whichever is less. Compressive strength testing shall conform to Supplement 1073.

2.1.3 CASTING

Prior to casting, the Manufacturer shall place the reinforcing steel, soil reinforcement attachment devices, inserts and lifting devices to the dimensions and tolerance shown on the shop drawings. The Manufacturer shall cast the panels on a flat area, with the front face down. To prevent the formation of stone pockets, air bubbles or cleavage planes, the Manufacturer shall place the concrete in each unit without interruption and shall consolidate the concrete with a vibrator, supplemented by hand-tamping as necessary to force the concrete into the corners of the forms. The Manufacturer shall use a clear form oil approved by the Tensar Earth Technologies Engineer and shall not substitute the form oil once the casting operation begins.

All forms shall remain in place until they can be removed without damage to the panel.

The final position of the soil reinforcement attachment devices shall be within 1 inch [25 mm] of their locations specified in the shop drawings. To ensure proper consolidation, the Manufacturer shall rap the attachment devices with a rubber mallet. No concrete or other debris shall be on the exposed portion of the attachment devices in the finished panels.

2.1.4 CURING

The Manufacturer's curing method shall be as prescribed by Tensar Earth Technologies. The cure time shall be of sufficient length such that the concrete will develop the minimum compressive strength specified in 2.1.1. Do not ship products from a production lot represented by strength tests that do not conform to the requirements of Section 2.1.1.

2.1.5 CONCRETE FINISH

The front face of the reinforced concrete panels shall have an architectural surface finish

treatment as shown on the shop drawings. The rear face of the reinforced concrete panels shall have an unformed surface finish and shall not have open pockets of aggregate and surface distortions in excess of 1/4 inch [6 mm]. Seal all panels with an epoxy-urethane sealer according to CMS 512.

2.1.6 TOLERANCES

All panels shall be fabricated to the following tolerances:

A. Panel Dimensions
   1. Position of the attachment device .....± 1" [25 mm]
   2. All other dimensions .....± 1/4" [5 mm]

B. Panel Squareness (difference between the two diagonals) .....± 1/2" [13 mm]

C. Panel Surface Finish (size of surface defect over a length of 5 ft [1.5 m])
   1. Smooth formed surfaces .....± 1/8" [3 mm]
   2. Textured finished surfaces .....± 5/16" [8 mm]

2.1.7 REJECTION

The Department will reject panels with any of the following:

A. Defects that indicate imperfect molding

B. Defects indicating honeycombed or open texture concrete

C. Defects in the physical characteristics of the concrete, such as broken or chipped concrete

D. Stained form face, due to excess form oil or other contaminants

E. Signs of aggregate segregation

F. Broken or cracked corners

G. Face panels that do not meet the tolerances specified in 2.1.6.

H. Misaligned, warped or unevenly embedded soil reinforcements that can not provide 100% positive connection to the embankment reinforcements.

I. Embedded soil reinforcements with visible ruptures to the ribs and junctions

I. Lifting inserts not useable

J. Exposed reinforcing steel

K. Cracks at soil reinforcement attachment devices

L. Insufficient concrete compressive strength

M. Panel thickness in excess of 3/16 inch [5 mm] from that shown on the plans

The Engineer will decide if an attempt may be made to repair a defective panel. The Contractor or supplier shall make the repairs at his own expense. If the repairs are made to the Engineer's satisfaction, the panel will be acceptable.

2.1.8 MARKING

The Manufacturer shall clearly mark the back surface of each panel with the date of manufacture, the production lot number and the piece-mark detailed in the shop drawings.

2.1.9 HANDLING, STORING AND SHIPPING

Handle, store, and ship panels in such a manner as to avoid chipping, cracking and fracturing the panels; excessive bending stresses; and damaging embedded soil reinforcements. Support panels on firm blocking while storing and shipping.

2.2 SOIL REINFORCEMENT

Furnish UX1600HS or US1700HS geogrid reinforcements supplied by Tensar Earth Technologies along with certified test data showing the minimum design requirements of Section 6.0 (H) have been met.

Check the geogrid upon delivery to ensure that the proper material has been received, and is free from defects that may impair its strength and durability. Store the geogrids in conditions above -20EF [-29EC] and not greater than 140EF [60EC]. Prevent excessive mud, wet cement, epoxy, and like materials from coming into contact with and affixing to the geogrid material. Store geogrid rolls laid flat or stood on end.

2.3 JOINT MATERIALS

2.3.1 BEARING PADS

In the horizontal joints between the reinforced concrete facing panels, install at least two bearing pads per panel at a uniform spacing. The bearing pads shall be neoprene elastomeric pads having a durometer hardness of 55 ± 5, high density polyethylene pads with a minimum density of 59 lb/ft^3 [0.946 g/cm^3] or equivalent. Supply certified test data to the Engineer upon delivery of the material to the project.

2.3.2 JOINT COVER

Cover all joints between panels on the back side of the wall with a geotextile material meeting the minimum requirements for filtration applications as specified by AASHTO M288. The minimum width and lap shall be 1'-0" [300 mm]. The adhesive used to attach the geotextile material to the panels shall be Pliobond 5001, as manufactured by Goodyear Rubber Company or equal as approved by Tensar Earth Technologies. Supply certified test data to the Engineer upon delivery of the geotextile material to the project.

2.4 SELECT GRANULAR EMBANKMENT

The select granular embankment material in the reinforced soil mass shall be CMS 304 Aggregate Base or CMS 703.11 Structural Backfill Type 2; except as follows:

A. The material shall not contain slag.

B. The pH range of the material shall be between 4.5 and 9.0 according to the AASHTO T 289-91 method.

Take all acceptance samples from the stockpile. Transport and handle the material to minimize the segregation of the material prior to the placement.

Furnish the Engineer a Certificate of Compliance from an independent Testing Laboratory, certifying that the above material complies with this specification and a copy of all test results performed for contract compliance. The Engineer will accept the material based upon a visual inspection of the material and a review of the Certificate of Compliance and all test reports.

2.5 CONCRETE LEVELING PAD

The leveling pad may be unreinforced cast-in-place concrete or reinforced precast concrete. The concrete shall be at least 6 inches [150 mm] thick and have a minimum compressive strength of 2500 psi [17.2 Mpa]. Cure the cast-in-place concrete for a minimum of 12 hours prior to placing the first row of facing panels.

2.6 BACKFILL DRAINAGE

Furnish porous backfill, CMS 518, with filter fabric, CMS 712.09 Type B, and 6 inch [150 mm] perforated plastic pipe, 707.33, as shown in the plans. The pipe shall be continuous and sloped to provide a positive gravity flow.

2.7 CONCRETE COPING

The coping shall be cast-in-place, Class C concrete, in accordance with CMS 511. The Department will not accept precast concrete copings. Reinforcing steel shall be epoxy coated meeting the requirements of CMS 509. Seal the concrete coping with an epoxy-urethane sealer

in accordance with CMS 512.

3.0 DETAIL DRAWINGS

Prepare detail drawings and design calculations in accordance with the 17th Edition of the AASHTO *Standard Specifications for Highway Bridges* and this specification. In the event of a conflict, this specification will govern.

The detail drawings shall include the following information:

A. A site plan for the full length of the retaining wall

B. An elevation view of the full length of the retaining wall showing the location of each individually labeled facing panels

C. The soil reinforcement lengths

D. Representative cross-sections at each design change

E. Backfill drainage details

F. Actual bearing pressures

G. Allowable bearing pressures

H. Design life

I. Angle of internal friction of select granular material

An Ohio Registered Engineer shall sign, seal and date the detail drawings, design calculations and acceptance letter provided in the appendix of this provision.

Thirty (30) days prior to the commencement of wall construction, submit to the Engineer: two copies of the detail drawings on 11" x 17" sheets; two copies of the design calculations; and the signed acceptance letter. The Engineer will submit the drawings, calculations and acceptance letter to the Office of Structural Engineering (OSE) for information. Department approval is not required.

Ensure that the shop drawings meet the requirements for materials, field measurements, construction requirements and contract requirements. Coordinate details of the work to be performed by other entities on the project. The Department will not make allowance for additional cost or delays to the Contractor for incorrect fabrication as a result of failure to coordinate or perform this coordination. Submit two copies of the shop drawings on 11" x 17" sheets to the Engineer with the delivery of the materials to the project. Department approval of the shop drawings is not required.

The Manufacturer shall maintain record fabrication drawings according to Supplement 1073 for each panel design produced.

4.0 CONSTRUCTION REQUIREMENTS

4.1 WALL EXCAVATION

Perform wall excavation to the bottom of the leveling pad and reinforced soil mass in accordance with CMS 503.

4.2 UNDERCUT AND BACKFILL

Remove unsuitable foundation soils below the reinforced soil mass to the limits shown in the project plans or as directed by the Engineer. Use the select granular embankment material, section 2.4, for backfill and compact according to CMS 203.06 and 203.07.

4.3 FOUNDATION PREPARATION

For a width equal to or exceeding the width of the reinforced soil mass, level and compact the foundation soil according to CMS 203.05.

4.4 WALL ERECTION

Place concrete panels as shown on the accepted detail drawings. Lift panels from the lifting devices set into the upper edge of each panel. Place panels and backfill in successive horizontal lifts according to the sequence shown on the detail drawings. Use external bracing as necessary for the initial lift. As the backfill material is placed behind the panels, maintain the panels in vertical position by means of temporary wooded wedges placed in the panel joints on the external side of the wall. Remove the wedges as soon as the panel above the wedged panel is completely erected and backfilled.

For vertical walls, vertical tolerances (plumbness) and horizontal alignment tolerances shall not exceed 3/4 inch [20 mm] when measured along 10 feet [3000 mm] straight edge. The maximum allowable offset in any panel joint shall be 3/4 inch [20 mm]. For vertical walls, the overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed ½ inch [13 mm] per 10 feet [3000 mm] of wall height.

Place soil reinforcement perpendicular to the wall facing unless otherwise shown on the plans or directed by the Engineer. Attach the reinforcement to the facing panel as directed by the manufacturer's guidelines. Prior to placement of the granular backfill, ensure that the reinforcement is continuous from the wall panel to the end of the reinforcing zone; pulled taut with enough force to eliminate wrinkles or folds; and held in a manner approved by the manufacturer. Do not splice the soil reinforcement or operate equipment directly on the soil reinforcement.

4.5 SELECT GRANULAR EMBANKMENT MATERIAL CONSTRUCTION

The placement of the select granular embankment material shall closely follow the erection of each lift of facing panels. Place the select granular embankment material level up to the elevation of the soil reinforcement before attaching the soil reinforcements to the back of the precast panels. Attach and place soil reinforcements according to the recommendations of Tensar Earth Technologies, Inc.

Construct the reinforced soil mass according to CMS 203.06 and 203.07. Place the granular backfill in loose lifts not exceeding 8 inches [200 mm]. Decrease the lift thickness as necessary to obtain the specified density.

At the end of each day's operations, shape the last level of embankment to rapidly direct rain water runoff away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction site.

Compact the reinforced zone of fill without disturbing or distorting the soil reinforcement and facing panels. Place the embankment material within 3 feet [1000 mm] of the backside of the panels in 6 to 8 inch thick lifts and compact this area by at least 3 passes of a light mechanical tamper. This area does not have to satisfy density test requirements.

4.6 EMBANKMENT CONSTRUCTION

Construct embankment within the plan specified limits of the proprietary wall embankment and outside the plan specified limits of the select granular embankment material, according to CMS 203.

