Iowa Department of Transportation

SPECIAL PROVISION
FOR
MSE WALL WITH LIGHTWEIGHT FOAMED CONCRETE FILL

Van Buren County
BRF-098-1(7)--38-89

Effective Date
September 17, 2013

THE STANDARD SPECIFICATIONS, SERIES 2012, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

120082.01 DESCRIPTION.

A. This work consists of providing and placing Lightweight Foamed Concrete Fill (LFCF) as backfill for MSE Walls at locations designated on the plans, and furnishing and placing PVC Geomembrane as specified in this specification.

B. The LFCF Manufacturer shall be recommended in writing by the MSE Wall Vendor. The LFCF Manufacturer and Installer shall coordinate their work with the MSE Wall Designer-Supplier and the MSE Wall Installer.

120082.02 DESIGN.

A. Wall Design Engineer.
The wall design shall be performer by a Professional Engineer licensed in the State of Iowa that prepares and seals the design submittals as defined in this specification.

B. Design Requirements.

1. The design by the wall system supplier shall consider the internal stability of the wall mass. Wall design shall be as per Section 5, “Retaining Walls”, of the AASHTO Standard Specifications for Highway Bridges.

2. Design calculations shall include a summary of all design parameters used, including material types, Strength values and assumed allowable soil bearing pressure, assumed load and loading combinations. And factor of safety parameters.

3. Soil reinforcement elements and connections in the structure shall be designed to have a corrosion resistance / durability to ensure a minimum service life of 75 years.

4. The design of the structure shall incorporate the following minimum factors of safety:

a. Sliding of the reinforced soil mass: FS = 1.5
b. Overturning of the reinforced soil mass: FS = 2.0
c. Yield of the soil reinforcing elements: FS = 1.5 at end of service life
d. Pullout of the soil reinforcing elements: FS = 1.5 against 0.5 inch deformation. The maximum allowable reinforcement tension shall not exceed two-thirds of the pullout resistance determined at 0.5 inch deformation.
e. Connection of the reinforcing elements to facing units: The maximum allowable reinforcement tension shall not exceed one-half of the ultimate breaking load of the connection.
f. The allowable soil reinforcement tensile strength at the end of the service life shall not exceed 55 percent of the yield strength of the steel (i.e. FS = 1.5 against yield of steel at end of service life).
g. The wall shall be designed for a 250 pounds per square foot surcharge load to account for traffic live loads.
h. The minimum length of the reinforced zone due to global stability shall be 80% of the wall height restricted to a minimum width of 10 feet.

5. Earth reinforcing, and their connections to concrete panels, shall be designed for corrosion over the design life using the following electrochemical criteria:

Requirement	Test Method
Resistivity > 2,000 ohm-cm	AASHTO T 288
Chlorides < 200 ppm	AASHTO T 291
Sulfates < 300 ppm	AASHTO T 290

6. All appurtenances behind, in front of, under, mounted upon, or passing through the wall such as drainage structures, utilities, or other appurtenances shown on the plans shall be accounted for in the stability design of the wall.

7. Unless otherwise noted on the plans, a minimum cover of 3½ feet shall be provided from the bottom of the reinforced soil mass to finish grade.

8. The concrete face panels shall be designed to accommodate differential settlement of 1 foot in 100 feet. The spacing between adjacent panels shall be designed to be at least 0.75 inches.

C. Submittals.

1. The Contractor shall submit seven copies of the design computations and seven sets of MSE system construction drawings at least four weeks prior to beginning construction.

