OHIO DEPARTMENT OF TRANSPORTATION

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

April 15, 2005

To: Users of the Bridge Design Manual

From: Tim Keller, Administrator, Office of Structural Engineering

By: Sean Meddles, Bridge Standards Engineer

Re: 2005 Second 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

Until July 1, 2005, 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 Second Quarter, 2005 Revisions to the ODOT BDM

BDM Section	Affected Pages	Revision Description
207.1	2-34 through 2-35.2	This section has been revised in order to clarify the project requirements for the vertical clearance of new bridges and existing bridges to remain over roadways. The wording in the January 2005 quarterly revisions inadvertently included existing bridges to remain with new bridges.
302.1	3-1 through 3-2.2	The purpose for this revision is to clarify the amount of detail required for structure plans at each Detail Design submission. Based upon initial detail design reviews performed under the new Plan Development Process, there has been a lack of consistency among structural plans submitted for review at Stage 2 and Stage 3.
AN-1	Appendix-2 Appendix-10.1 through Appendix-10.3	In Section 1.0, the reference to concrete traffic barrier was replaced with a reference to concrete coping. Traffic barriers are paid for as a separate item as specified in Section 8.0. However, concrete copings are paid for with the wall. In Section 6.0, the soil parameters for foundation soils were removed from the table in item (G) because the wall vendor does not need to calculate bearing capacity of the foundation soils. Also in Section 6.0, item (M), a definition for wall height was provided for walls supporting abutments.
AN-2	Appendix-11 Appendix-19.1 through Appendix-19.3	In Section 1.0, the reference to concrete traffic barrier was replaced with a reference to concrete coping. Traffic barriers are paid for as a separate item as specified in Section 8.0. However, concrete copings are paid for with the wall. In Section 6.0, the soil parameters for foundation soils were removed from the table in item (G) because the wall vendor does not need to calculate bearing capacity of the foundation soils. Also in Section 6.0, item (M), a definition for wall height was provided for walls supporting abutments.

BDM Section	Affected Pages	Revision Description
AN-3	Appendix-20 Appendix-28.1 through Appendix-28.3	In Section 1.0, the reference to concrete traffic barrier was replaced with a reference to concrete coping. Traffic barriers are paid for as a separate item as specified in Section 8.0. However, concrete copings are paid for with the wall. In Section 6.0, the soil parameters for foundation soils were removed from the table in item (G) because the wall vendor does not need to calculate bearing capacity of the foundation soils. Also in Section 6.0, item (M), a definition for wall height was provided for walls supporting abutments.
AN-4	Appendix-29 Appendix-37.1 through Appendix-37.3	In Section 1.0, the reference to concrete traffic barrier was replaced with a reference to concrete coping. Traffic barriers are paid for as a separate item as specified in Section 8.0. However, concrete copings are paid for with the wall. In Section 6.0, the soil parameters for foundation soils were removed from the table in item (G) because the wall vendor does not need to calculate bearing capacity of the foundation soils. Also in Section 6.0, item (M), a definition for wall height was provided for walls supporting abutments.

[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

The "Required Minimum" and "Actual Minimum" Vertical Clearances and their locations shall be shown on the Preliminary Structure Site Plan, Section 201.2.2. The "Actual Minimum" Vertical Clearance is the minimum overhead clearance provided by the design plans.

A. For new and reconstructed grade separation structures, the "Required Minimum" Vertical Clearance shall not be less than the preferred clearance specified in ODOT's Location and Design Manual, Figure 302-1 unless otherwise specified in the scope of services. A "Required Minimum" Vertical Clearance less than the L&D Manual minimum clearance will require a Design Exception in accordance with Section 105 of the L&D Manual.

B. For grade separation structures to remain, the "Required Minimum" Vertical Clearance shall not be less than the minimum clearance specified in ODOT's Location and Design Manual, Figure 302-2 or 302-3 unless otherwise specified in the scope of services. A "Required Minimum" Vertical Clearance less than the L&D Manual minimum clearance will require a Design Exception in accordance with Section 105 of the L&D Manual.

For the purposes of determining vertical clearances, "Reconstructed" shall refer to an improvement of an existing structure involving the replacement of the entire superstructure.

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 Location and Design Manual, Figure 307-2. To satisfy cost considerations or in order to maintain the typical roadway section (including roadway ditch) of the underpass through the structure, for four or more lane highways, wall abutments or the 2:1 slope of typical two-span grade separation structures may be located farther than 30 feet [9000 mm] from the near edge of traveled lane.

Lateral clearances for other roadway classifications 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.

207.4 INTERFERENCE DUE TO EXISTING SUBSTRUCTURE

Where a new pier or abutment is placed at the location of an existing pier or abutment the usual "Removal" note (and also the text of CMS 202.03) calls for sufficient removal of the old pier or abutment to permit construction of the new. However, a new pier or abutment preferably should not be located at an existing pier or abutment where the existing masonry may extend appreciably below the bottom of the proposed footing, or appreciably below the ground in case of capped-pile construction. This applies particularly where piles are to be driven. It is desirable to avoid the difficulty and expense of removing deep underground portions of the existing substructure and to avoid the resultant disturbance of the ground.

Where existing substructure units are shown on the Site Plan, the accuracy of the locations and extent should be carefully drawn. The existing substructure configuration should be shown based on existing plans or field verified dimensions, otherwise just a vertical line showing the approximate face of the abutment or pier widths should be shown. Misrepresentation of the location of the existing substructure units has resulted in expensive change orders during construction. Existing dimensions should be labeled as (+/-) plus or minus.

207.5 BRIDGE STRUCTURE, SKEW, CURVATURE AND SUPERELEVATION

During the Assessment of Feasible Alternatives, the location of the proposed structure should be studied to attempt to eliminate the presence of excessive skew, curves or extreme superelevation transitions within the actual bridge limits.

208 TEMPORARY SHORING

Whenever shoring is required to support a roadway where traffic is being maintained and the height of the retained earth will be over eight foot [2.5 meters], the Design Agency shall be required to provide a temporary shoring design with details provided in the plans and feasibility studied during the Structure Type Study.