4.7 PILE SLEEVES

Pile sleeves are required when piles are located inside the reinforced soil mass. Install piles through sleeves after the wall construction has been completed. The sleeve material shall be corrugated smooth lined pipe, 707.33 or 707.42. Maintain alignment of the pile sleeve during construction of the embankment. Place a bentonite slurry in the void located between the pile and the sleeve. The slurry shall consist of one part cement, one part bentonite and ten parts water.

5.0 PROJECT INSPECTION

Tensar Earth Technologies shall provide a company representative to monitor the precast operation and ensure that the requirements of this specification are met. The representative shall submit all documentation to the Engineer when the panels are delivered to the project.

Tensar Earth Technologies shall provide on-site technical assistance to ensure that the Contractor and the Engineer understand the construction procedures and operations of the wall system.

Hire an independent soils consultant to ensure the placement and compaction of the select granular embankment material is in compliance with the requirements of this specification. The soil consultant shall provide the Engineer with two copies of all inspection reports signed by an Ohio Registered Professional Engineer.

The Engineer will inspect the material delivered to the site; review certified test data; monitor the erection of the structure and placement of the select granular embankment material; and consult with the soils consultant and Tensar Earth Technologies as necessary for acceptance to the requirements of this specification.

6.0 DESIGN REQUIREMENTS FOR MSE PANEL WALLS

The design of the Tensar Ares Retaining Wall shall be in strict conformance with the 17th edition of the *AASHTO Standard Specifications for Highways and Bridges*, 2002, and the design requirements listed below:

A. The design shall meet all of the plan requirements. The recommendations of the wall system suppliers shall not override the minimum performance requirements shown herein. Do not submit other systems offered by the approved supplier in lieu of the system which is called for in the plans.

B. Where walls or wall sections intersect with an included angle of 130 degrees or less, a vertical corner element, separate from the standard panel face, shall abut and interact with the opposing standard panels. The corner element shall have geogrid reinforcement connected specifically to that panel and be designed to preclude lateral spread of the intersecting panels.

C. One hundred percent of the geogrid reinforcement designed and placed in the reinforced earth volume shall extend to and be connected to the facing element through the use of sleeve or another acceptable method. The Department will allow field cutting of the geogrid reinforcement where it interferes with an obstacle, provided that Tensar and the Engineer approve of the cutting and a detail for the partial removal of the geogrid has been designed and shown in the plans.

D. Under service loads the minimum factor of safety at the connection between the face panel and the geogrid reinforcement shall be 1.5 as defined in AASHTO Section 5.8.7.2. The minimum factor of safety against reinforcement pullout shall be 1.5 at ½ inch [13 mm] deformation. The maximum allowable reinforcement tension shall not exceed the LTDS of the geogrid, using criteria set by the AASHTO Standard Specifications.

E. Compute the coefficient of lateral earth pressure Ka and the application of the lateral forces to the reinforced soil mass for external stability analysis using the Coulomb method, but assuming no wall friction.

F. Soil parameters for use in design are as follows:

Fill Zone	Type of Soil	Soil Unit Weight	Friction Angle	Cohesion
Reinforced Zone	Compacted Select Granular Embankment Material with less than 7% P200 Material	120 lbs/ft^3 [18.9 kN/m^3]	34^o	0
Retained Soil	On-site soil varying from sandy lean clay to silty sand	120 lbs/ft^3 [18.9 kN/m^3]	30^o	0
Foundation Soil	Variable - ranging from existing uncontrolled fill to natural silty sand	120 lbs/ft^3 [18.9 kN/m^3]	30^o	0

G. Design all walls with coping as specified in the plans.

H. The allowable reinforcement tension for polymeric (extensible) reinforcement shall be based on AASHTO Section 5.8.7.2. Apply the following reduction factors to the Tensar HDPE geogrid soil reinforcements for determination of the allowable long term design strength, T_{al}, based on the type of backfill used in the reinforced zone.

TENSAR STRUCTURAL GEOGRIDS FOR ARES WALLS, AASHTO STANDARD SPECIFICATIONS				
	UX1600HS		UX1700HS	
$T_{ALL} = T_{ULT} / RF_{CR} \times RF_{ID} \times R_{FD}$				
Ultimate Strength lb/ft [kN/m]	9000 [131.3]		10800 [157.6]	
Calculated Creep Reduction Factor, RF_{CR}	3.1		3.1	
Durability, RF_D	1.1		1.1	
Installation Damage, RF_{ID}	1.25		1.25	

I. The design life of the mechanically stabilized earth retaining wall system shall be 100 years.

J. Compute the internal stability, including the definition of the failure plane and the lateral earth pressure coefficient, for Tensar Ares retaining walls with extensible reinforcement according to AASHTO Section 5.8.4.1, including the use of the Coherent Gravity Method.

K. The minimum thickness of the concrete leveling pad shall be 6 inch [150 mm] .

L. The connections for the geogrid reinforcement to the panels shall be in two places for standard panels and the connections shall be no more than 2.5 feet [750 mm] apart vertically.

M. The wall height for design purposes shall be measured from the top of the leveling pad to the top of the coping. When the wall is retaining a sloping surcharge then the wall height shall

be defined as the equivalent design height (h) as shown in AASHTO Figure 5.8.2B. The minimum geogrid reinforcement length shall be 70 percent of the wall height, as appropriately defined for either a level or sloping backfill, but no less than 8 feet [2400 mm].

N. The minimum thickness for the precast reinforced concrete panels shall be 6 inch [150 mm].

O. The wall system, regardless of the size of the panels shall accommodate up to one percent differential settlement along the length of the wall in the longitudinal direction.

P. Compute the vertical stress at each reinforcement level by considering local equilibrium of all the forces acting above the level under investigation. The vertical stress (bearing pressure) at each reinforcement level may be computed using the Meyerhoff method in the same manner that the bearing pressure is computed at the base.

Q. The minimum length of wall between leveling pad elevation changes shall be 9'-0" [2.75 m].

7.0 METHOD OF MEASUREMENT

The Department will measure the Ares Retaining Wall System by the number of square feet [square meter]. The Department will determine the area of the wall system from plan dimensions using a length measured along the outside of the uppermost facing panels and a height from the bottom of the concrete leveling pad to the top of the concrete coping. If a traffic barrier is provided atop the concrete coping, the height will be measured to the bottom of the traffic barrier. The Department will not adjust pay quantities to account for variations in the concrete leveling pad elevations required to accommodate actual panel placement.

The Department will measure the Ares Retaining Wall System on a lump sum basis when shown on the plans.

The Department will measure undercut and backfill on a lump sum basis.

The Department will measure concrete coping by the number of feet [meter] from plan dimensions as measured along the outside of the uppermost facing panels.

8.0 BASIS OF PAYMENT

The Department will pay for undercut and backfill quantities beyond the limits shown in the plans as Extra Work, as described in 109.04.

The Department will pay for the costs of concrete traffic barriers and sealers placed on traffic barriers under a separate pay item.

If a separate pay item for Cofferdams, Cribs and Sheeting is not included in the Contract, the Department will pay for cofferdams, cribs and sheeting under the contract unit price for the Ares Retaining Wall System.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
Special	Square Foot [Square Meter]	Ares Retaining Wall System.
Special	Lump Sum	Ares Retaining Wall System
Special	Lump Sum	Undercut and Backfill
Special	Foot [Meter]	Concrete Coping
Special	Foot [Meter]	Concrete Coping including Sleeper Slab

MSE Wall Acceptance Letter

Project No.:	
Wall No.:	

Design Data	
Design Life	100 yrs
Angle of Internal Friction – Reinforced Zone	34º
Actual Bearing Pressure at base of reinforced soil mass	
Allowable Bearing Pressure at base of reinforced soil mass (Reproduced from project plans)	

I hereby certify that the design calculations for the internal stability of the mechanically stabilized earth retaining structure and the detail drawings included in this construction submission are in complete conformance with the AASHTO Standard Specifications for Highway Bridges, 17th Edition, 2002 and the MSE wall special provisions. I further certify that the design data provided above and data assumed for the design calculation submitted herein is accurate for the above referenced wall.

Engineer's Seal	
Signature:	
Date:	

(Provide an MSE Wall Acceptance Letter for each wall designated in the project plans.)

AN-2 REINFORCED EARTH WALLS

The following un-numbered note should be part of any project allowing the use of the Reinforced Earth Wall System. The designer must revise this note to meet project conditions and forward the revised note for inclusion into the project as Special Provisions.

Included on Figure APP-1 [APP-1M] are standard details for the MSE wall coping and MSE wall mounted deflector parapet. The designer is required to include these details in the plans along with all additional details required to define, location, reinforcing, contraction and expansion joints, and other details specific to the project to construct the copings on the top of the MSE walls.

1.0 GENERAL

This work consists of designing the internal stability of the wall; preparing shop drawings; and fabricating and constructing Reinforced Earth Retaining Walls. This work also includes excavation for the wall; the construction of the wall leveling pad, engineered backfill, backfill drainage and concrete traffic barrier; and placement of concrete sealer. In this specification, the subject, "the Bidder" or "the Contractor" is understood.

2.0 MATERIALS

Furnish the Reinforced Earth Retaining Walls, including the soil reinforcement, precast facing panels, joint materials and all necessary incidentals from:

The Reinforced Earth Company
1444 N. Farnsworth Ave., #505
Aurora, Illinois 60505
(630)898-3334

The Department will not accept precast concrete elements from manufacturers that are not certified by the Office of Material Management according to Supplement 1073.

2.1 REINFORCED CONCRETE FACING PANELS

The materials shall conform to the following:

Portland cement 701.02, 701.04, 701.05
Reinforcing steel 709.00
Microsilica 701.10
Ground granulated blast furnace slag (GGBFS) 701.11
Fly ash 701.13
Fine aggregate 703.02
Coarse aggregate 703.02
Air-entraining admixture 705.10

Chemical admixtures 705.12

Tie strip material shall conform to ASTM A1011[M], Grade 50 [345], galvanized according to 711.02.

2.1.1 CONCRETE PROPORTIONING

Mix the concrete according to CMS 499. Proportion the concrete materials to provide a minimum compressive strength of 4000 psi [27.5 Mpa]. The air content shall be 6 ± 2 percent. Add an approved corrosion inhibiting admixture at the approved dosage.

2.1.2 CONCRETE TESTING

During the production of the concrete panels, the Manufacturer shall randomly sample the concrete in accordance with ASTM C 172. A single compressive strength sample shall consist of a minimum of four test cylinders for each production lot. A production lot consists of either 40 panels or a single day's production, whichever is less. Compressive strength testing shall conform to Supplement 1073.

2.1.3 CASTING

Prior to casting, the Manufacturer shall place the reinforcing steel, soil reinforcement attachment devices, lifting devices and PVC alignment pipes to the dimensions and tolerance shown on the shop drawings. The PVC pipe shall be straight, not bent or bowed. The Manufacturer shall cast the panels on a flat area, with the front face down. To prevent the formation of stone pockets, air bubbles or cleavage planes, the Manufacturer shall place the concrete in each unit without interruption and shall consolidate the concrete with a vibrator, supplemented by hand-tamping as necessary to force the concrete into the corners of the forms. The Manufacturer shall use a clear form oil approved by the Retained Earth Engineer and shall not substitute the form oil once the casting operation begins.

All forms shall remain in place until they can be removed without damage to the panel.