2. These construction drawings shall include all details, dimensions, and cross-sections necessary to construct the wall and shall include, but shall not be limited to the following:
a. An elevation sheet or sheets for each wall.
b. The elevation view(s) of the wall shall include top of wall elevations. The elevations at the top of the wall shall be provided at all horizontal and vertical break points and at least every 15 feet along the face of the wall. The elevation view(s) shall also show all steps in the leveling pads, the designation as to the type of panel, the length of soil reinforcing elements, the distance along the face of the wall to where changes in length of the soil reinforcing elements occur, and an indication of the final ground line and maximum calculated bearing pressures.
c. Details of the architectural treatment to precast concrete face panels. Refer to plans for details and nominal dimensions.
d. Panel details shall show all dimensions necessary to construct the precast concrete panels, all reinforcing steel in the panels, and the location of soil reinforcing connection devices embedded in the panels.

e. A typical cross section or cross sections showing the elevation relationship between ground conditions and proposed grades.
f. General notes pertaining to design criteria and wall construction.
g. The details for diverting soil reinforcements around obstructions such as corrugated metal pipe sleeves for piles, catch basins, and other utilities.
h. Clearly indicated details for construction of walls around drainage facilities.
i. General location of subdrains and outlets of the internal drainage system.
j. Total plan area of wall in square feet, measured from top of leveling pad to top of coping.

120082.03 MATERIALS

A. Concrete panels.

1. Approved Manufacturers.
Precast concrete wall panels shall be manufactured by a company on the approved manufacturer's list in Materials I.M. 445.03, Appendix A.

2. Concrete.
a. Cement shall be Type 1, meeting requirements of Section 4101 of the Standard Specifications.
b. Cement content per cubic yard of concrete for face panels and precast coping sections shall be not less than 610 pounds or more than 700 pounds.
c. Concrete aggregates shall meet requirements of Sections 4110 and 4115 of the Standard Specifications. Coarse aggregate shall be Class 3 durability, as defined in Article 4115.04 of the Standard Specifications. The use of gravel is subject to approval by the Engineer, based on past history of deleterious and stain-producing material found in the aggregate source.
d. Air entrainment shall be obtained by addition of an approved air-entraining agent. The air content of fresh, unvibrated concrete, as determined by AASHTO T 152, shall be 6.5% as a target value, with a maximum variation of ± 1.0%. When specified or authorized by the Engineer, approved admixtures for the purpose of improving workability or for retardation may be used according to the Engineer's instructions.
e. The final mix design is subject to the approval of the Engineer.

3. Compressive Strength.
a. The concrete in reinforced earth face panels shall have the following minimum compressive strength.

Strength prior to moving	Strength at 28 days
1800 psi	4000 psi

b. Acceptance of the concrete face panels with respect to compressive strength will be determined on a lot basis. The lot will consist of all production units (batches of concrete or panels) produced within a consecutive 7 day production period. Production units will be randomly selected in accordance with the production day sample sizes of Table A and tested for compressive strength. Compression tests shall be made on the test specimens in accordance with Materials I.M. 315.

Table A

Production Day Quantities	Sample Size
35 cubic yards or less (50 panels or less)	1
35-70 cubic yards (50 – 100 panels)	2
70-100 cubic yards (100-150 panels)	3
Over 100 cubic yards (150 panels)	5

c. A minimum of six test cylinders shall be cast for each production unit sampled. All of the specimens shall be cured in accordance with this Supplemental Specification.

d. Three specimens shall be tested at 7 days and three at 28 days. A test will be the average compressive strength of three cylinders.

e. Acceptance of the lot will be made if all acceptance tests in a lot are greater than 4000 psi or provided no individual 28 day compressive-strength test result falls below 3500 psi, and the average 28 day compressive strength of all test results of the lot equals or exceeds the acceptance limits set forth in Table B.

f. The acceptance limits of Table B shall also apply to core compressive strength test results.

Table B. Lot Acceptance Limits

Number of Lot Acceptance Tests	Average of all Lot Acceptance Tests Shall Equal or Exceed these Limits
3-7	4000 psi + 0.33R*
8-15	4000 psi + 0.44R*
16+	4000 psi + 0.46R*

*R is the range – the difference between the highest and lowest acceptance test result.

4. Reinforcement.
Reinforcement steel shall be per Article 4151.03 of the Standard Specifications and shall be epoxy coated per Article 4151.03, C.

5. Casting.
Earth reinforcement connections or ties, PVC pipe, and lifting devices shall be set in place to the required dimensions and tolerances, prior to casting.