For projects involving Railroads, the requirements will be different as each railroad company has their own specific requirements. The Design Agency is responsible for contacting the responsible railroad and obtaining the specific requirements for design and construction.

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Following are some conceptual ideas for the design of temporary shoring:

A. A cantilever sheet pile wall should generally be used for excavation up to approximately 12 feet [3.5 meters] in height. Design computations are necessary.

B. For cuts greater than 12 feet [3.5 meters] in height, anchored or braced walls will generally be required.

C. For anchored walls, the use of deadmen is preferred. Braced walls using waler and struts can sometimes be braced against another rigid element on the excavated side.

The use of soil or rock anchors(tiebacks) is generally the last option considered in the design of anchored walls.

D. The use of steel "H" piles with lagging is also a practical solution for some sites. Please note that some railroad companies allow only interlocking steel sheet piling adjacent to their tracks.

E. Where sufficient embedment can not be attained by driving sheet piling because of the location of shallow bedrock, predrilled holes into the bedrock with soldier "H" piles and lagging should be considered.

   For cuts greater than 12-15 feet [3.5-4.5 meters], the "H" piles may need to be anchored.

F. The highway design live loading should be equal to two feet [600 mm] of equivalent soil height as a surcharge.

G. The following items at a minimum should be shown on the detail plans:

   1. Minimum section modulus

   2. Top and minimum bottom elevation of shoring

   3. Limits of shoring

   4. Sequence of installation and/or operations.

   5. Method of payment

   6. If bracing or tiebacks are required, all details, connections and member sizes shall be detailed.

   7. A general note in plans allowing a Contractor designed alternate for temporary shoring.

SECTION 300 – DETAIL DESIGN

301 GENERAL

301.1 DESIGN PHILOSOPHY

Section 300 of this Manual establishes general design guidelines, details, special requirements and reasonable alternatives, which, when incorporated by the engineer in a set of bridge plans, will provide a bridge structure that meets load requirements, provides structural integrity, provides structural efficiency and reduces long term maintenance to a minimum level.

301.2 DETAIL DESIGN REVIEW SUBMISSIONS

The detail design review for structures is conducted as part of the Stage 2 and Stage 3 review submission.

The Stage 2 Detail Design submission should include an updated cost estimate and the items listed below. Not every item listed will apply to every project.

A. Bridge Plans generally consisting of the following:
   1. Site Plan in compliance with all Stage 1 review comments
   2. General Plan (if required)
   3. General Notes
   4. Phase Construction Details
   5. Foundation Plan
   6. Abutment Details with all dimensioning, bar marks and bar spacings properly shown
   7. Pier Details with all dimensioning, bar marks and bar spacings properly shown
   8. Superstructure Details with all dimensioning, bar marks and bar spacings properly shown
   9. Other Details as necessary

B. Retaining Wall Plans generally consisting of the following:
   1. General Notes
   2. Retaining wall details
   3. Other Details as necessary

C. Noise Barrier Plans generally consisting of the following:
   1. General Notes
   2. Plan and Profile Views
   3. Noise Barrier Details
   4. Foundations Table
   5. Subsurface Investigation Plan Sheets
   6. Other Details as necessary

D. Special Provisions

E. Load Rating Reports for bridges (Major and Minor PDP)

The Stage 3 Detail Design plan submission should include an updated cost estimate and the

following:
A. Stage 2 Detail Design plans in compliance with all Stage 2 review comments.
B. Completed Estimated Quantities Table
C. Completed Reinforcing Steel Schedule
D. Estimated Quantities calculations
E. Load Rating Reports for bridges (Minimal PDP only)

Refer to Section 1400 of the ODOT Location and Design Manual, Volume Three, for additional staged review submission requirements.

For structures with non-redundant and/or fracture critical design details, a complete Stage 2 Detail Design Review Submission shall be made to the Office of Structural Engineering for concurrent review and comment. The Office of Structural Engineering will forward all comments to the responsible District Office or LPA.

301.3 DESIGN METHODS

Ohio Department of Transportation bridge designs are to be developed in general conformance with the latest edition of the American Association of State Highway and Transportation Officials' Standard Specifications for Highway Bridges (AASHTO), including all interims. Exceptions to AASHTO standards are documented in this Manual. Bridges designed within the limitations placed on the various superstructure types by AASHTO and this Manual can be considered as "typical" or "normal" in that these designs make use of empirical formulae and methods rather than more refined analysis methods.

The Strength Design Method (i.e. Load Factor Design) is preferred over the Service Load Design Method (i.e. Allowable or Working Stress Design). If a designer determines that an existing superstructure is structurally deficient based on the Service Load Design Method, the designer shall re-analyze the structure based on the Strength Design Method before opting for a total superstructure replacement.

When site conditions require the use of a superstructure type that exceeds the recommended limits set forth by AASHTO and/or this Manual, a special design method may be required using either a two-dimensional or three-dimensional model and some type of numerical analysis to solve the model. When this occurs, the designer should place a note in the General Notes section of the detail construction plans listing the type of model used, method of analysis and assumptions made during the design. Examples of special design methods include grillage, finite element, finite strip and classical plate solutions. A sample note can be found in Section 600 of this Manual.

For design of Temporary Structures see Section 500 of this Manual.

301.4 LOADING REQUIREMENTS

All bridge structures shall be designed for an HS25 [MS22.5] loading or the alternate military loading, whichever produces the greatest stresses and live load deflections, unless otherwise stated in this manual. Figure 301 illustrates the HS25 [MS22.5] truck and lane loadings.

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

All steel structures shall be designated as Case I or Case II as defined by AASHTO for fatigue design.

Bridge structures on LPA projects shall be designed to the same loading requirements as traditionally funded projects except an HS20-44 [MS18] loading may be used in lieu of the HS25 [MS22.5] loading.

301.4.1 PEDESTRIAN AND BIKEWAY BRIDGES

Pedestrian and bikeway bridges shall be designed in accordance with the latest edition of AASHTO, ODOT design guidelines and this Manual. The most current design guidelines can be obtained from ODOT'S Office of Local Projects (614)644-7095.