The final position of the soil reinforcement attachment devices (i.e. tie strips) shall be within 1 inch [25 mm] of their locations specified in the shop drawings. No concrete or other debris shall be on the exposed portion of the attachment devices in the finished panels.

2.1.4 CURING

The Manufacturer's curing method shall be as prescribed by the Retained Earth Company. The cure time shall be of sufficient length such that the concrete will develop the minimum compressive strength specified in 2.1.1. Do not ship products from a production lot represented by strength tests that do not conform to the requirements of Section 2.1.1.

2.1.5 CONCRETE FINISH

The front face of the reinforced concrete panels shall have an architectural surface finish treatment as shown on the shop drawings. The rear face of the reinforced concrete panels shall have an unformed surface finish and shall not have open pockets of aggregate and surface distortions in excess of 1/4 inch [6 mm]. Seal all panels with an epoxy-urethane sealer according to CMS 512.

2.1.6 TOLERANCES

All panels shall be fabricated to the following tolerances:

A. Panel Dimensions:
   1. Position of the attachment device .....± 1" [25 mm]
   2. All other dimensions .....± 3/16" [5 mm]

B. Panel Squareness (difference between the two diagonals) .....± 1/2" [13 mm]

C. Panel Surface Finish (size of surface defect over a length of 5 ft [1.5 m])
   1. Smooth formed surfaces .....± 1/8" [3 mm]
   2. Textured finished surfaces .....± 5/16" [8 mm]

2.1.7 REJECTION

The Department will reject panels with any of the following:

A. Defects that indicate imperfect molding

B. Defects indicating honeycombed or open texture concrete

C. Defects in the physical characteristics of the concrete, such as broken or chipped concrete

D. Stained form face, due to excess form oil or other contaminants

E. Signs of aggregate segregation

F. Broken or cracked corners

G. Face panels that do not meet the tolerances specified in 2.1.6.

H. Tie strips bent or damaged

I. Lifting inserts not useable

J. Exposed reinforcing steel

K. Cracks at the PVC pipe or pin

L. Insufficient concrete compressive strength

M. Panel thickness in excess of 3/16 inch [5 mm] from that shown on the plans

The Engineer will decide if an attempt may be made to repair a defective panel. The Contractor or supplier shall make the repairs at his own expense. If the repairs are made to the Engineer's satisfaction, the panel will be acceptable.

2.1.8 MARKING

The Manufacturer shall clearly mark the back surface of each panel with the date of manufacture, the production lot number and the piece-mark detailed in the shop drawings.

2.1.9 HANDLING, STORING AND SHIPPING

Handle, store, and ship panels in such a manner as to avoid chipping, cracking and fracturing the panels; excessive bending stresses; and damaging the soil reinforcement attachment devices. Support panels on firm blocking while storing and shipping.

2.2 SOIL REINFORCEMENT

The soil reinforcement material shall conform to ASTM A572[M], Grade 65 [475], galvanized according to 711.02 and shaped according to the shop drawing. The fasteners shall be galvanized, ½ inch [13 mm] diameter, hexagonal cap screw bolts and nuts, conforming to 711.09 (ASTM A325[M]).

2.3 JOINT MATERIALS

2.3.1 BEARING PADS

In the horizontal joints between the reinforced concrete facing panels, install at least two bearing pads per panel at a uniform spacing. The bearing pads shall be neoprene elastomeric pads having a durometer hardness of 55 ± 5, high density polyethylene pads with a minimum density of 59 lb/ft^3 [0.946 g/cm^3] or equivalent. Supply certified test data to the Engineer upon delivery of the material to the project.

2.3.2 JOINT COVER

Cover all joints between panels on the back side of the wall with a geotextile material meeting the minimum requirements for filtration applications as specified by AASHTO M288. The minimum width and lap shall be 1'-0" [300 mm]. The adhesive used to attach the geotextile material to the panels shall be Pliobond 5001, as manufactured by Goodyear Rubber Company or

equal as approved by the Reinforced Earth Company. Supply certified test data to the Engineer upon delivery of the geotextile material to the project.

2.4 ALIGNMENT PINS

The pins used to align the face panels during construction shall be round, smooth number 5 bars made of mild steel or smooth 3/4 [19 mm] diameter PVC rod.

2.5 SELECT GRANULAR EMBANKMENT

The select granular embankment material in the reinforced soil mass shall be CMS 304 Aggregate Base or CMS 703.11 Structural Backfill Type 2; except as follows:

A. The material shall not contain slag.

B. The material shall conform to AASHTO T 289-91 with a pH range between 4.5 and 9.0.

C. The material shall conform to AASHTO T 288-91 with a resistivity greater than 3,000 ohm-cm. If the resistivity is greater than 5,000 ohm-cm, AASHTO T 290-95 and T 291-94 may be waived.

D. The material shall conform to AASHTO T 291-94 with chloride levels less than 100 ppm.

E. The material shall conform to AASHTO T 290-95 with sulfate levels less than 200 ppm.

Take all acceptance samples from the stockpile. Transport and handle the material to minimize the segregation of the material prior to the placement.

Furnish the Engineer a Certificate of Compliance from an independent Testing Laboratory, certifying that the above material complies with this specification and a copy of all test results performed for contract compliance. The Engineer will accept the material based upon a visual inspection of the material and a review of the Certificate of Compliance and all test reports.

2.6 CONCRETE LEVELING PAD

The leveling pad may be unreinforced cast-in-place concrete or reinforced precast concrete. The concrete shall be at least 6 inches [150 mm] thick and have a minimum compressive strength of 2500 psi [17.2 Mpa]. Cure the cast-in-place concrete for a minimum of 12 hours prior to placing the first row of facing panels.

2.7 BACKFILL DRAINAGE

Furnish porous backfill, CMS 518, with filter fabric, CMS 712.09 Type B, and 6 inch [150 mm] perforated plastic pipe, 707.33, as shown in the plans. The pipe shall be continuous and sloped to provide a positive gravity flow.

2.8 CONCRETE COPING AND SLEEPER SLAB

The coping and sleeper slab shall be cast-in-place, Class C concrete, in accordance with CMS 511. The Department will not accept precast concrete copings. Reinforcing steel shall be epoxy coated meeting the requirements of CMS 509. Seal the concrete coping with an epoxy-urethane sealer in accordance with Supplemental Specification 864.

3.0 DETAIL DRAWINGS

Prepare detail drawings and design calculations in accordance with the 17th Edition of the AASHTO *Standard Specifications for Highway Bridges* and these provisions. In the event of a conflict, this specification will govern.

The detail drawings shall include the following information:

A. A site plan for the full length of the retaining wall

B. An elevation view of the full length of the retaining wall showing the location of each individually labeled panel section

C. The soil reinforcement lengths

D. Representative cross-sections at each design change

E. Backfill drainage details

F. Actual bearing pressures

G. Allowable bearing pressures

H. Design life

I. Angle of internal friction of select granular material

An Ohio Registered Engineer shall sign, seal and date the detail drawings, design calculations and acceptance letter provided in the appendix of this provision.

Thirty (30) days prior to the commencement of wall construction, submit to the Engineer: two copies of the detail drawings on 11" x 17" sheets; two copies of the design calculations; and the signed acceptance letter. The Engineer will submit the drawings, calculations and acceptance letter to the Office of Structural Engineering (OSE) for information. Department approval is not required.

Ensure that the shop drawings meet the requirements for materials, field measurements, construction requirements and contract requirements. Coordinate details of the work to be

performed by other entities on the project. The Department will not make allowance for additional cost or delays to the Contractor for incorrect fabrication as a result of failure to coordinate or perform this coordination. Submit two copies of the shop drawings on 11" x 17" sheets to the Engineer with the delivery of the materials to the project. Department approval of the shop drawings is not required.

The Manufacturer shall maintain record fabrication drawings according to Supplement 1073 for each standard panel design produced.

4.0 CONSTRUCTION REQUIREMENTS

4.1 WALL EXCAVATION

Perform wall excavation to the bottom of the leveling pad and reinforced soil mass in accordance with CMS 503.

4.2 UNDERCUT AND BACKFILL

Remove unsuitable foundation soils below the reinforced soil mass to the limits shown in the project plans or as directed by the Engineer. Use the select granular embankment material, section 2.4, for backfill and compact according to CMS 203.06 and 203.07.

4.3 FOUNDATION PREPARATION

For a width equal to or exceeding the width of the reinforced soil mass, level and compact the foundation soil according to Item 203.05.

4.4 WALL ERECTION

Place concrete panels as shown on the accepted detail drawings. Lift panels from the lifting devices set into the upper edge of each panel. Place panels and backfill in successive horizontal lifts according to the sequence shown on the detail drawings. Use external bracing as necessary for the initial lift. As the backfill material is placed behind the panels, maintain the panels in vertical position by means of temporary wooded wedges placed in the panel joints on the external side of the wall. Remove the wedges as soon as the panel above the wedged panel is completely erected and backfilled.

For vertical walls, vertical tolerances (plumbness) and horizontal alignment tolerances shall not exceed 3/4 inch [20 mm] when measured along 10 feet [3000 mm] straight edge. The maximum allowable offset in any panel joint shall be 3/4 inch [20 mm]. For vertical walls, the overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed ½ inch [13 mm] per 10 feet [3000 mm] of wall height.

Place soil reinforcement perpendicular to the wall facing unless otherwise shown on the plans or directed by the Engineer. Attach the reinforcement to the facing panel as directed by the

manufacturer's guidelines. Prior to placement of the granular backfill, ensure that the reinforcement is continuous from the wall panel to the end of the reinforcing zone; pulled taut with enough force to eliminate wrinkles or folds; and held in a manner approved by the manufacturer. Do not splice the soil reinforcement or operate equipment directly on the soil reinforcement.

4.5 SELECT GRANULAR EMBANKMENT PLACEMENT

The placement of the select granular embankment material shall closely follow the erection of each lift of facing panels. Place the select granular embankment material level up to the elevation of the soil reinforcement before attaching the soil reinforcements to the back of the precast panels. Attach and place soil reinforcements according to the recommendations of The Reinforced Earth Company.

Construct the reinforced soil mass according to CMS 203.06 and 203.07. Place the granular backfill in loose lifts not exceeding 8 inches [200 mm]. Decrease the lift thickness as necessary to obtain the specified density.

At the end of each day's operations, shape the last level of embankment to rapidly direct rain water runoff away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction site.

Compact the reinforced zone of fill without disturbing or distorting the soil reinforcement and facing panels. Place the embankment material within 3 feet [1000 mm] of the backside of the panels in 6 to 8 inch thick lifts and compact this area by at least 3 passes of a light mechanical tamper. This area does not have to satisfy density test requirements.

4.6 EMBANKMENT CONSTRUCTION

Construct embankment within the plan specified limits of the proprietary wall embankment and outside the plan specified limits of the select granular embankment material, according to CMS 203.

4.7 PILE SLEEVES

Pile sleeves are required when piles are located inside the reinforced soil mass. Install piles through sleeves after the wall construction has been completed. The sleeve material shall be corrugated smooth lined pipe, 707.33 or 707.42. Maintain alignment of the pile sleeve during construction of the embankment. Place a bentonite slurry in the void located between the pile and the sleeve. The slurry shall consist of one part cement, one part bentonite and ten parts water.

5.0 PROJECT INSPECTION

The Reinforced Earth Company shall provide a company representative to monitor the precast

operation and ensure that the requirements of this specification are met. The representative shall submit all documentation to the Engineer when the panels are delivered to the project.