The panels shall be cast on a flat area, the front face of the panel at the bottom, the back face at the upper part. Reinforcement connection guides shall be set on the rear face. The concrete in each unit shall be placed without interruption and shall be consolidated by use of an approved vibrator, supplemented by such hand-tamping as may be necessary to force the concrete into the corners of the forms and to prevent the formation of stone pockets or cleavage planes. Clear form oil of the same manufacturer shall be used throughout the casting operation.

6. Concrete Finish.
The formed front face shall have a uniform surface as designated. The rear face of the panel shall be roughly screeded to eliminate open pockets of aggregate and surface distortions.

7. Marking.
The date of manufacture, production lot number, and piece-mark shall be clearly scribed on the rear face of each panel.

8. Fasteners.
Bolts and nuts for fasteners, where required, shall be of type and length recommended by the Wall Design Engineer; high strength, conforming to ASTM A 325 or equivalent, and galvanized.

9. Tolerances.
All units shall be manufactured within the following tolerances:

a. Attachment Device Locations and Alignment -- Lateral position of reinforcing strip attachment devices shall be within one inch. Embedment measured from the back face of the panel shall be within +0.25 inch and -0.50 inch. Bearing surfaces of multiple attachment points for a single soil reinforcing element shall align within 1/16 inch.

b. Panel Dimensions – All panel dimensions shall be within 0.25 inch. All hardware embedded in the panel with the exception of attachment devices shall be within 0.25 inch.
c. Panel Squareness -- Squareness, as determined by the difference between the two diagonals, shall not exceed 0.50 inch.
d. Panel Surface Finish – Surface defects on smooth-formed surfaces, measured on a length of 5 feet, shall not exceed 0.25 inch. Surface defects on textured-finished surfaces, measured on a length of 5 feet, shall not exceed 5/16 inch.

10. Curing.
a. As soon as practical after casting, but not later than 30 minutes, the panels shall be covered with wet burlap and kept wet. Within two hours of the initial covering, water shall be applied to the burlap by means of a continuous, pressure-sprinkling system that is effective in keeping the burlap wet during the initial curing period. The initial curing period shall continue until the minimum moving strength is obtained.
b. After the initial curing period is complete, panels may be moved from the casting beds to a secondary curing area and covered with one layer of wet burlap and one layer of 3 mil plastic, secured to retain curing moisture. The concrete face panels shall not be uncovered more than 30 minutes during the moving process. Curing shall continue until the specified strength is obtained.
c. Steam curing procedures may be approved by the Engineer.

11. Removal of Forms.
The forms shall remain in place until they can be removed without damage to the unit.

12. Testing and Inspection.
Acceptability of the precast units will be determined on the basis of compression tests and visual inspection.

The precast units shall be considered acceptable, regardless of age, when compression test results indicate the concrete will meet the specified 28-day strength. The Contractor or the Contractor's supplier shall furnish facilities and collaborate with the Engineer so that all necessary sampling and testing is done in an expeditious and satisfactory manner, subject to approval of the Engineer. Panels shall be considered acceptable for placement in the wall when 7-day strengths exceed 80% of 28-day requirements.

13. Rejection.
Units shall be subject to rejection because of failure to meet any of the requirements specified above. In addition, any or all or the following defects shall be sufficient cause for rejection.
a. Defects that indicate imperfect molding.
b. Defects indicating honeycombed or open-texture concrete.

14. Handling, Storage, and Shipping.
All units shall be handled, stored, and shipped in such a manner as to eliminate the danger of chipping, cracks, fractures, and excessive bending stresses. Panels in storage shall be supported on firm blocking located immediately adjacent to earth reinforcing connections to avoid damage.

B. Leveling Pad.
A concrete leveling pad shall be required under the precast concrete panels. Concrete for the leveling pad may be any mix the supplier markets as having a nominal strength of 3500 psi.

C. Joint Materials.

1. Horizontal and Vertical Joints.

Cover for horizontal and vertical joints between panels shall be a polyester fabric meeting requirements of Article 4196.01, B, 3 of the Standard Specifications and acceptable to the MSE wall company. Adhesives used to temporarily attach the fabric to the back of the facing panels shall be approved by the Engineer.