Bridges that cannot accommodate vehicles because of narrow roadway or walkway widths or other access limitations shall be designed in accordance with the AASHTO Guide Specifications for Design of Pedestrian Bridges.

Bridges whose width can accommodate service vehicles shall be designed in accordance with the AASHTO Guide Specifications for Design of Pedestrian Bridges and an H15-44 [M13.5] vehicle.

301.4.2 RAILROAD BRIDGES

Bridges are to be designed in accordance with current AREMA specifications and the individual railway company's loading requirements. All other aspects of the structure design shall conform to AASHTO.

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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 coping; 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

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

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. When the wall is supporting an abutment then the wall height shall be measured from the top of the leveling pad to the profile grade elevation at the face of the wall. The minimum geogrid reinforcement length shall be 70 percent of the wall height, as defined above, 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].

R. For walls supporting an abutment on a spread footing, all soil reinforcements for panels located within a distance of h/2 of the abutment footing, shall have the same density, length and cross-section as the soil reinforcements beneath the abutment footing. See Figure 1. "h" is the wall height as defined in (M) above.

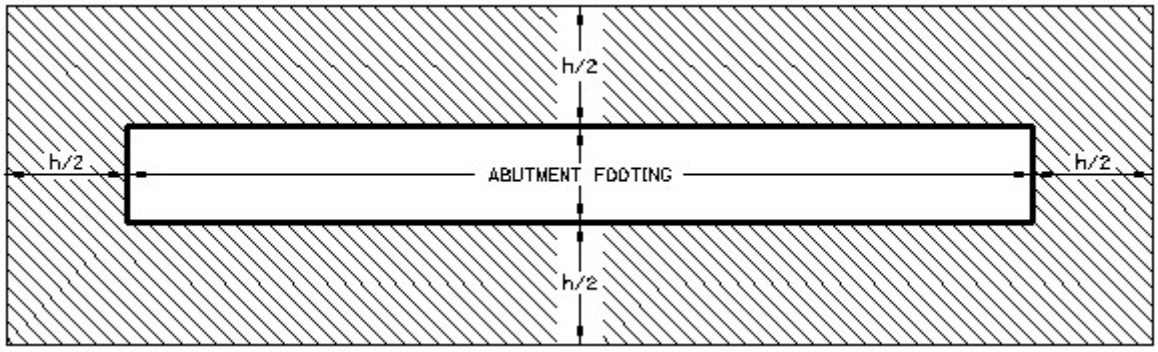

Figure 1

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 coping; 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.

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

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. When the wall is supporting an abutment then the wall height shall be measured from the top of the leveling pad to the profile grade elevation at the face of the wall. The minimum reinforcing strip length shall be 70 percent of the wall height, as defined above, 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].

S. For walls supporting an abutment on a spread footing, all soil reinforcements for panels located within a distance of h/2 of the abutment footing, shall have the same density, length and cross-section as the soil reinforcements beneath the abutment footing. See Figure 1. "h" is the wall height as defined in (M) above.

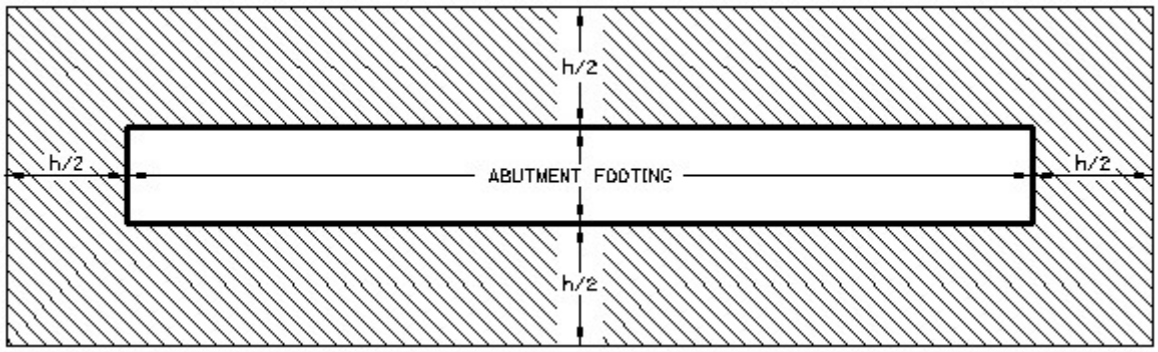

Figure 1

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 coping; 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

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

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. When the wall is supporting an abutment then the wall height shall be measured from the top of the leveling pad to the profile grade elevation at the face of the wall. The minimum reinforcing strip length shall be 70 percent of the wall height, as defined above, 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].

S. For walls supporting an abutment on a spread footing, all soil reinforcements for panels located within a distance of h/2 of the abutment footing, shall have the same density, length and cross-section as the soil reinforcements beneath the abutment footing. See Figure 1. "h" is the wall height as defined in (M) above.

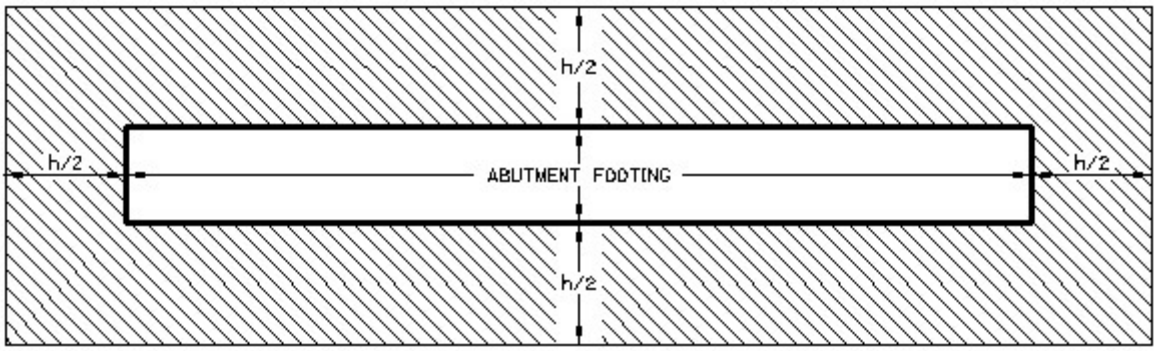

Figure 1

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 coping; 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.