The Reinforced Earth Company shall provide on-site technical assistance to ensure that the Contractor and the Engineer understand the construction procedures and operations of the wall system.

Hire an independent soils consultant to ensure the placement and compaction of the select granular embankment material is in compliance with the requirements of this specification. The soil consultant shall provide the Engineer with two copies of all inspection reports signed by an Ohio Registered Professional Engineer.

The Engineer will inspect the material delivered to the site; review certified test data; monitor the erection of the structure and placement of the select granular embankment material; and consult with the soils consultant and the Reinforced Earth Company as necessary for acceptance to the requirements of this specification.

6.0 DESIGN REQUIREMENTS FOR MSE PANEL WALLS

The design of the Reinforced Earth Wall shall be in strict conformance with the 17th edition of the AASHTO *Standard Specifications for Highway Bridges*, 2002, and the design requirements listed below:

A. The design shall meet all plan requirements. The recommendations of the wall system suppliers shall not override the minimum performance requirements shown herein. Other systems offered by the approved supplier shall not be submitted in lieu of the system which is called for in the plans.

B. Where walls or wall sections intersect with an included angle of 130 degrees or less, a vertical corner element separate from the standard panel face shall abut and interact with the opposing standard panels. The corner element shall have steel reinforcing strips connected specifically to that panel and be designed to preclude lateral spread of the intersecting panels.

C. One hundred percent of the steel reinforcing strips which are designed and placed in the reinforced earth volume shall extend to and be connected to the facing element through the use of tie strips or another acceptable method. The Department will not allow field cutting of steel reinforcing strips to avoid obstacles, such as abutment piles. Also, steel reinforcing strips shall not be bent around such obstacles.

D. Under service loads, the minimum factor of safety at the connection between the face panel and the steel reinforcing strips shall be 1.5. The minimum factor of safety against reinforcement pullout shall be 1.5 at ½ inch [13 mm] deformation. The maximum allowable reinforcement tension shall not exceed two-thirds of the connection strength determined at ½ inch [13 mm] deformation.

E. Compute the coefficient of lateral earth pressure k_a and the application of the lateral forces to the reinforced soil mass for external stability analysis using the Coulomb method, but assuming no wall friction.

F. Design all walls with a coping as specified in the plans.

G. Soil parameters for use in design are as follows:

Fill Zone	Type of Soil	Soil Unit Weight	Friction Angle	Cohesion
Reinforced Zone	Compacted Select Granular Embankment Material with less than 7% P200 Material	120 lbs/ft^3 [18.9 kN/m^3]	34^o	0
Retained Soil	On-site soil varying from sandy lean clay to silty sand	120 lbs/ft^3 [18.9 kN/m^3]	30^o	0
Foundation Soil	Variable - ranging from existing uncontrolled fill to natural silty sand	120 lbs/ft^3 [18.9 kN/m^3]	30^o	0

H. The allowable reinforcement tension of steel (inextensible) reinforcement elements for structural design and connection (pullout) design shall be based on the thickness of the elements at the end of the structure's design life. In essence, the minimum thickness of the reinforcement elements shall be that thickness which will provide for the structural requirement plus the sacrificed thickness at the end of the design life.

I. The design life of the mechanically stabilized earth retaining wall system shall be 100 years.

J. Compute the internal stability, including definition of failure plane and lateral earth pressure coefficient, for Reinforced Earth walls according to AASHTO Section 5.8.4.1, including the use of the Coherent Gravity Method.

K. The minimum thickness of the concrete leveling pad shall be 6 inch [150 mm].

L. The connections of the reinforcing strips to the panels shall be in two elevations for standard panels and the connections shall be no more than 2.5 feet [750 mm] apart vertically.

M. The wall height for design purposes shall be measured from the top of the leveling pad to the top of the coping. When the wall is retaining a sloping surcharge then the wall height shall be defined as the equivalent design height (h) as shown in AASHTO Figure 5.8.2B. The minimum reinforcing strip length shall be 70 percent of the wall height, as appropriately defined for either a level or sloping backfill, but no less than 8 feet [2400 mm].

N. The minimum thickness of the precast reinforced concrete face panels shall be 5.5 inch [140 mm].

O. The yield strength (Fy) for the metallic soil reinforcement shall be 65 ksi [450 MPa].

P. The wall system, regardless of the size of panels, shall accommodate up to one percent differential settlement along the length of the wall in the longitudinal direction.

Q. Compute the vertical stress at each reinforcement level by considering local equilibrium of all the forces acting above the level under investigation. The vertical stress (bearing pressure) at each reinforcement level may be computed using the Meyerhof method in the same manner as the bearing pressure computed for the base of the wall.

R. The minimum length of wall between leveling pad elevation changes shall be 9'-0" [2.75 m].

7.0 METHOD OF MEASUREMENT

The Department will measure the Reinforced Earth Wall System by the number of square feet [square meter]. The Department will determine the area of the wall system from plan dimensions using a length measured along the outside of the uppermost facing panels and a height from the bottom of the concrete leveling pad to the top of the concrete coping. If a traffic barrier is provided atop the concrete coping, the height will be measured to the bottom of the traffic barrier. The Department will not adjust pay quantities to account for variations in the concrete leveling pad elevations required to accommodate actual panel placement.

The Department will measure the Reinforced Earth Wall System on a lump sum basis when shown on the plans.

The Department will measure undercut and backfill on a lump sum basis.

The Department will measure concrete coping by the number of feet [meter] from plan dimensions as measured along the outside of the uppermost facing panels.

8.0 BASIS OF PAYMENT

The Department will pay for undercut and backfill quantities beyond the limits shown in the plans as Extra Work, as described in 109.04.

The Department will pay for the costs of concrete traffic barriers and sealers placed on traffic barriers under a separate pay item.

If a separate pay item for Cofferdams, Cribs and Sheeting is not included in the Contract, the Department will pay for cofferdams, cribs and sheeting under the contract unit price for the Reinforced Earth Wall System.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
Special	Square Foot [Square Meter]	Reinforced Earth Wall System.
Special	Lump Sum	Reinforced Earth Wall System
Special	Lump Sum	Undercut and Backfill
Special	Foot [Meter]	Concrete Coping
Special	Foot [Meter]	Concrete Coping including Sleeper Slab

MSE Wall Acceptance Letter

Project No.:	
Wall No.:	

Design Data	
Design Life	100 yrs
Angle of Internal Friction – Reinforced Zone	34º
Actual Bearing Pressure at base of reinforced soil mass	
Allowable Bearing Pressure at base of reinforced soil mass (Reproduced from project plans)	

I hereby certify that the design calculations for the internal stability of the mechanically stabilized earth retaining structure and the detail drawings included in this construction submission are in complete conformance with the AASHTO Standard Specifications for Highway Bridges, 17th Edition, 2002 and the MSE wall special provisions. I further certify that the design data provided above and data assumed for the design calculation submitted herein is accurate for the above referenced wall.

Engineer's Seal	
Signature:	
Date:	

(Provide an MSE Wall Acceptance Letter for each wall designated in the project plans.)

AN-3 FOSTER GEOTECHNICAL RETAINED EARTH WALLS

The following un-numbered note should be part of any project allowing the use of the FG retained earth wall system. The designer must revise this note to meet project conditions and forward the revised note for inclusion into the project as Special Provisions.

Included on Figures APP-1 [APP-1M] are standard details for the MSE wall coping and MSE wall mounted deflector parapet. The designer is required to include these details in the plans along with all additional details required to define, location, reinforcing, contraction and expansion joints, and other details specific to the project to construct the copings on the top of the MSE walls.

1.0 GENERAL

This work consists of designing the internal stability of the wall; preparing shop drawings; and fabricating and constructing Foster Geotechnical Retained Earth walls. This work also includes excavation for the wall; the construction of the wall leveling pad, engineered backfill, backfill drainage and concrete traffic barrier; and placement of concrete sealer. In this specification, the subject, "the Bidder" or "the Contractor" is understood.

2.0 MATERIALS

Furnish the Foster Geotechnical Retained Earth walls, including the soil reinforcement, precast facing panels, joint materials and all necessary incidentals from:

Foster Geotechnical
Division of L.B. Foster Company
1372 Old Bridge Road, Suite 101
Woodbridge, Virginia 22192
(703)499-9818

The Department will not accept precast concrete elements from manufacturers that are not certified by the Office of Material Management according to Supplement 1073.

2.1 REINFORCED CONCRETE FACING PANELS

The materials shall conform to the following:

Portland cement 701.02, 701.04, 701.05
Reinforcing steel 709.00
Microsilica 701.10
Ground granulated blast furnace slag (GGBFS) 701.11
Fly ash 701.13
Fine aggregate 703.02
Coarse aggregate 703.02

Air-entraining admixture 705.10
Chemical admixtures 705.12

Loop Insert material shall conform to ASTM A510[M] or ASTM A82, welded according to ASTM A185 and galvanized according to 711.02.

Connector bar material shall conform to 709.08 and be galvanized according to 711.02.

2.1.1 CONCRETE PROPORTIONING

Mix the concrete according to CMS 499. Proportion the concrete materials to provide a minimum compressive strength of 4000 psi [27.5 Mpa]. The air content shall be 6 ± 2 percent. Add an approved corrosion inhibiting admixture at the approved dosage.

2.1.2 CONCRETE TESTING

During the production of the concrete panels, the Manufacturer shall randomly sample the concrete in accordance with ASTM C 172. A single compressive strength sample shall consist of a minimum of four test cylinders for each production lot. A production lot consists of either 40 panels or a single day's production, whichever is less. Compressive strength testing shall conform to Supplement 1073.

2.1.3 CASTING

Prior to casting, the Manufacturer shall place the reinforcing steel, soil reinforcement attachment devices, lifting devices and PVC alignment pipes to the dimensions and tolerance shown on the shop drawings. The PVC pipe shall be straight, not bent or bowed. The Manufacturer shall cast the panels on a flat area, with the front face down. To prevent the formation of stone pockets, air bubbles or cleavage planes, the Manufacturer shall place the concrete in each unit without interruption and shall consolidate the concrete with a vibrator, supplemented by hand-tamping as necessary to force the concrete into the corners of the forms. The Manufacturer shall use a clear form oil approved by the Foster Geotechnical Engineer and shall not substitute the form oil once the casting operation begins.

All forms shall remain in place until they can be removed without damage to the panel.

The Manufacturer shall attach all coil loop inserts to an alignment template using bolts provided with the forms. The final position of the soil reinforcement attachment devices shall be within 1/8 inch [3 mm] of their locations specified in the shop drawings. The holes inside the coil loop inserts shall be 2 3/8 inches [60 mm] deep in the finished panel. No concrete or other debris shall be on the exposed portion of the attachment devices in the finished panels. Immediately after the alignment template is removed, the Manufacturer shall place duct tape over the coil loop insert holes to prevent debris from collecting inside. Do not remove the duct tape until the wall is assembled.

2.1.4 CURING

The Manufacturer's curing method shall be as prescribed by Foster Geotechnical. The cure time shall be of sufficient length such that the concrete will develop the minimum compressive strength specified in 2.1.1. Do not ship products from a production lot represented by strength tests that do not conform to the requirements of Section 2.1.1.

2.1.5 CONCRETE FINISH

The front face of the reinforced concrete panels shall have an architectural surface finish treatment as shown on the shop drawings. The rear face of the reinforced concrete panels shall have an unformed surface finish and shall not have open pockets of aggregate and surface distortions in excess of 1/4 inch [6 mm]. Seal all panels with an epoxy-urethane sealer according to CMS 512.