2. Bearing or Filter Pads.
Where required, bearing and filter pads shall be of the quality and dimensions recommended by the MSE wall company, subject to approval of the Engineer.

D. Subdrains.

1. Subdrains shall be perforated, plastic pipe of one of the types described in Article 4143.01, C, of the Standard Specifications. If the size is not designated, the nominal diameter shall be not less than 4 inches or more than 6 inches.

2. Standard Road Plan RF-19F Type A or Type B outlet shall be provide and fitted with a Standard Road Plan RF-19E rodent guard.

E. LFCF Backfill and Backfill in Temporary Excavation Zone.
Materials shall meet the following requirements:

1. Portland Cement and Portland Pozzolan Cement Type 1 meeting the requirements of Section 4101 of the Standard Specifications

2. Air Entraining, water reducing, set retarding admixtures meeting the requirement of Section 4103 of the Standard Specifications

3. Engineering fabrics meeting the requirements of Materials I.M. 496.01

4. Pozzolans and admixtures (for accelerating, water reducing, retaining, improving the bond, etc.) may only be used if specifically designated and approved by the LFCF Manufacturer.

5. The foaming agent from the selected manufacturer will produce a LFCF Material; will comply with the specifications in the table below.

Table for LFCF Specifications

Property	REQUIREMENTS	TEST METHOD
Cast Density (after pumping)	48 pcf	ASTM C 796
Class IV – Maximum Dry Density Minimum Dry Density	 48.0 pcf 40.0 pcf	Unit Weight (ASTM C 796)
Unconfined Compressive Strength	120 psi minimum at 28 days curing for Class IV	ASTM C 796
Internal Friction Angle	45° (min.)	AASHTO T236 (ASTM D3080-72)
Frost Heave	<0.5 in	British Road Research Laboratory, Lab Report LR 90, 1967, by Croney, Jacobs. Sample @ 250 hr exposure, 4.5 inches high x 4 inch dia.
Freeze-Thaw Resistance – minimum cycles @ relative E = N/N ≥ 70% per ASTM C666 modified per Bidwell Report dated April, 1975	Relative Young's Modulus, E ≥ 80% at 300 cycles	ASTM C 666* As modified below
Coefficient of permeability	1 x 10-5 cm/sec @ 13.8 kPa (2.0 psi)	

***Modifications to ASTM C 666**

The ASTM C 666 modifications are as follows:

a. *The temperature of the center of the specimens did not rise from 3°F to 37°F in less than 50% of the thaw cycle nor did the temperature of the center of specimen drop from 37°F to 3°F in less than 50% of the freeze cycle.*

b. *The freeze-thaw cycle was not completed within the 4 hour maximum time limit. The temperatures at the center of the instrumented specimens were monitored before the other test specimens were put in the facility (before they were 14 days old) and during the early stages of the formal freeze-thaw testing. A complete freeze-thaw cycle for the 35 pcf specimen (3°F to 37°F and 37°F to 3°F including the requirement that it be done in 50% of the time period) would take approximately 10 hours. Without the 50% requirement, but still holding to the 3°F and 37° requirements, a complete cycle requires 4 hours and 30 minutes. However, because it was obvious the ASTM C-666-71 requirements could not be met, the thaw cycle was set at 105 minutes and the freeze cycle at 135 minutes. This allowed the 144-150 pcf specimens to meet ASTM C-666-71 requirement and also best serve the 35-55 pcf specimens. The glass tube on the 45 pcf specimen was broken during preliminary testing, but the other densities showed the following temperatures at the center of the specimen at the end of the freeze and the end of the thaw portions of the cycle.*

c.

Density Pcf	*Temperature at Center of Specimen*	
	End of Freeze	*End of Thaw*
35	*0°F*	*25°F*
40	*0°F*	*33°F*
45	*Thermocouple tube broken*	
50	*-3°F*	*35°F*

This data indicates the 35 pcf specimens did not completely thaw in the centers. It is believed, however, that they did completely thaw to less than full depth, permitting some test of durability. In addition, it can be argued that these lower density specimens were, in fact, subjected to durability tests, because the 35, 40 and 45 pcf specimens have no aggregate (no sand, only cement, water, and air) and, therefore, should scale on the outside as they would have done had ASTM C-666-71 been met.