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

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. When the wall is supporting an abutment then the all height shall be measured from the top of the leveling pad to the profile grade elevation at the face of the wall. The minimum reinforcing strip length shall be 70 percent of the wall height, as defined above, 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].

S. For walls supporting an abutment on a spread footing, all soil reinforcements for panels located within a distance of h/2 of the abutment footing, shall have the same density, length and cross-section as the soil reinforcements beneath the abutment footing. See Figure 1. "h" is the wall height as defined in (M) above.

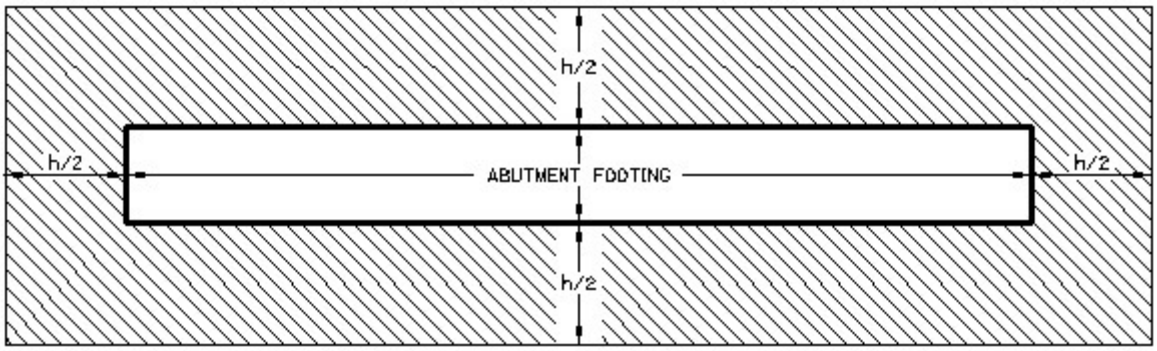

Figure 1

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,

ARN-22 6 mm (1/4”) EPOXY WATERPROOFING OVERLAY FOR BRIDGE DECKS

This proposal note was retired in April 2005.

6mm (1/4 INCH) EPOXY WATERPROOFING OVERLAY FOR BRIDGE DECKS - 04/19/02

GENERAL

This specification describes a two component 100% solid, flexible epoxy system and a special aggregate designed to provide a minimum 6mm (1/4") thick bridge deck overlay for the purpose of providing a waterproofing system which remains flexible at all operating temperatures and a non-skid surface.

MATERIALS

Formulation

The material shall be a two component epoxy or an epoxy derived co-polymer system consisting of simple volumetric mixing ratios such as one to one or two to one. For the remainder of this specification, the material systems shall be referred to as "epoxy".

The epoxy system shall be formulated to provide flexibility in the system without any sacrifice of the hardness, chemical resistance or strength of the epoxy system.

Properties

Adhesion to Concrete: When the finished system (including aggregate) has been applied as per manufacturers recommendation and tested according to ACI Method 503R-30, it shall have 100% failure in concrete. The prepared specimens, (minimum of 3) shall be conditioned for 7 days at 24 +/- 1 ºC (75 +/- 2 ºF) prior to testing.

Hardness: The epoxy material, when tested according to ASTM D 2240, shall have a Shore D Hardness between 50 to 75. Three samples shall be prepared on a structurally sound surface with a minimum thickness of 3 mm (0.12 inch) and allowed to cure for 7 days at 24 +/- 1 ºC (75 +/- 2 ºF) prior to performing the indicated tests.

Abrasion Resistance: Abrasion resistance shall be evaluated on Tabor abrader with a 1000 gram load and CS-17 wheel. Duration of the test shall be 1000 cycles. The wear index shall be calculated based on ASTM C 501 and wear index of the catalyzed materials shall be under 80. The test shall be run on cured samples of material which shall be applied at a film thickness of 15 to 20 mil to a stainless steel (316) plate. The film shall be allowed to cure for 7 days at 24 +/- 1 ºC (75 +/- 2 ºF) prior to performing the indicated test.

Tensile Strength: When tested according to ASTM D 638, the epoxy material shall have a tensile strength not less than 17.2 MPa (2500 psi). The Type IV, semi-rigid specimens, shall be cast in the specified mold and pulled at a rate of 5mm (0.20 inches) per minute by a suitable dynamic testing machine. The samples (minimum of 3) shall be allowed to cure at room temperature for at least 7 days at 24 +/- 1 ºC (75 +/- 2 ºF) prior to performing the indicated test.

Tensile Elongation: The elongation produced at the break in the tensile strength test must be a minimum of 30 percent.

Compressive Strength: When tested according to ASTM C 109, the cured epoxy material (including aggregate) shall have a compressive strength not less than 5000 psi. Three samples shall be cast and tested using the specified size and amount of aggregate. The samples shall be conditioned for 7 days at 24 +/- 1 ºC (75 +/- 2 ºF) before performing the indicated test. The rate of compression of these samples shall be no more than 12.7mm (0.5 inches) per minute.

Water Absorption: When tested as per ASTM D 570 the cured epoxy system shall not exceed the water absorption of 0.5 percent. Sample specimens shall be prepared according to section 4.1 and allowed to cure at 23 +/- 2 ºC (73.4 +/- 3.6 ºF) and 50 +/- 5% relative humidity. Tests are then to be carried out as per section 6.1.

Aggregate:

Aggregate for all layers shall be bauxite, crushed granite, aluminum oxide, flint, Washington Steilacoom, Tuff-Grane Type A (furnished by Emeri-Crete, Inc., Portsmouth, N.H.) or other aggregate as recommended by the Manufacturer of the Overlay System, provided it has MOH scale hardness of 7 or more and meets the following gradation:

Sieve Size	% Passing
No. 6	95-100
No. 10	10-35
No. 20	0-3

Repair of Spalled Areas:

Deck patching shall be performed as outlined in Proposal Note entitled "Patching Concrete Bridge Decks".