2.1.6 TOLERANCES

All panels shall be fabricated to the following tolerances:

A. Panel Dimensions:
   1. Position of the attachment device .....± 1/8" [3 mm]
   2. All other dimensions .....± 3/16" [5 mm]

B. Panel Squareness (difference between the two diagonals) .....± 1/2" [13 mm]

C. Panel Surface Finish (size of surface defect over a length of 5 ft [1.5 m])
   1. Smooth formed surfaces .....± 1/8" [3 mm]
   2. Textured finished surfaces .....± 5/16" [8 mm]

2.1.7 REJECTION

The Department will reject panels with any of the following:

A. Defects that indicate imperfect molding

B. Defects indicating honeycombed or open texture concrete

C. Defects in the physical characteristics of the concrete, such as broken or chipped concrete

D. Stained form face, due to excess form oil or other contaminants

E. Signs of aggregate segregation

F. Broken or cracked corners

G. Face panels that do not meet the tolerances specified in 2.1.6.

H. Lifting inserts not useable

I. Exposed reinforcing steel

J. Cracks at the PVC pipe or pin

K. Insufficient concrete compressive strength

L. Panel thickness in excess of 3/16 inch [5 mm] from that shown on the plans

The Engineer will decide if an attempt may be made to repair a defective panel. The Contractor or supplier shall make the repairs at his own expense. If the repairs are made to the Engineer's satisfaction, the panel will be acceptable.

2.1.8 MARKING

The Manufacturer shall clearly mark the back surface of each panel with the date of manufacture, the production lot number and the piece-mark detailed in the shop drawings.

2.1.9 HANDLING, STORING AND SHIPPING

Handle, store, and ship panels in such a manner as to avoid chipping, cracking and fracturing the panels; excessive bending stresses; and damaging the soil reinforcement attachment devices. Support panels on firm blocking while storing and shipping.

2.2 SOIL REINFORCEMENT

The soil reinforcement shall consist of a welded wire mesh conforming to the requirements of 709.10 and be galvanized according to 711.02.

2.3 JOINT MATERIALS

2.3.1 BEARING PADS

In the horizontal joints between the reinforced concrete facing panels, install at least two bearing pads per panel at a uniform spacing. The bearing pads shall be neoprene elastomeric pads having a durometer hardness of 55 ± 5, high density polyethylene pads with a minimum density of 59 lb/ft^3 [0.946 g/cm^3] or equivalent. Supply certified test data to the Engineer upon delivery of the material to the project.

2.3.2 JOINT COVER

Cover all joints between panels on the back side of the wall with a geotextile material meeting

the minimum requirements for filtration applications as specified by AASHTO M288. The minimum width and lap shall be 1'-0" [300 mm]. The adhesive used to attach the geotextile material to the panels shall be Pliobond 5001, as manufactured by Goodyear Rubber Company or equal as approved by Foster Geotechnical. Supply certified test data to the Engineer upon delivery of the geotextile material to the project.

2.4 ALIGNMENT PINS

The pins used to align the face panels during construction shall be round, smooth number 5 bars made of mild steel or smooth 3/4 [19 mm] diameter PVC rod.

2.5 SELECT GRANULAR EMBANKMENT

The select granular embankment material in the reinforced soil mass shall be CMS 304 Aggregate Base or CMS 703.11 Structural Backfill Type 2; except as follows:

A. The material shall not contain slag.

B. The material shall conform to AASHTO T 289-91 with a pH range between 4.5 and 9.0.

C. The material shall conform to AASHTO T 288-91 with a resistivity greater than 3,000 ohm-cm. If the resistivity is greater than 5,000 ohm-cm, AASHTO T 290-95 and T 291-94 may be waived.

D. The material shall conform to AASHTO T 291-94 with chloride levels less than 100 ppm.

E. The material shall conform to AASHTO T 290-95 with sulfate levels less than 200 ppm.

Take all acceptance samples from the stockpile. Transport and handle the material to minimize the segregation of the material prior to the placement.

Furnish the Engineer a Certificate of Compliance from an independent Testing Laboratory, certifying that the above material complies with this specification and a copy of all test results performed for contract compliance. The Engineer will accept the material based upon a visual inspection of the material and a review of the Certificate of Compliance and all test reports.

2.6 CONCRETE LEVELING PAD

The leveling pad may be unreinforced cast-in-place concrete or reinforced precast concrete. The concrete shall be at least 6 inches [150 mm] thick and have a minimum compressive strength of 2500 psi [17.2 Mpa]. Cure the cast-in-place concrete for a minimum of 12 hours prior to placing the first row of facing panels.

2.7 BACKFILL DRAINAGE

Furnish porous backfill, CMS 518, with filter fabric, CMS 712.09 Type B, and 6 inch [150 mm] perforated plastic pipe, 707.33, as shown in the plans. The pipe shall be continuous and sloped to provide a positive gravity flow.

2.8 CONCRETE COPING AND SLEEPER SLAB

The coping and sleeper slab shall be cast-in-place, Class C concrete, in accordance with CMS 511. The Department will not accept precast concrete copings. Reinforcing steel shall be epoxy coated meeting the requirements of CMS 509. Seal the concrete coping with an epoxy-urethane sealer in accordance with Supplemental Specification 864.

3.0 DETAIL DRAWINGS

Prepare detail drawings and design calculations in accordance with the 17th Edition of the AASHTO *Standard Specifications for Highway Bridges* and these provisions. In the event of a conflict, this specification will govern.

The detail drawings shall include the following information:

A. A site plan for the full length of the retaining wall

B. An elevation view of the full length of the retaining wall showing the location of each individually labeled panel section

C. The soil reinforcement lengths

D. Representative cross-sections at each design change

E. Backfill drainage details

F. Actual bearing pressures

G. Allowable bearing pressures

H. Design life

I. Angle of internal friction of select granular material

An Ohio Registered Engineer shall sign, seal and date the detail drawings, design calculations and acceptance letter provided in the appendix of this provision.

Thirty (30) days prior to the commencement of wall construction, submit to the Engineer: two copies of the detail drawings on 11” x 17” sheets; two copies of the design calculations; and the

signed acceptance letter. The Engineer will submit the drawings, calculations and acceptance letter to the Office of Structural Engineering (OSE) for information. Department approval is not required.

Ensure that the shop drawings meet the requirements for materials, field measurements, construction requirements and contract requirements. Coordinate details of the work to be performed by other entities on the project. The Department will not make allowance for additional cost or delays to the Contractor for incorrect fabrication as a result of failure to coordinate or perform this coordination. Submit two copies of the shop drawings on 11" x 17" sheets to the Engineer with the delivery of the materials to the project. Department approval of the shop drawings is not required.

The Manufacturer shall maintain record fabrication drawings according to Supplement 1073 for each standard panel design produced.

4.0 CONSTRUCTION REQUIREMENTS

4.1 WALL EXCAVATION

Perform wall excavation to the bottom of the leveling pad and reinforced soil mass in accordance with CMS 503.

4.2 UNDERCUT AND BACKFILL

Remove unsuitable foundation soils below the reinforced soil mass to the limits shown in the project plans or as directed by the Engineer. Use the select granular embankment material, section 2.4, for backfill and compact according to CMS 203.06 and 203.07.

4.3 FOUNDATION PREPARATION

For a width equal to or exceeding the width of the reinforced soil mass, level and compact the foundation soil according to Item 203.05.

4.4 WALL ERECTION

Place concrete panels as shown on the accepted detail drawings. Lift panels from the lifting devices set into the upper edge of each panel. Place panels and backfill in successive horizontal lifts according to the sequence shown on the detail drawings. Use external bracing as necessary for the initial lift. As the backfill material is placed behind the panels, maintain the panels in vertical position by means of temporary wooded wedges placed in the panel joints on the external side of the wall. Remove the wedges as soon as the panel above the wedged panel is completely erected and backfilled.

For vertical walls, vertical tolerances (plumbness) and horizontal alignment tolerances shall not exceed 3/4 inch [20 mm] when measured along 10 feet [3000 mm] straight edge. The maximum

allowable offset in any panel joint shall be 3/4 inch [20 mm]. For vertical walls, the overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed ½ inch [13 mm] per 10 feet [3000 mm] of wall height.

Place soil reinforcement perpendicular to the wall facing unless otherwise shown on the plans or directed by the Engineer. Attach the reinforcement to the facing panel as directed by the manufacturer's guidelines. Prior to placement of the granular backfill, ensure that the reinforcement is continuous from the wall panel to the end of the reinforcing zone; pulled taut with enough force to eliminate wrinkles or folds; and held in a manner approved by the manufacturer. Do not splice the soil reinforcement or operate equipment directly on the soil reinforcement.

4.5 SELECT GRANULAR EMBANKMENT PLACEMENT

The placement of the select granular embankment material shall closely follow the erection of each lift of facing panels. Place the select granular embankment material level up to the elevation of the soil reinforcement before attaching the soil reinforcements to the back of the precast panels. Attach and place soil reinforcements according to the recommendations of Foster Geotechnical.

Construct the reinforced soil mass according to CMS 203.06 and 203.07. Place the granular backfill in loose lifts not exceeding 8 inches [200 mm]. Decrease the lift thickness as necessary to obtain the specified density.

At the end of each day's operations, shape the last level of embankment to rapidly direct rain water runoff away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction site.

Compact the reinforced zone of fill without disturbing or distorting the soil reinforcement and facing panels. Place the embankment material within 3 feet [1000 mm] of the backside of the panels in 6 to 8 inch thick lifts and compact this area by at least 3 passes of a light mechanical tamper. This area does not have to satisfy density test requirements.

4.6 EMBANKMENT CONSTRUCTION

Construct embankment within the plan specified limits of the proprietary wall embankment and outside the plan specified limits of the select granular embankment material, according to CMS 203.

4.7 PILE SLEEVES

Pile sleeves are required when piles are located inside the reinforced soil mass. Install piles through sleeves after the wall construction has been completed. The sleeve material shall be corrugated smooth lined pipe, 707.33 or 707.42. Maintain alignment of the pile sleeve during construction of the embankment. Place a bentonite slurry in the void located between the pile

and the sleeve. The slurry shall consist of one part cement, one part bentonite and ten parts water.

5.0 PROJECT INSPECTION

Foster Geotechnical shall provide a company representative to monitor the precast operation and ensure that the requirements of this specification are met. The representative shall submit all documentation to the Engineer when the panels are delivered to the project.

Foster Geotechnical shall provide on-site technical assistance to ensure that the Contractor and the Engineer understand the construction procedures and operations of the wall system.

Hire an independent soils consultant to ensure the placement and compaction of the select granular embankment material is in compliance with the requirements of this specification. The soil consultant shall provide the Engineer with two copies of all inspection reports signed by an Ohio Registered Professional Engineer.

The Engineer will inspect the material delivered to the site; review certified test data; monitor the erection of the structure and placement of the select granular embankment material; and consult with the soils consultant and Foster Geotechnical as necessary for acceptance to the requirements of this specification.

6.0 DESIGN REQUIREMENTS FOR MSE PANEL WALLS

The design of the FG Retained Earth Wall shall be in strict conformance with the 17th edition of the AASHTO *Standard Specifications for Highway Bridges*, and the design requirements listed below:

A. The design shall meet all plan requirements. The recommendations of the wall system suppliers shall not override the minimum performance requirements shown herein. Do not submit other systems offered by the approved supplier in lieu of the system which is called for in the plans.