In Wilson's tests, the 85 pcf cellular concrete was unable to meet the old ASTM VC-290-63T. They went to a 5 hour cycle time and, by so doing, apparently met all other requirements. It appears; the ASTM Test Methods are intended for regular, 144-150 pcf, concrete and do not have enough latitude to properly account for the behavior of cellular concrete and its insulating characteristics.

Table for PVC Geo-membrane Properties

Property	TEST METHOD	REQUIREMENTS
Gauge (nominal)		50 Mil
Thickness (mils)	ASTM D 1593	±5%
Specific Gravity	ASTM D 792	1.2
Tensile Properties	ASTM D 882	
-Break Strength, lbs/in	Method A (MD&TD)	121
-Elongation at Break%	Method A (MD&TD)	425
-Modulus at 100%	Method A (MD&TD)	50
Tear Resistance, lbs/in	ASTM D 1004, Die C	13
Resistance to Soil Burial	ASTM D 3083	
-Breaking Factor		5%
-Elongation at Break		20%
-Modulus at 100%		20%
Hydrostatic Resistance, lbs/in^2	ASTM D 751 (A)	150

Peel Strength, lbs/in		15
Shear Strength, lbs/in		96

F. Earth Reinforcing.

1. All reinforcing shall be carefully inspected to insure they are true to size and free from defects that may impair their strength and durability.

2. Reinforcing and Tie Strip.
Tie strips shall be shop-fabricated from hot-rolled steel conforming to the minimum requirements of ASTM A 570, Grade 50, or equivalent. Galvanization shall conform to the minimum requirements of ASTM A 123 or equivalent. Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to ASTM A 572, Grade 65, or equivalent. Galvanization shall conform to ASTM A 123. Strips shall be cut to lengths and tolerances shown on the plans or recommended. Holes for bolts shall be punched in the locations shown.

120082.04 CONSTRUCTION.

A. Construction Supervision.

1. MSE units, reinforcement material suppliers and LFCF suppliers shall provide a qualified and experienced representative on site at beginning of wall construction for up to 3 working days at no additional cost to the Contracting Authority.

2. The Contractor's field construction supervisor shall have demonstrated experience and be qualified to direct all work at the site.

B. Excavation.
Excavation shall conform to the limits and construction stages shown on the construction drawings. Any core-outs or other remedial/ground improvement procedures identified in the construction drawing shall be completed and approved prior to start of MSE wall construction. Temporary or other excavation lines shown or depicted in the construction drawings are for right of way, quantity calculation, and/or other design purposes only. All excavation cuts and slopes shall comply with the requirements of the Occupational Safety and Health Administration.

C. Foundation Soil Preparation.
The foundation for the structure shall be graded level for a width equal to or exceeding the length of reinforcing mesh or strips, unless otherwise shown on the construction drawings. Prior to wall construction, the foundation shall be compacted with a smooth-wheel, vibratory roller.

D. Leveling Pad.

1. At each panel leveling pad, an unreinforced concrete leveling pad shall be provided as shown on the construction drawings. The footing shall be cured a minimum of 24 hours before placement of wall panels.

2. The top of the leveling pad shall be embedded 3½ -ft minimum, below finished grade surface as shown in the drawings.

E. Wall Erection.

1. Reinforcement Placement.
a. The reinforcement shall be installed in accordance with the manufacturer's recommendations, unless otherwise modified by this Supplemental Specification. The reinforcement shall be placed within the layers of the LFCF as shown on the plans or as directed.

b. The reinforcement shall be placed in continuous longitudinal strips in the direction of main reinforcement. Joints in the design strength direction shall not be permitted.

c. Horizontal coverage of less than 100% shall not be allowed unless specifically detailed in the construction drawings. In the case of 100% coverage in plan view adjacent strips need not be overlapped.

d. Place only that amount of reinforcement required for immediately pending work to prevent undue damage. Suitable arrangement such as supporting the panel from the front temporarily shall be made to hold the reinforcing in place before placing the LFCF backfill. Care should be taken that the reinforcement is not damaged or displaced during the placement of the LFCF.

e. After the specified LFCF layer has been placed, the next reinforcement layer shall be installed. The process shall be repeated for each subsequent layer of reinforcement and LFCF.

f. During construction, the surface of the fill should be kept relatively horizontal. Reinforcements are to be placed within 3 inches of the design elevations and extend the length as shown on the elevation view unless otherwise directed by the Engineer. Correct orientation of the reinforcement shall be verified by the Contractor.