The patching material shall be a quick setting cementitious mortar meeting the requirements of 705.21, Type I (Magnesium Phosphate Based Materials will not be allowed).

All patches shall be allowed to cure a minimum of 14 days before the overlay is placed. Traffic shall be allowed to use the bridge during the curing period of the patches.

The bridge shall be open to traffic during all non-working hours, therefore, patching must be scheduled and performed accordingly. Exceptions to this would be other construction activities on the approach roadway which prevent opening the road to traffic.

Preparation:

After all patches have cured for a minimum of 14 days, the entire deck shall be cleaned by shotblasting to remove any oil, dirt, rubber or any other potentially detrimental material such as curing compound and laitances which would prevent bonding and curing of the epoxy material.

Only areas that the shotblasting equipment cannot reach (i.e., along curbs and median walls) will the use of sandblasting be permitted to an extent satisfactory to the epoxy manufacturer and Engineer. This should be performed prior to the shotblasting whenever applicable and practical. Abrasives containing more than 1% free silica will not be allowed (No silica sand). If it rains on the prepared surface, the surface shall be reblasted.

Traffic shall not be allowed on any portion of the deck which has been shotblasted or on areas where all coats have not already been placed. The overlay application equipment, however, will be allowed to drive on the deck surface during application, provided planking or similar

precaution is taken to insure that the deck surface will not become contaminated or otherwise damaged.

Test Patch:

Prior to placing the first course, the Contractor shall use the test method prescribed in ACI 503R - Appendix A of the ACI Manual of Concrete Practice (modified as per Virginia Transportation Research Council, Michael M. Sprinkel, 804-293-1941) to determine the cleaning practice (size of shot, flow of shot, forward speed of shotblast machine, and number of passes) necessary to provide a tensile bond strength greater than or equal to 1.7 MPa (250 psi) or a failure area, at a depth of 6mm (1/4 inch) or more into the base concrete, greater than 50% of the test area. A test result shall be the average of three tests on a test patch of approximately 0.3m x 0.9m (1 ft x 3 ft), consisting of two courses.

One test result must be obtained from each span or 167 m2 (200 square yards), which ever is the smaller area. The Engineer will designate the location of these test patches. To provide assurance that the cleaning procedure, materials, installation procedure, and curing period will provide the desired overlay, test patches shall be installed with the same materials, equipment, personnel, timing, sequence of operations, and curing period prior to opening to traffic, that will be used for the installation of the overlay. The cleaning practice, materials and installation procedure will be approved if one passing test result is obtained from each test area.

If the cleaning practice, materials and installation procedure are not acceptable, the Contractor must remove failed test patches and make the necessary adjustments and re-test all areas at no additional cost to the Department until satisfactory test results are obtained.

Application of Overlay:

All surfaces to be overlaid shall be dry at the time of application. Immediately before applying the epoxy material, all prepared surfaces shall be cleaned with compressed air to remove dust and debris.

The application of the epoxy system shall not be made when it has rained or snowed within 24 hours prior to application and rain or snow is forecast within 8 hours after application. If rain occurs during the application, all operations shall cease and the surfaces allowed to dry, before continuing.

The minimum temperature at which the epoxy can be applied is to be 10 ºC (50 ºF) and rising.

The epoxy manufacturer shall have a representative on the job site at all times who, upon consultation with the Engineer, may suspend any item of work that is suspect and does not meet the requirements of this specification. Resumption of work will occur only after the epoxy manufacturer's representative and the Engineer are satisfied that appropriate remedial action has been taken by the Contractor.

The overlay system shall be applied on all deck areas using metering, mixing and distribution machinery approved by the epoxy manufacturer. The application machine shall feature positive displacement volumetric metering pumps. The resin shall be stored in temperature controlled reservoirs capable of maintaining 38 ºC (100 ºF) plus/minus 4 ºC (10 ºF) to insure optimum mixing. Ratio check verification at the pump outlets as well as cycle counting capabilities to monitor output will be standard features.

The number of layers (minimum of two) and the application rates of the epoxy in the various layers shall be as recommended by the manufacturer in order to achieve a minimum overlay thickness of 6mm (1/4 inches) measured from the highest point on the deck surface to the top of epoxy (not the peaks of the aggregate).

Application of the Epoxy: After mixing of the components, the epoxy shall be evenly distributed on the clean, dry deck surface at the rate as recommended by the manufacturer.

Application of Aggregate: After the application of the epoxy, broadcasting of the aggregate on decks shall be by automated dispenser depositing the aggregate onto the deck in a uniform manner as directed by the epoxy manufacturer.

The aggregate shall be broadcast at a rate in excess of that needed to cover the surface so that no wet spots appear. The aggregate must be dropped vertically in such a manner that the level of the epoxy will not be unduly disturbed.

When working within the confines of one lane, (i.e. aggregate truck driving over freshly placed epoxy and aggregate) planking or 3/4" plywood shall be placed under the wheels of the truck or any other equipment to distribute the load and prevent displacement of the fresh epoxy.

Consolidation: (If required by manufacturer) A hand operated roller as approved by the epoxy manufacturer and the Engineer shall be used at surface temperature below 16 ºC (60 ºF) within ten minutes after the application of the aggregate to evenly consolidate the aggregate into the epoxy.

Removal of Excess Aggregate: After the overlay has hardened, removal of all loose and excess aggregate with a power vacuum or other method shall be made prior to the application of subsequent coats.

Application of Additional Layers: May be made immediately after the preceding layer has completely hardened and all excess aggregate has been removed. The time between each coat will vary depending on the temperature and circumstances of the project.

Joints in the Overlay (i.e., between two adjacent lanes) shall be staggered and overlapped 76mm (3 inch) minimum between successive layers so that no ridges appear.

Traffic shall be allowed on the final layer after the system has cured (as determined by the manufacturer) and after removal of all excess, loose aggregate, unless other construction activities prevent the re-opening to traffic.