B. Where walls or wall sections intersect with an included angle of 130 degrees or less, a vertical corner element separate from the standard panel face shall abut and interact with the opposing standard panels. The corner element shall have steel reinforcing strips connected specifically to that panel and be designed to preclude lateral spread of the intersecting panels.

C. One hundred percent of the steel reinforcing strips which are designed and placed in the reinforced earth volume shall extend to and be connected to the facing element through the use of tie strips or another acceptable method. The Department will not allow field cutting of steel reinforcing strips to avoid obstacles, such as abutment piles. Also, steel reinforcing strips shall not be bent around such obstacles.

D. Under service loads, the minimum factor of safety at the connection between the face panel

and the steel reinforcing strips shall be 1.5. The minimum factor of safety against reinforcement pullout shall be 1.5 at ½ inch [13 mm] deformation. The maximum allowable reinforcement tension shall not exceed two-thirds of the connection strength determined at ½ inch [13 mm] deformation.

E. Compute the coefficient of lateral earth pressure k_a and the application of the lateral forces to the reinforced soil mass for external stability analysis using the Coulomb method, but assuming no wall friction.

F. Design all walls with a coping as specified in the plans.

G. Soil parameters for use in design are as follows:

Fill Zone	Type of Soil	Soil Unit Weight	Friction Angle	Cohesion
Reinforced Zone	Compacted Select Granular Embankment Material with less than 7% P200 Material	120 lbs/ft^3 [118.9 kN/m^3]	34^o	0
Retained Soil	On-site soil varying from sandy lean clay to silty sand	120 lbs/ft^3 [18.9 kN/m^3]	30^o	0
Foundation Soil	Variable - ranging from existing uncontrolled fill to natural silty sand	120 lbs/ft^3 [18.9 kN/m^3]	30^o	0

H. The allowable reinforcement tension of steel (inextensible) reinforcement elements for structural design and connection (pullout) design shall be based on the thickness of the elements at the end of the structure's design life. In essence, the minimum thickness of the reinforcement elements shall be that thickness which will provide for the structural requirement plus the sacrificed thickness at the end of the design life.

I. The design life of the mechanically stabilized earth retaining wall system shall be 100 years.

J. Compute the internal stability, including definition of failure plane and lateral earth pressure coefficient, for Reinforced Earth walls according to AASHTO Section 5.8.4.1, including the Coherent Gravity Method.

K. The minimum thickness of the concrete leveling pad shall be 6 inch [150 mm].

L. The connections of the reinforcing strips to the panels shall be in two elevations for standard panels and the connections shall be no more than 2.5 feet [750 mm] apart vertically.

M. The wall height for design purposes shall be measured from the top of the leveling pad to the

top of the coping. When the wall is retaining a sloping surcharge then the wall height shall be defined as the equivalent design height (h) as shown in AASHTO Figure 5.8.2B. The minimum reinforcing strip length shall be 70 percent of the wall height, as appropriately defined for either a level or sloping backfill, but no less than 8 feet [2400 mm].

N. The minimum thickness of the precast reinforced concrete face panels shall be 5.5 inch [140 mm].

O. The yield strength (Fy) for the metallic soil reinforcement shall be 65 ksi [450 MPa].

P. The wall system, regardless of the size of panels, shall accommodate up to one percent differential settlement along the length of the wall in the longitudinal direction.

Q. Compute the vertical stress at each reinforcement level by considering local equilibrium of all the forces acting above the level under investigation. The vertical stress (bearing pressure) at each reinforcement level may be computed using the Meyerhof method in the same manner as the bearing pressure computed for the base of the wall.

R. The minimum length of wall between leveling pad elevation changes shall be 9'-0" [2.75 m].

7.0 METHOD OF MEASUREMENT

The Department will measure the Retained Earth Wall System by the number of square feet [square meter]. The Department will determine the area of the wall system from plan dimensions using a length measured along the outside of the uppermost facing panels and a height from the bottom of the concrete leveling pad to the top of the concrete coping. If a traffic barrier is provided atop the concrete coping, the height will be measured to the bottom of the traffic barrier. The Department will not adjust pay quantities to account for variations in the concrete leveling pad elevations required to accommodate actual panel placement.

The Department will measure the Retained Earth Wall System on a lump sum basis when shown on the plans.

The Department will measure undercut and backfill on a lump sum basis.

The Department will measure concrete coping by the number of feet [meter] from plan dimensions as measured along the outside of the uppermost facing panels.

8.0 BASIS OF PAYMENT

The Department will pay for undercut and backfill quantities beyond the limits shown in the plans as Extra Work, as described in 109.04.

The Department will pay for the costs of concrete traffic barriers and sealers placed on traffic

barriers under a separate pay item.

If a separate pay item for Cofferdams, Cribs and Sheeting is not included in the Contract, the Department will pay for cofferdams, cribs and sheeting under the contract unit price for the Retained Earth Wall System.

The Department will pay for accepted quantities at the contract price as follows:

Item	**Unit**	**Description**
Special	Square Foot [Square Meter]	Retained Earth Wall System.
Special	Lump Sum	Retained Earth Wall System
Special	Lump Sum	Undercut and Backfill
Special	Foot [Meter]	Concrete Coping
Special	Foot [Meter]	Concrete Coping including Sleeper Slab

MSE Wall Acceptance Letter

Project No.:	
Wall No.:	

Design Data	
Design Life	100 yrs
Angle of Internal Friction – Reinforced Zone	34º
Actual Bearing Pressure at base of reinforced soil mass	
Allowable Bearing Pressure at base of reinforced soil mass (Reproduced from project plans)	

I hereby certify that the design calculations for the internal stability of the mechanically stabilized earth retaining structure and the detail drawings included in this construction submission are in complete conformance with the AASHTO Standard Specifications for Highway Bridges, 17th Edition, 2002 and the MSE wall special provisions. I further certify that the design data provided above and data assumed for the design calculation submitted herein is accurate for the above referenced wall.

Engineer's Seal	
Signature:	
Date:	

(Provide an MSE Wall Acceptance Letter for each wall designated in the project plans.)

AN-4 SSL LLC MSE PLUS RETAINING WALLS

The following un-numbered note should be part of any project allowing the use of the SSL LLC retained earth wall system. The designer must revise this note to meet project conditions and forward the revised note for inclusion into the project as Special Provisions.

Included on Figures APP-1 [APP-1M] are standard details for the MSE wall coping and MSE wall mounted deflector parapet. The designer is required to include these details in the plans along with all additional details required to define, location, reinforcing, contraction and expansion joints, and other details specific to the project to construct the copings on the top of the MSE walls.

1.0 GENERAL

This work consists of designing the internal stability of the wall; preparing shop drawings; and fabricating and constructing SSL, LLC MSE Plus Retaining Walls. This work also includes excavation for the wall; the construction of the wall leveling pad, engineered backfill, backfill drainage and concrete traffic barrier; and placement of concrete sealer. In this specification, the subject, "the Bidder" or "the Contractor" is understood.

2.0 MATERIALS

Furnish the SSL, LLC MSE Plus Retaining Walls, including the soil reinforcement, precast facing panels, joint materials and all necessary incidentals from:

SSL, LLC
4740 Scotts Valley Dr. Ste. E
Scotts Valley, CA 95066
Phone: (831)430-9300
Fax: (831)430-9340

The Department will not accept precast concrete elements from manufacturers that are not certified by the Office of Material Management according to Supplement 1073.

2.1 REINFORCED CONCRETE FACING PANELS

The materials shall conform to the following:

Portland cement	701.02, 701.04, 701.05
Reinforcing steel	709.00
Microsilica	701.10
Ground granulated blast furnace slag (GGBFS)	701.11
Fly ash	701.13
Fine aggregate	703.02
Coarse aggregate	703.02

Air-entraining admixture 705.10
Chemical admixtures 705.12

Loop Insert material shall conform to ASTM A510[M] or ASTM A82, welded according to ASTM A185 and galvanized according to 711.02.

Connector bar material shall conform to 709.08 and be galvanized according to 711.02.

2.1.1 CONCRETE PROPORTIONING

Mix the concrete according to CMS 499. Proportion the concrete materials to provide a minimum compressive strength of 4000 psi [27.5 Mpa]. The air content shall be 6 ± 2 percent. Add an approved corrosion inhibiting admixture at the approved dosage.

2.1.2 CONCRETE TESTING

During the production of the concrete panels, the Manufacturer shall randomly sample the concrete in accordance with ASTM C 172. A single compressive strength sample shall consist of a minimum of four test cylinders for each production lot. A production lot consists of either 40 panels or a single day's production, whichever is less. Compressive strength testing shall conform to Supplement 1073.

2.1.3 CASTING

Prior to casting, the Manufacturer shall place the reinforcing steel, soil reinforcement attachment devices and lifting devices and PVC alignment pipes to the dimensions and tolerance shown on the shop drawings. The PVC pipe shall be straight, not bent or bowed. The Manufacturer shall cast the panels on a flat area, with the front face down. To prevent the formation of stone pockets, air bubbles or cleavage planes, the Manufacturer shall place the concrete in each unit without interruption and shall consolidate the concrete with a vibrator, supplemented by hand-tamping as necessary to force the concrete into the corners of the forms. The Manufacturer shall use a clear form oil approved by the SSL, LLC Engineer and shall not substitute the form oil once the casting operation begins.

All forms shall remain in place until they can be removed without damage to the panel.

The Manufacturer shall attach all coil loop inserts to an alignment template using bolts provided with the forms. The final position of the soil reinforcement attachment devices shall be within 1/8 inch [3 mm] of their locations specified in the shop drawings. The holes inside the coil loop inserts shall be 2 3/8 inches [60 mm] deep in the finished panel. No concrete or other debris shall be on the exposed portion of the attachment devices in the finished panels. Immediately after the alignment template is removed, the Manufacturer shall place duct tape over the coil loop insert holes to prevent debris from collecting inside. Do not remove the duct tape until the wall is assembled.

2.1.4 CURING

The Manufacturer's curing method shall be as prescribed by SSL, LLC. The cure time shall be of sufficient length such that the concrete will develop the minimum compressive strength specified in 2.1.1. Do not ship products from a production lot represented by strength tests that do not conform to the requirements of Section 2.1.1.

2.1.5 CONCRETE FINISH

The front face of the reinforced concrete panels shall have an architectural surface finish treatment as shown on the shop drawings. The rear face of the reinforced concrete panels shall have an unformed surface finish and shall not have open pockets of aggregate and surface distortions in excess of 1/4 inch [6 mm]. Seal all panels with an epoxy-urethane sealer according to CMS 512.

2.1.6 TOLERANCES

All panels shall be fabricated to the following tolerances:

A. Panel Dimensions:
   1. Position of the attachment device .....± 1/8" [3 mm]
   2. All other dimensions .....± 3/16" [5 mm]

B. Panel Squareness (difference between the two diagonals) .....± 1/2" [13 mm]

C. Panel Surface Finish (size of surface defect over a length of 5 ft [1.5 m])
   1. Smooth formed surfaces .....± 1/8" [3 mm]
   2. Textured finished surfaces .....± 5/16" [8 mm]

2.1.7 REJECTION

The Department will reject panels with any of the following:

A. Defects that indicate imperfect molding

B. Defects indicating honeycombed or open texture concrete

C. Defects in the physical characteristics of the concrete, such as broken or chipped concrete

D. Stained form face, due to excess form oil or other contaminants

E. Signs of aggregate segregation

F. Broken or cracked corners

G. Face panels that do not meet the tolerances specified in 2.1.6.

H. Lifting inserts not useable

I. Exposed reinforcing steel

J. Cracks at the PVC pipe or pin

K. Insufficient concrete compressive strength

L. Panel thickness in excess of 3/16 inch [5 mm] from that shown on the plans

The Engineer will decide if an attempt may be made to repair a defective panel. The Contractor or supplier shall make the repairs at his own expense. If the repairs are made to the Engineer's satisfaction, the panel will be acceptable.