2. Panels.

For erection, panels are to be handled by means of a lifting device set into the upper edge of the panels. Vertical tolerances and horizontal alignment tolerance shall not exceed 0.75 inch when measured along a 10 foot straight edge. The maximum allowable offset in any panel joint shall be 0.75 inch. The overall vertical tolerance of the wall shall not exceed 0.50 inch per 10 feet of wall height, with a maximum total out of tolerance between top and bottom of wall of 2 inches, whichever is less. The panels shall be placed as specified in the plans or as directed by the Engineer during the wall construction. The panels shall be connected to the reinforcing strips as per the methods and materials designed by and specified by the MSE wall vendor.

3. Coping.

The coping shall be placed as shown on the construction drawings as part of the wall construction. Precast coping units shall be mixed, cast, and cured with the same concrete mixture and in the same manner as used for construction of the panels. Cast-in-place coping may be constructed in the same manner or Class C structural concrete may be used; however, the aggregates shall meet the same quality requirements as are specified in Article 4115.02 of the Standard Specifications.

F. Subdrains.

1. The subdrains shall be installed behind the bottom of the MSE wall panels as shown in the drawings. A Second subdrain shall be installed at the base of the temporary excavation backslope, behind the reinforced zone, and at an elevation similar to the subdrain behind the bottom of the MSE wall panels. If required, vertical pipes shall be placed as shown on the plans. The subdrain shall be installed as shown in the construction drawings to maintain gravity flow of water to outside of the reinforced zone. The subdrain should outlet into a storm sewer access or along a slope at an elevation lower than the lowest point of the pipe. Pressure release outlets (RF-19F, Type B) may be used if necessary.

2. Porous backfill, in accordance with Section 4131 of the Standard Specifications, shall be placed around the subdrain to a minimum cover of 3 inches.

G. Placement of LFCF.

1. LFCF shall be a homogeneous mixture and all materials shall be approved prior to use.

2. The areas to be filled shall not have any standing water in it prior to placement of the LFCF. The contractor shall ensure the LFCF remains above the water table at all times during construction.

3. Subgrade for LFCF fill will be prepared in accordance with Section 2109 of the Standard Specifications.

4. Material shall be protected before, during and after installation, and the Installer shall protect the work and materials of other trades. In the event of damage, immediately make replacements and repairs to the acceptance of the Resident at no additional cost to the Department.

5. Precast panels and MSE steel reinforcing strips to be fully or partially encased in the LCFC shall be properly set and stable prior to the installation of the LFCF. Drainage pipes, or any other items that will be encased in the LFCF, shall be set and stable prior to installation of the LFCF.

6. If the LFCF must be placed in freezing conditions, the manufacturer shall be consulted as to what precautions are necessary to assure installation of an acceptable LFCF. LFCF shall not be placed at a temperature of less than 32°F, nor when freezing conditions are expected in less than 24 hours unless precautions are taken to maintain temperatures above freezing. Do not place LFCF on frozen ground.

7. Cure LFCF in accordance with the accepted installation plan.

8. LFCF shall only be proportioned, mixed, and placed using equipment approved by the manufacturer as indicated in the accepted LFCF placement plan. Once mixed, the LFCF concrete shall be conveyed promptly to the location of placement without excessive handling.

9. LFCF shall be placed in lifts not exceeding 24 inches in depth. The first lift shall be at least 2 inches below the top of the lowest MSE wall precast panel.

10. Prior to placing LFCF, vertical and horizontal joints between MSE wall panels shall be covered with geotextile fabric on the back face of the panels.