STORAGE AND HANDLING:

Epoxy Material: Epoxy material shall be transported to the job site in their original containers inside a dry, temperature controlled facility maintained at a minimum temperature 16 ºC (60 ºF) and not to exceed 49 ºC (120 ºF). The containers shall be identified as "Part A - Contains Resin" and "Part B - Contains Curing Agent" and shall be clearly marked with the name and address of the manufacturer, name of the product, mixing proportions and instruction, lot and batch numbers, date of manufacture, and quantity contained therein. Material Safety Data Sheets shall accompany each shipment and the driver must have a ready access to them.

Job Site Storage: The epoxy material shall be stored on the job site in a dry, temperature controlled facility within the temperature range of 16 ºC (60 ºF) to 49 ºC (120 ºF). If the epoxy material is transported or stored on the job in the application machine tank, the material must also be maintained within the above temperature range.

Handling of Epoxy on the Job: Protective gloves, clothing, boots, and goggles shall be provided by the Contractor to workers and inspectors directly exposed to the epoxy material. Material Safety Data Sheets shall be provided to all workers and inspectors as obtained from the manufacturer. Disposal of all material containers shall be the Contractor's responsibility.

Aggregate: All aggregate shall be stored in dry, moisture free atmosphere. The aggregate shall be fully protected from any contaminants on the job site and shall be stored so as not to be exposed to rain or other moisture sources.

SAMPLING AND ACCEPTANCE:

Acceptance: The following are acceptable materials, pending submission of approved, certified independent laboratory results:

FLEXOGRID as manufactured by **POLY-CARB, INC.**

33095 Bainbridge Road, Solon, Ohio 44060.

FLEXOLITH, as manufactured by TAMMS INDUSTRIES, CO.

7405 Production Drive, Mentor, Ohio 44060.

SIKADUR EPOXY BROADCAST OVERLAY SYSTEM as manufactured by

SIKA CORP.

201 Polito Avenue, Lyndhurst, NJ 07071.

Upon approval by independent testing laboratory, other products will be considered as equal, providing they:

- meet or exceed the requirements of this specification

- are specifically marketed as bridge deck overlays

- have been successfully used on bridge decks in the continental United States or Canada for at least three years.

Certified Test Data: See 101.061

Laboratory Sample: At the preconstruction conference, the Contractor shall notify the Engineer of the source of material he expects to use. The material manufacturer shall furnish samples of epoxy material as may be required by the Engineer.

Thickness Verification: The Contractor shall establish that the overlay is at least 6mm (1/4 inch) thick (measured from the deck surface to the top of the epoxy) at three random locations selected by the Engineer for every 836 m2 (1,000 square yards) of deck surface. Thin areas shall be recoated as described above by the Contractor and retested at no additional cost to the State. This verification may consist of cores, holes, etc., but in all cases any tested areas shall be repaired by the Contractor.

Epoxy Overlay Guarantee

The Contractor and/or the epoxy Manufacturer shall furnish to the State a written (5) five year guarantee on the completed epoxy overlay. This guarantee shall commence on the date of acceptance by the State and shall cover faulty materials and/or workmanship. Failure is defined as any peeling, cracking or rupture of the overlay and any delamination or disbanding from the deck surface.

The State agrees to notify the Contractor/Manufacturer of the need for any repairs covered by the guarantee promptly upon discovery of same and said repairs shall be commenced within a reasonable period of time after receipt by Contractor/Manufacturer of said notice from the State, subject to delays by strikes, acts of God or other causes beyond the reasonable control of Contractor/Manufacturer.

Manufacturer's/Contractor's sole responsibility to the State of Ohio, Department of Transportation shall be to make the repairs referred to herein.

The guarantee shall be sent in triplicate by the Contractor/Manufacturer to the State for review and filing. Final payment will not be made until the warranty is received.

BASIS OF PAYMENT

Payment for completed and accepted quantities as measured above will be made at the contract price bid for:

ITEM	UNIT	DESCRIPTION
Special	Square meter (square yard)	Patching Concrete Bridge Decks
Special	Square meter (square yard)	Epoxy Waterproofing Overlay 6mm (1/4 inch thick)
Special	Lump	Test Patch

ARN-23 CONCRETE REPAIR USING PREPLACED AGGREGATE CONCRETE

This proposal note was retired in April 2005.

CONCRETE REPAIR USING PREPLACED AGGREGATE CONCRETE - 04/19/02

Scope of Work:

The work covered by these specifications consists of furnishing all labor, materials and equipment for the removal of unsound concrete, the placing of coarse aggregate and the mixing and pumping of mortar into the voids of the preplaced aggregate for the purpose of making preplaced aggregate concrete.

General:

a. The removal of disintegrated concrete and preparation of the surface shall be as specified in 519.03 and 519.04.

b. Preplaced aggregate concrete shall be composed of graded coarse aggregate solidified with mortar.

c. Mortar shall consist of a mixture of Portland cement, pozzolan, fluidifier, sand and water so proportioned and mixed as to produce a grout capable of maintaining the solids in suspension without appreciable water gain, yet which may be pumped without difficulty and which will penetrate and fill completely the voids in the aggregate mass. Furthermore, these materials shall be so proportioned as to produce a hardened preplaced aggregate concrete of 31 MPa (4,500 psi) minimum in 28 days.

d. The proportioning and placing of the coarse aggregate and mortar shall be performed in accordance with provisions of these specifications. The Contractor shall submit for approval to the Engineer, a description of the type and proportioning of materials to be used; the method of procedure; furnish records of past experience in performing this type of work; and furnish records and data to prove conclusively that the resulting concrete will meet the quality and properties required by these specifications.

e. Two companies which specialize in this type of work are: Anderco, Inc., 7804 Hillside Road, Independence, Ohio 44131 and the Prepakt Concrete Co., The Superior Building, Cleveland, Ohio 44114.