2.1.8 MARKING

The Manufacturer shall clearly mark the back surface of each panel with the date of manufacture, the production lot number and the piece-mark detailed in the shop drawings.

2.1.9 HANDLING, STORING AND SHIPPING

Handle, store, and ship panels in such a manner as to avoid chipping, cracking and fracturing the panels; excessive bending stresses; and damaging the soil reinforcement attachment devices. Support panels on firm blocking while storing and shipping.

2.2 SOIL REINFORCEMENT

The soil reinforcement shall consist of a welded wire mesh conforming to the requirements of 709.10 and be galvanized according to 711.02.

2.3 JOINT MATERIALS

2.3.1 BEARING PADS

In the horizontal joints between the reinforced concrete facing panels, install at least two bearing pads per panel at a uniform spacing. The bearing pads shall be neoprene elastomeric pads having a durometer hardness of 55 ± 5, high density polyethylene pads with a minimum density of 59 lb/ft^3 [0.946 g/cm^3] or equivalent. Supply certified test data to the Engineer upon delivery of the material to the project.

2.3.2 JOINT COVER

Cover all joints between panels on the back side of the wall with a geotextile material meeting

the minimum requirements for filtration applications as specified by AASHTO M288. The minimum width and lap shall be 1'-0" [300 mm]. The adhesive used to attach the geotextile material to the panels shall be Pliobond 5001, as manufactured by Goodyear Rubber Company or equal as approved by SSL, LLC. Supply certified test data to the Engineer upon delivery of the geotextile material to the project.

2.4 ALIGNMENT PINS

The pins used to align the face panels during construction shall be round, smooth number 5 bars made of mild steel or smooth 3/4 [19 mm] diameter PVC rod.

2.5 SELECT GRANULAR EMBANKMENT

The select granular embankment material in the reinforced soil mass shall be CMS 304 Aggregate Base or CMS 703.11 Structural Backfill Type 2; except as follows:

A. The material shall not contain slag.

B. The material shall conform to AASHTO T 289-91 with a pH range between 4.5 and 9.0.

C. The material shall conform to AASHTO T 288-91 with a resistivity greater than 3,000 ohm-cm. If the resistivity is greater than 5,000 ohm-cm, AASHTO T 290-95 and T 291-94 may be waived.

D. The material shall conform to AASHTO T 291-94 with chloride levels less than 100 ppm.

E. The material shall conform to AASHTO T 290-95 with sulfate levels less than 200 ppm.

Take all acceptance samples from the stockpile. Transport and handle the material to minimize the segregation of the material prior to the placement.

Furnish the Engineer a Certificate of Compliance from an independent Testing Laboratory, certifying that the above material complies with this specification and a copy of all test results performed for contract compliance. The Engineer will accept the material based upon a visual inspection of the material and a review of the Certificate of Compliance and all test reports.

2.6 CONCRETE LEVELING PAD

The leveling pad may be unreinforced cast-in-place concrete or reinforced precast concrete. The concrete shall be at least 6 inches [150 mm] thick and have a minimum compressive strength of 2500 psi [17.2 Mpa]. Cure the cast-in-place concrete for a minimum of 12 hours prior to placing the first row of facing panels.

2.7 BACKFILL DRAINAGE

Furnish porous backfill, CMS 518, with filter fabric, CMS 712.09 Type B, and 6 inch [150 mm] perforated plastic pipe, 707.33, as shown in the plans. The pipe shall be continuous and sloped to provide a positive gravity flow.

2.8 CONCRETE COPING AND SLEEPER SLAB

The coping and sleeper slab shall be cast-in-place, Class C concrete, in accordance with CMS 511. The Department will not accept precast concrete copings. Reinforcing steel shall be epoxy coated meeting the requirements of CMS 509. Seal the concrete coping with an epoxy-urethane sealer in accordance with Supplemental Specification 864.

3.0 DETAIL DRAWINGS

Prepare detail drawings and design calculations in accordance with the 17th Edition of the AASHTO *Standard Specifications for Highway Bridges* and these provisions. In the event of a conflict, this specification will govern.

The detail drawings shall include the following information:

A. A site plan for the full length of the retaining wall

B. An elevation view of the full length of the retaining wall showing the location of each individually labeled panel section

C. The soil reinforcement lengths

D. Representative cross-sections at each design change

E. Backfill drainage details

F. Actual bearing pressures

G. Allowable bearing pressures

H. Design life

I. Angle of internal friction of select granular material

An Ohio Registered Engineer shall sign, seal and date the detail drawings, design calculations and acceptance letter provided in the appendix of this provision.

Thirty (30) days prior to the commencement of wall construction, submit to the Engineer: two copies of the detail drawings on 11” x 17” sheets; two copies of the design calculations; and the

signed acceptance letter. The Engineer will submit the drawings, calculations and acceptance letter to the Office of Structural Engineering (OSE) for information. Department approval is not required.

Ensure that the shop drawings meet the requirements for materials, field measurements, construction requirements and contract requirements. Coordinate details of the work to be performed by other entities on the project. The Department will not make allowance for additional cost or delays to the Contractor for incorrect fabrication as a result of failure to coordinate or perform this coordination. Submit two copies of the shop drawings on 11" x 17" sheets to the Engineer with the delivery of the materials to the project. Department approval of the shop drawings is not required.

The Manufacturer shall maintain record fabrication drawings according to Supplement 1073 for each standard panel design produced.

4.0 CONSTRUCTION REQUIREMENTS

4.1 WALL EXCAVATION

Perform wall excavation to the bottom of the leveling pad and reinforced soil mass in accordance with CMS 503.

4.2 UNDERCUT AND BACKFILL

Remove unsuitable foundation soils below the reinforced soil mass to the limits shown in the project plans or as directed by the Engineer. Use the select granular embankment material, section 2.4, for backfill and compact according to CMS 203.06 and 203.07.

4.3 FOUNDATION PREPARATION

For a width equal to or exceeding the width of the reinforced soil mass, level and compact the foundation soil according to Item 203.05.

4.4 WALL ERECTION

Place concrete panels as shown on the accepted detail drawings. Lift panels from the lifting devices set into the upper edge of each panel. Place panels and backfill in successive horizontal lifts according to the sequence shown on the detail drawings. Use external bracing as necessary for the initial lift. As the backfill material is placed behind the panels, maintain the panels in vertical position by means of temporary wooded wedges placed in the panel joints on the external side of the wall. Remove the wedges as soon as the panel above the wedged panel is completely erected and backfilled.

For vertical walls, vertical tolerances (plumbness) and horizontal alignment tolerances shall not exceed 3/4 inch [20 mm] when measured along 10 feet [3000 mm] straight edge. The maximum

allowable offset in any panel joint shall be 3/4 inch [20 mm]. For vertical walls, the overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed ½ inch [13 mm] per 10 feet [3000 mm] of wall height.

Place soil reinforcement perpendicular to the wall facing unless otherwise shown on the plans or directed by the Engineer. Attach the reinforcement to the facing panel as directed by the manufacturer's guidelines. Prior to placement of the granular backfill, ensure that the reinforcement is continuous from the wall panel to the end of the reinforcing zone; pulled taut with enough force to eliminate wrinkles or folds; and held in a manner approved by the manufacturer. Do not splice the soil reinforcement or operate equipment directly on the soil reinforcement.

4.5 SELECT GRANULAR EMBANKMENT PLACEMENT

The placement of the select granular embankment material shall closely follow the erection of each lift of facing panels. Place the select granular embankment material level up to the elevation of the soil reinforcement before attaching the soil reinforcements to the back of the precast panels. Attach and place soil reinforcements according to the recommendations of SSL, LLC.

Construct the reinforced soil mass according to CMS 203.06 and 203.07. Place the granular backfill in loose lifts not exceeding 8 inches [200 mm]. Decrease the lift thickness as necessary to obtain the specified density.

At the end of each day's operations, shape the last level of embankment to rapidly direct rain water runoff away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction site.

Compact the reinforced zone of fill without disturbing or distorting the soil reinforcement and facing panels. Place the embankment material within 3 feet [1000 mm] of the backside of the panels in 6 to 8 inch thick lifts and compact this area by at least 3 passes of a light mechanical tamper. This area does not have to satisfy density test requirements.

4.6 EMBANKMENT CONSTRUCTION

Construct embankment within the plan specified limits of the proprietary wall embankment and outside the plan specified limits of the select granular embankment material, according to CMS 203.

4.7 PILE SLEEVES

Pile sleeves are required when piles are located inside the reinforced soil mass. Install piles through sleeves after the wall construction has been completed. The sleeve material shall be corrugated smooth lined pipe, 707.33 or 707.42. Maintain alignment of the pile sleeve during construction of the embankment. Place a bentonite slurry in the void located between the pile

and the sleeve. The slurry shall consist of one part cement, one part bentonite and ten parts water.

5.0 PROJECT INSPECTION

SSL, LLC shall provide a company representative to monitor the precast operation and ensure that the requirements of this specification are met. The representative shall submit all documentation to the Engineer when the panels are delivered to the project.

SSL, LLC shall provide on-site technical assistance to ensure that the Contractor and the Engineer understand the construction procedures and operations of the wall system.

Hire an independent soils consultant to ensure the placement and compaction of the select granular embankment material is in compliance with the requirements of this specification. The soil consultant shall provide the Engineer with two copies of all inspection reports signed by an Ohio Registered Professional Engineer.

The Engineer will inspect the material delivered to the site; review certified test data; monitor the erection of the structure and placement of the select granular embankment material; and consult with the soils consultant and SSL, LLC as necessary for acceptance to the requirements of this specification.

6.0 DESIGN REQUIREMENTS FOR MSE PANEL WALLS

The design of the SSL, LLC Retained Earth Wall shall be in strict conformance with the 17th edition of the AASHTO *Standard Specifications for Highway Bridges*, and the design requirements listed below:

A. The design shall meet all plan requirements. The recommendations of the wall system suppliers shall not override the minimum performance requirements shown herein. Do not submit other systems offered by the approved supplier in lieu of the system which is called for in the plans.

B. Where walls or wall sections intersect with an included angle of 130 degrees or less, a vertical corner element separate from the standard panel face shall abut and interact with the opposing standard panels. The corner element shall have steel reinforcing strips connected specifically to that panel and be designed to preclude lateral spread of the intersecting panels.

C. One hundred percent of the steel reinforcing strips which are designed and placed in the reinforced earth volume shall extend to and be connected to the facing element through the use of tie strips or another acceptable method. The Department will not allow field cutting of steel reinforcing strips to avoid obstacles, such as abutment piles. Also, steel reinforcing strips shall not be bent around such obstacles.