11. Scarify each lift before placing the next lift. Each lift shall be scarified to a minimum depth of 0.50 inch using a hand rake or other suitable means. Scarifying shall be done in a manner to not disturb the alignment of the reinforcing strips/mesh. Scarifying shall be done after sufficient curing time such that foot traffic will not excessively damage the lift surface (no greater than 0.25 inch) indentation).

12. Allow a minimum of 24 hours between subsequent lifts. Prior to verification of the minimum specified compressive strength by testing, additional lifts may be placed after the 2 day minimum at the Contractor's risk. Any material that does not meet the minimum specified strength within 28 days shall be removed and replaced by the Contractor at no additional cost.

13. Move the discharge hose(s) sufficiently to ensure level filling through the specified fill area. Uneven filling is not permitted.

14. Limit the area of placement to the volume that can be placed within 1 hour, up to the maximum 2 foot lift height. Stagger placements such that the vertical joints are at least 10 feet apart.

15. The discharge hose length shall not exceed 800 feet in length.

16. The final surface finish of LFCF shall be within + 0.1 foot of the elevations shown on the plans, and shall be sloped to promote drainage as indicated on the plans.

17. Paving machines, heavy construction equipment or other unusual loading of the LFCF shall not be permitted until it has attained the specified 28 day compressive strength.

18. Sawing or ripping of the LFCF for utilities, drains or other conflicts will be by methods approved by the Resident.

19. Any material that does not comply with the minimum specified criteria shall be removed and replaced at no additional cost.

20. PVC Geomembrane shall be installed at the top surface of the LFCF as waterproofing.

21. Application will be at locations designated on the Plans and in accordance with the manufacturer's recommendation.

120082.05 METHOD OF MEASUREMENT.

The work involved in construction of Mechanically Stabilized Earth Retaining Walls with LFCF will be measured as follows:

A. Mechanically Stabilized Earth Retaining Wall.
Plan quantity for the completed Mechanically Stabilized Earth Retaining Wall in place, in square feet as provided in the Vendor's approved design submittal to the Engineer will be used for method of measurement, based on the bottom of the leveling pad to the top of the coping.

B. LFCF Backfill Material.
The quantity of LFCF material, in tons or cubic yards, required in the reinforced earth zone and temporary excavation zone identified as an MSE wall design requirement in the contract documents will be the quantity shown in the contract documents.

C. Excavation required for preparing the reinforced earth zone to construct the wall and any core-outs or other remediation/ground improvement areas is included in the general earthwork quantities.

120082.06 BASIS OF PAYMENT.

Payment for construction of Mechanically Stabilized Earth Retaining Walls, satisfactorily placed, will be as follows:

A. Mechanically Stabilized Earth Retaining Wall.
For the number of square feet of Mechanically Stabilized Earth Retaining Wall constructed, the Contractor will be paid the contract unit price per square feet. This payment shall be full compensation for furnishing and erecting the MSE retaining wall including the design, foundation preparation, leveling pad, panels, coping, reinforcement placement, hardware connections between the panel and reinforcement, PVC geo-membrane, and subdrains in accordance with these special provisions.

B. LFCF Material.

1. For Contractor furnished LFCF Backfill material for the reinforced earth zone; any core-outs or other remedial/ground improvement locations; and placed in the temporary excavation zone behind the reinforced earth zone as shown in the contract documents, the Contractor will be paid for the quantity of material furnished, hauled, and actually placed for the contract unit price per ton or cubic yard up to the contract quantity.

2. If the Contractor determines that the slope shown for the temporary excavation zone in the contract documents is not adequate for safety, they shall provide written notification to the

Engineer, including a copy of a slope stability analysis, and identification of the additional quantity of LFCF Backfill that will be needed, before the work begins. The slope stability analysis shall be done by a Professional Engineer licensed in the State of Iowa. The cost of the slope stability analysis shall be the responsibility of the Contractor. If approved by the Engineer, the additional quantity for LFCF Backfill will be adjusted in accordance with Article 1109.03, A, of the Standard Specifications.