Materials:

a. Portland Cement: Shall conform to 701.01, 701.04.

b. Pozzolan: Shall conform to the requirements of ASTM C 618, Class F.

c. Fluidifier: A water-reducing, set controlling agent which imparts to the mortar the properties of a colloidal suspension to prevent the constituents of the mortar from settling, thereby assuring complete bond on the undersides of the aggregate particles and reinforcement; it shall act as a protective colloid to inhibit the early stiffening of the mortar, thereby facilitating pumping of the mortar through supply lines and voids in the aggregate mass; it shall eliminate the setting shrinkage observed to take place in all straight Portland-cement grout; and it shall produce the effect of air-entraining agents with respect to freezing and thawing resistance. It shall be as

manufactured by Concrete Chemicals of Cleveland, Ohio or equal and shall conform to ASTM C 937.

d. Water: Water for intrusion mortar shall be fresh, clean, and free from injurious amounts of sewage, oil, acid, alkali, salts, or organic matter.

e. Fine Aggregate: Sand shall meet the requirements of ASTM C-33 and 703.03, except that the gradation shall be as hereinafter specified.

The sand shall be well graded from fine to coarse and the gradation shall conform to the following requirements as delivered to the grout mixers:

Sieve Designation	**Cumulative Passing**	**Percentages by Weight Retained**
2.36 mm (8)	100	0
1.18 mm (16)	95-100	0-5
600 µm (30)	60-85	15-40
300 µm (50)	20-40	60-80
150 µm (100)	10-30	70-90
75 µm (200)	0-10	90-100

The sand shall have a fineness modulus of not less than 1.30 or more than 2.10. During normal operation, the grading of the sand shall be controlled so that the fineness modulus of a single sample taken at the mixer will not vary by more than 0.10 from the average fineness modulus. The fineness modulus is defined as the total divided by 100 of the percentages retained on sieve numbers 16, 30, 50 and 100.

f. Coarse Aggregate: Coarse aggregate shall meet the requirements ASTM C-33 and 703.02, except as to grading.

Coarse aggregate furnished shall be adequately washed and suitably clean for this type of work. It shall subsequently be drained until the residual free moisture is determined to be reasonably uniform and stable.

The coarse aggregate furnished shall be washed as outlined above immediately prior to placing in the forms and shall be in a suitably clean and washed condition at the time of placement in the forms. If necessary to stockpile, the coarse aggregate shall be stockpiled by approved means in such a manner as to prevent objectionable segregation of sizes.

The grading of the coarse aggregate shall be #4's (AASHTO M 43) or as follows:

Sieve	**Cumulative Percent Passing**
63mm (1 ½")	90-100
50mm (1")	20-45
19mm (3/4")	0-10
12.5mm (½")	0-1

g. Variation from the above gradations may be permitted by the Engineer only on the basis of tests submitted by the Contractor which will prove conclusively that the final concrete will meet or exceed the strength and durability requirements of these specifications.

Placing Coarse Aggregate: The coarse aggregate shall be handled and deposited in the form in such a manner that the grading of the aggregate in place will be as uniform as practicable. The

aggregate shall be lightly vibrated, tamped or rodded in approximately 200mm (8 inch) lifts during placing operations to reduce the voids to an economic minimum. Care shall be taken that reinforcing steel and embedded items are not displaced from the locations as indicated on the drawings.

Mixing and Pumping Mortar: All mixing and pumping equipment used in the preparation and handling of mortar will be subject to approval by the Engineer. All oil or other rust inhibitors shall be removed from the mixing drums, stirring mechanisms, and other portions of the equipment in contact with the mortar before the mixers are used.

All materials shall be accurately measured by volume or weight as they are fed to the mixer. The order of placing the materials in the mixer shall be as follows: (1) water, (2) fluidifier, (3) other solids. The quantity of water used and the time of mixing shall be as to produce homogeneous mortar capable of being pumped without difficulty and which will penetrate and completely fill all voids within the preplaced aggregate. Time of mixing shall be not less than one minute. The maximum time between charging of the mixer and placing of the concrete will depend on the temperature of the grout as follows:

Temperature Range	Minutes
Below 15 ºC (60 ºF)	90
15 to 30 ºC (60 to 85 ºF)	60
30 ºC (85 ºF) and higher	45

If there is a lapse in the operation of mortar injection, the mortar shall be recirculated through the pump, or through the mixer drum or agitator and pump. A screen no larger than 6mm (1/4 - inch) mesh shall be used between the mixer and pump, or between the mixer and agitator to remove large particles which might clog the smaller voids in the aggregate mass.

The method of injecting the intrusion mortar into the aggregate shall be submitted to the Engineer/Director for approval. Injection shall start at the lowest point in the form and shall continue thereafter at a point always below the surface of previously injected mortar. All pumping shall be done slowly and at a uniform rate without interruption so that as R rises in the aggregate-filled form, the mortar completely fills all voids in the coarse aggregate. When the aggregate mass is totally enclosed, the pumping shall continue until all excess air and water have been expelled through vents or venting surfaces at the top of the forms.

Forms: Forms shall be of wood, steel, or other approved material. Absorptive form lining will not be permitted. Forms shall be true to line and grade, mortar-tight and sufficiently rigid to prevent objectionable deformation under load. Where forms for continuous surfaces are placed in successive unit, care shall be taken to fit the forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar. Responsibility for their adequacy shall rest with the Contractor. The form surfaces shall be smooth, free from irregularities, dents, sags, or holes when used for permanently exposed surfaces. Bolts and rods used for internal ties shall be so arranged that when the forms are removed, all metal will be not less than 50mm (2 inches) from any concrete surface. Wire ties will not be permitted. All forms shall be so constructed and oiled so that they can be removed without hammering or prying against the concrete. All exposed joints shall be chamfered and suitable molding shall be placed to bevel or round exposed edges or corners, including the use of dummy chamfers and false

joints to provide a neat and uniform appearance, unless otherwise indicated on the drawing or directed.

Forms for exposed surfaces shall be coated with nonstaining mineral oil which shall be applied shortly before the coarse aggregate is placed. After oiling, surplus oil on the form surfaces and any oil on the reinforcing steel or other surfaces requiring bond with the concrete shall be removed. Forms for unexposed surfaces may be thoroughly wetted in lieu of oiling immediately before the placing of coarse aggregate, except that in freezing weather, oil shall be used.

When appropriate, during the pumping of the mortar, the forms shall be lightly vibrated on the outside in the vicinity of the mortar surface to remove air bubbles which sometimes adhere to the inside of the sheathing and to insure a continuous film of mortar between the aggregate particles and the forms. The vibrating shall be done on both the sheathing and the studs, using approved equipment.