D. Under service loads, the minimum factor of safety at the connection between the face panel

and the steel reinforcing strips shall be 1.5. The minimum factor of safety against reinforcement pullout shall be 1.5 at 1/2 inch [13 mm] deformation. The maximum allowable reinforcement tension shall not exceed two-thirds of the connection strength determined at 1/2 inch [13 mm] deformation.

E. Compute the coefficient of lateral earth pressure k_a and the application of the lateral forces to the reinforced soil mass for external stability analysis using the Coulomb method, but assuming no wall friction.

F. Design all walls with a coping as specified in the plans.

G. Soil parameters for use in design are as follows:

Fill Zone	Type of Soil	Soil Unit Weight	Friction Angle	Cohesion
Reinforced Zone	Compacted Select Granular Embankment Material with less than 7% P200 Material	120 lbs/ft^3 [18.9 kN/m^3]	34^o	0
Retained Soil	On-site soil varying from sandy lean clay to silty sand	120 lbs/ft^3 [18.9 kN/m^3]	30^o	0
Foundation Soil	Variable - ranging from existing uncontrolled fill to natural silty sand	120 lbs/ft^3 [18.9 kN/m^3]	30^o	0

H. The allowable reinforcement tension of steel (inextensible) reinforcement elements for structural design and connection (pullout) design shall be based on the thickness of the elements at the end of the structure's design life. In essence, the minimum thickness of the reinforcement elements shall be that thickness which will provide for the structural requirement plus the sacrificed thickness at the end of the design life.

I. The design life of the mechanically stabilized earth retaining wall system shall be 100 years.

J. Compute the internal stability, including definition of failure plane and lateral earth pressure coefficient, for Reinforced Earth walls according to AASHTO Section 5.8.4.1, including the Coherent Gravity Method.

K. The minimum thickness of the concrete leveling pad shall be 6 inch [150 mm].

L. The connections of the reinforcing strips to the panels shall be in two elevations for standard panels and the connections shall be no more than 2.5 feet [750 mm] apart vertically.

M. The wall height for design purposes shall be measured from the top of the leveling pad to the

top of the coping. When the wall is retaining a sloping surcharge then the wall height shall be defined as the equivalent design height (h) as shown in AASHTO Figure 5.8.2B. The minimum reinforcing strip length shall be 70 percent of the wall height, as appropriately defined for either a level or sloping backfill, but no less than 8 feet [2400 mm].

N. The minimum thickness of the precast reinforced concrete face panels shall be 5 1/2 inch [140 mm].

O. The yield strength (Fy) for the metallic soil reinforcement shall be 65 ksi [450 MPa].

P. The wall system, regardless of the size of panels, shall accommodate up to one percent differential settlement along the length of the wall in the longitudinal direction.

Q. Compute the vertical stress at each reinforcement level by considering local equilibrium of all the forces acting above the level under investigation. The vertical stress (bearing pressure) at each reinforcement level may be computed using the Meyerhof method in the same manner as the bearing pressure computed for the base of the wall.

R. The minimum length of wall between leveling pad elevation changes shall be 9'-0" [2.75 m].

7.0 METHOD OF MEASUREMENT

The Department will measure the MSE Plus Retaining Wall System by the number of square feet [square meter]. The Department will determine the area of the wall system from plan dimensions using a length measured along the outside of the uppermost facing panels and a height from the bottom of the concrete leveling pad to the top of the concrete coping. If a traffic barrier is provided atop the concrete coping, the height will be measured to the bottom of the traffic barrier. The Department will not adjust pay quantities to account for variations in the concrete leveling pad elevations required to accommodate actual panel placement.

The Department will measure the MSE Plus Retaining Wall System on a lump sum basis when shown on the plans.

The Department will measure undercut and backfill on a lump sum basis.

The Department will measure concrete coping by the number of feet [meter] from plan dimensions as measured along the outside of the uppermost facing panels.

8.0 BASIS OF PAYMENT

The Department will pay for undercut and backfill quantities beyond the limits shown in the plans as Extra Work, as described in 109.04.

The Department will pay for the costs of concrete traffic barriers and sealers placed on traffic

barriers under a separate pay item.

If a separate pay item for Cofferdams, Cribs and Sheeting is not included in the Contract, the Department will pay for cofferdams, cribs and sheeting under the contract unit price for the MSE Plus Retaining Wall System.

The Department will pay for accepted quantities at the contract price as follows:

Item	**Unit**	**Description**
Special	Square Foot [Square Meter]	MSE Plus Retaining Wall System.
Special	Lump Sum	MSE Plus Retaining Wall System
Special	Lump Sum	Undercut and Backfill
Special	Foot [Meter]	Concrete Coping
Special	Foot [Meter]	Concrete Coping including Sleeper Slab

MSE Wall Acceptance Letter

Project No.:	
Wall No.:	

Design Data	
Design Life	100 yrs
Angle of Internal Friction – Reinforced Zone	34º
Actual Bearing Pressure at base of reinforced soil mass	
Allowable Bearing Pressure at base of reinforced soil mass (Reproduced from project plans)	

I hereby certify that the design calculations for the internal stability of the mechanically stabilized earth retaining structure and the detail drawings included in this construction submission are in complete conformance with the AASHTO Standard Specifications for Highway Bridges, 17th Edition, 2002 and the MSE wall special provisions. I further certify that the design data provided above and data assumed for the design calculation submitted herein is accurate for the above referenced wall.

Engineer's Seal	
Signature:	
Date:	

(Provide an MSE Wall Acceptance Letter for each wall designated in the project plans.)

AN-5 3 COAT SHOP PAINT SYSTEM IZEU

Un-numbered plan note to define specification requirements for shop application of the 3 coat IZEU paint system. To use this note The 863 item shall be AS PER PLAN.

As example:
Item 863 Lump Sum STRUCTURAL STEEL MEMBERS, LEVEL ?, AS PER PLAN

The note AN-4 follows as the AS PER PLAN specifications to have a a three (3) coat shop paint system applied.

1.0 DESCRIPTION

In addition to the requirements of Supplemental Specification 863, this item shall consist of furnishing all necessary labor, materials and equipment to clean, apply a three(3) coat shop applied IZEU system for Item 863 Structural Steel, including requirements for field cleaning and coating of surfaces only prime coated at the shop, and methods of repair for surfaces damaged in shipping, handling and erecting the structural steel and any other damages during construction. Section 863.29 and 863.30 shall not apply.

This specification shall also include galvanizing, CMS 711.02, of all nuts, washers, bolts, anchor bolts, and any other structural steel items requiring galvanizing as part of item 863.

All shop painting shall be applied in a structural steel fabrication shop having permanent buildings per SS863.07 and pre qualified at the same SS863 level as the structural steel fabricator. The painter is under the supervision of a QCPS and is the SS863 Fabricator, the field painting sub-contractor performing touch up work in the field and or shop coating at the 863 Fabricator's facility or an independent painter meeting the qualifications of SSPC QP3 with facilities evaluation and acceptance by the Department.

2.0 MATERIAL

A. A three coat paint system consisting of an:

1. Inorganic Zinc Prime Coat meeting the requirements of CMS 708.17

2. Epoxy Intermediate Coat meeting the requirements of Supplemental Specification 910 entitled "OZEU Structural Steel Paint".

3. Urethane Finish Coat meeting the requirements of Supplemental Specification 910 entitled "OZEU Structural Steel Paint".

B. A tie coat consisting of an Epoxy Intermediate Coat, meeting the requirements of Supplemental Specification 910, "Epoxy Intermediate Coat" and thinned 50%, by volume,

because of the availability of Standard Bridge Drawing DS-1-92.

ARN-19 RETIRED NOTE 85

Use the following note for composite deck prestressed box beams, prestressed I-beams, concrete deck on steel stringers and reinforced concrete slab with over the side drainage. A detail will be required in the plans showing the drip strip.

[85] STAINLESS STEEL DRIP STRIP: Prior to the concrete deck placement a bent drip strip shall be installed along the edges of the deck by anchoring to the top layer of reinforcing steel and being butted, with a 90 degree bend, against the formwork. An additional 1'-0" long drip strip shall also be installed centered on each post.

The strips shall be placed the full length of the deck, ending at the abutments. Where splices are required the individual pieces shall be butted together. Stainless steel shall be 22 gauge ASTM A167, Type 304, mill finish.

The final pay quantity shall be the actual overall length of the drip strip. Additional strips at posts shall not be measured for payment.

Payment shall be at the contract price bid for Item Special, linear feet, Steel Drip Strip, which shall include all materials, labor, tools, and incidentals necessary to complete the item.

HISTORY: Note **[85]** was retired by the April 2000 Edition of the Bridge Design Manual because of the availability of Standard Bridge Drawing DS-1-92.

ARN-20 RETIRED NOTE 86

On rehabilitation plans where new reinforcing steel may require field bending and cutting, the following note can be used. Generally, all reinforcing steel shall be dimensioned to fit and shown on the plans.

[86] REINFORCING STEEL: New reinforcing steel may require field cutting or bending to be properly fitted. Payment shall be included in the applicable concrete item.

HISTORY: Note **[86]** was retired by the October 18, 2002 Edition of the Bridge Design Manual because a new general note **[43a]** was added that makes field cutting or bending an "As Per Plan" pay item.

ARN-21 RETIRED NOTE 28

Provide the following note when there is a pay item for Item 503:

[28] ITEM 503, UNCLASSIFIED EXCAVATION ***, AS PER PLAN: The backfill material behind the abutments shall be Type B granular material, 703.16.C, placed and compacted in 6 inch [150 mm] lifts.

*** Use of excavation 503 items as defined above.

HISTORY: Note **[28]** was retired by the January 2005 revisions to the Bridge Design Manual because the 2005 CMS revised 503.08 to include the material previously defined by note **[28]**.

(THIS PAGE INTENTIONALLY LEFT BLANK)

AP-1 RATING OF BRIDGES AND POSTED LOADS

RATING OF BRIDGES AND POSTING FOR REDUCED LOAD LIMITS

I. PURPOSE

This Standard Operating Procedure outlines the procedures to be performed for rating the relative strength of bridges and for posting warnings of bridge strength deficiencies.

II. REFERENCE

Ohio Revised Code, Section 5591.42:

****or the Director of Transportation, may ascertain the safe carrying capacity of the bridges on roads or highways under their jurisdiction. Where the safe carrying capacity of any such bridge is ascertained and found to be less than the load limit prescribed by sections 5577.01to 5577.12, of the Ohio Revised Code, warning notice shall be conspicuously posted near each end of the bridge as per section IV.C.

Supersedes Standard Operating Procedure OPS-116, dated July 1, 1993.

III. PROCEDURE FOR RATING

A. The relative strength ratings for each bridge shall be determined in the following manner:

1. A careful field inspection of the bridge shall be made by the District Bridge Engineer and/or other qualified structural engineer to determine its condition, and the percent of effectiveness of the various members for carrying load. All information shown in the Bridge Inventory and Inspection Records shall also be carefully checked and revised as necessary to show the current condition of the bridge.

2. Using pertinent current information, the District Bridge Engineer shall determine the Inventory, Operating, and Ohio Legal Load Ratings for the structure as follows:

   a. The Inventory Rating shall be determined by Load Factor Methods and shall be expressed in tons, in terms of the AASHTO-HS Loading.

   b. The Operating Rating shall be determined by Load Factor Methods and shall be expressed in tons, in terms of the AASHTO-HS Loading.

   c. The Ohio Legal Load shall be determined by Load Factor Methods and shall be expressed in terms of the Percent of Ohio Legal Loads.