Form removal shall be accomplished in a manner which will prevent injury to the concrete.

Curing: Preplaced aggregate concrete shall be cured by the application of approved curing compounds or by continuous wetting as required under 511.17.

Testing: Prior to the start of the patching operation, the Contractor will be required to perform a 1m x 1m (3 foot x 3 foot) (approximately) test patch at a location selected by the Engineer. The Contractor will use the same procedures, materials, equipment and curing as will be used for the rest of the patching. A core will be obtained from the test patch to determine the filling of all voids, and that the required strength has been obtained. The average 7-day strength of three cores shall be 21MPa (3000 psi). After curing and before final acceptance of the finished project, all patched areas shall be visually inspected and sounded. In addition, the Contractor shall remove a representative number of cores shall be taken from the patched areas (at least one core per pier). The core locations shall be determined by the Engineer and shall extend into the concrete at least 200mm (8 inch). The cores shall be visually inspected for pockets, hollow areas, voids around reinforcing steel or other signs of improper consolidation. The cores shall then be tested by an independent testing laboratory approved by the Department. The average 28-day compressive strength of the cores shall be at least 31MPa (4500 psi). All defective patches as determined by the above methods shall be removed and replaced, followed by further coring. Core holes shall be filled with 705.21 material.

All coring, repair of core holes, independent laboratory testing and replacement of rejected areas shall be the responsibility of the Contractor and included in the unit price bid for this item.

Method of Measurement: The quantity shall be the actual area in square feet of the exposed surfaces of all completed patches, irrespective of the depth or thickness of the patch; if a patch includes corners or edges of such members as beams, curbs, columns, etc., all of the exposed surfaces shall be included, or if a patch extends completely through a member or a slab, both exposed surfaces shall be measured.

Basis for Payment: Payment shall be made at the contract price bid for:

Item	Unit	Description
Special	Square meter (square feet)	Preplaced Aggregate Concrete

ARN-24 STRUCTURAL SURVEY AND MONITORING OF VIBRATIONS

This proposal note was retired in April 2005.

ITEM SPECIAL - STRUCTURAL SURVEY AND MONITORING OF VIBRATIONS - 04/19/02

1.0 Description. This work consists of conducting a survey of the condition of structures and the monitoring of ground vibrations. The survey work is to be conducted before and after all construction work is performed which could cause undesirable ground vibrations. Ground vibrations and acoustics shall be monitored at the appropriate times during the duration of this project.

2.0 Personnel Qualifications. A Professional Engineer, registered in the State of Ohio, shall be engaged by the Contractor to be in charge of conducting a structural survey and in charge of monitoring vibrations and acoustics. The engineer in charge of performing the required work under this item is herein referred to as the Monitoring Foreman. The Monitoring Foreman and/or his team of experts shall have collectively worked on two similar projects or shall have collectively accrued not less than two years of successful experience in performing the type of work specified by this note. The monitoring foreman and/or his team of experts shall have expertise in (1) conducting structural surveys by video methods, (2) monitoring vibrations with a seismograph or with other appropriate instrumentation, and (3) assessing sites for potential damage that may occur as a result of the proposed construction. Documentation of this experience shall be furnished at the preconstruction meeting.

2.1 The requirement for the Monitoring Foreman to be an engineer can be waived provided that the Monitoring Foreman's experience or the collective experience of the monitoring team shows substantial expertise in performing the required work.

3.0 Structural Survey. The structural survey shall include but not be limited to the following:

3.1 Documentation of, the integrity of existing building materials and the general overall condition of the structures recorded by written text, photographs, and VHS video cassette recording.

3.2 The establishment of locations and elevations of reference points, chosen by the Monitoring Foreman, for documentation of measurements.

3.3 A detailed on-site inspection conducted in the presence of the Project Engineer, the Contractor, property owners, property tenants if appropriate, and representatives of any involved utility companies.

3.4 Documentation of all structural deficiencies with regard to location, size, type, etc.

4.0 Monitoring of Vibrations and Acoustics. The monitoring of vibrations and acoustics shall include but not be limited to the following:

4.1 Determination and documentation of existing levels of vibrations and noise.

4.2 Monitoring of all construction operations that significantly contribute to the production of vibrations and noise with a special effort made to document the vibration and sound levels associated with blasting and/or pile installation procedures.

4.3 The development of criteria for controlling construction activities so that the Monitoring Foreman's allowable predetermined vibration levels are not exceeded during construction.

5.0 Water Quality. When appropriate, water samples shall be collected from wells, streams or project runoff areas to document before and after construction site conditions regarding the quality of water available in the vicinity of the project.

6.0 Ground Vibration. Vibration monitoring guidelines can be found in FHWA's May 1985 manual entitled "Rock Blasting" and in various other reports.

The peak particle velocity (PPV) of ground vibrations is generally used to monitor the effect of vibrations on structures. When monitoring vibrations consideration must be given to (1) the type of structure being evaluated and (2) the frequency of the vibrations (low frequency 40 Hz). Generally allowable ground vibration peak particle velocities range from 13mm/second (0.5 inches per second) to 50mm/second (2.0 inches per second) depending on the type of structure under consideration. When an allowable PPV is exceeded, the vibration producing operation shall be suspended and alternative construction procedures should be evaluated. The Director shall be consulted whenever the measured magnitude of the vibration level is considered potentially capable of producing structural damage.

7.0 Method of Measurement. The final twenty percent of the payment for this work shall not be made until the Office of Structural Engineering has received and approved three copies of the Monitoring Foreman's final report. The final report shall be typed and contain all measurements, conclusions, and recommendations which resulted from performing the above required work. Included with the reports shall be one copy of all pictures and video recordings. Interim reports shall be furnished to the Project Engineer during construction thereby keeping the Project Engineer informed of the Monitoring Foreman's progress and findings. The original tapes shall remain in the exclusive possession of the Monitoring Foreman for a period of not less than 10 years.

8.0 Method of Payment. Payment for this item will be made at the contract lump sum price for Item Special - “Structural Survey and Monitoring of Vibrations".

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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.