SPECIFICATION FOR EXODERMIC® DECK SYSTEMS

[Note: Highlighted regions require input from the author or provide guidance. Highlighting should not be visible on the completed document]

1. DESCRIPTION

[For Precast Decks]

1.01 Contractor shall furnish, deliver, and install the precast Exodermic® deck panels, reinforcing steel, and rapid-setting concrete as shown in the contract drawings and in accordance with the manufacturer's recommendations.

[Or, For Cast-in-Place Decks]

1.01 Contractor shall furnish, deliver, and install the steel Exodermic® grid panels, any miscellaneous metal forms (or other related forming materials), reinforcing steel, and structural concrete as shown in the contract drawings and in accordance with the manufacturers' recommendations. All concrete required for this item shall be placed in the field.

2. MATERIALS

2.01 The materials for this work shall meet the quality requirements of [the relevant portions of the owner's Standard Specifications], unless the same are altered by any specific requirements under any Special Provision, or by notes shown on the contract drawings, or in the Proposal.

[For Precast Decks]

Within 10 days after the contract is awarded, the contractor shall notify the Engineer of the name, address, telephone number, and contact person of the steel grid fabricator and precaster of all deck panels to be manufactured, supplied, and installed.

[Or, For Cast-in-Place Decks]

Within 10 days after the contract is awarded, the contractor shall notify the Engineer of the name, address, telephone number, and contact person of the steel grid fabricator of all deck panels to be manufactured, supplied, and installed.

2.02 The Exodermic® grid deck system must be purchased from one of the following AISC certified fabricators and participating BGFMA members:

Frontier Grating	(256) 845-9556
Mission Critical Solutions	(412) 551-9506

Further information may be obtained from:

BGFMA
Attn: Mike Riley
Tel: (724) 355-1878
bgfma@bgfma.org

2.03 The main bearing bars of the steel grid deck shall be fabricated from WT structural shapes using ASTM A992 steel [A588/A709 Grade 50W [A588M/A709M Grade 345W] may also be specified as an alternate for uncoated applications], and distribution bars and miscellaneous plates shall meet the requirements of A572/A709 Grade 50 [A572M/A709M Grade 345] steel [A588/A709 Grade 50W [A588M/A709M Grade 345W] may also be specified as an alternate]. Welding shall be in conformance with established grid industry practice, including the permitted use of Gas Metal Arc Welding (MIG). Weld qualification and weld procedures in accordance with AWS D1.5 [or per the relevant portions of the owner's Standard Specifications] shall be approved prior to deck panel fabrication.

2.04 The panel layout shown on the Contract plans is suggested. The fabricator shall develop the layout and detail it on the shop drawings.

2.05 Concrete shall be in conformance with [the relevant portions of the owner's Standard Specifications], except that maximum coarse aggregate shall not exceed 3/8" [9.5mm] in size.

2.06 Reinforcing steel shall be in conformance with ASTM A615 Grade 60 [A615M Grade 400].

2.07 Galvanized coatings shall conform to ASTM A123/A123M. Any defects in galvanizing shall be repaired as specified in ASTM A780. Repair materials containing aluminum shall not be used to restore defective areas.

2.08 Unless specified otherwise, leveling bolts, nuts, and washers shall conform to the specifications of ASTM A307, ASTM A563 and ASTM F844 respectively. Leveling bolts need not be galvanized if minimum top cover over the bolts of 2.5 inches [63.5 mm] is provided.

2.09 The vertical steel sheet metal form pans installed in the grid prior to galvanizing shall conform to the latest specification for ASTM A366/A366M or A1011/A1011M. Galvanized steel sheet metal forms installed following grid

panel galvanizing shall conform to the latest specification for ASTM A653/A653M, furnished in the gauge specified on the contract drawings. All metal forms shall be protected during shipment and site storage to retain their shape until deck panel installation.

[Include 2.10 for Precast Panels]

2.10 Rapid-setting concrete for the field closure pours shall conform to [the relevant portions of the owner's Standard Specifications]. Coarse aggregate shall not exceed 3/8" [9.5 mm] in size. Prior to opening to traffic, the design compressive strength of the closure pour concrete shall be attained, or other design strength allowable in accordance with the manufacturer's recommendations. Where no overlay is specified and to the extent feasible, rapid-setting concrete color shall match that of the precast concrete surface of the precast panel.

3. CONSTRUCTION DETAILS

3.01 **Steel Grid Deck**

A. The steel grid deck shall be fabricated to the dimensions and properties as shown on the plans, shop drawings, and in accordance with [the relevant portions of the owner's Standard Specifications]. The use of tertiary or supplemental bars to develop composite action between the concrete deck and steel grid shall not be allowed. Weld sizes shall be in conformance with established grid industry practice unless otherwise indicated on the contract plans. It shall be the contractor's responsibility to field verify all dimensions in order to make necessary changes prior to fabrication. Due consideration shall be given to the placement of leveling devices to provide adequate clearance for their field adjustment from above using a socket wrench and for adequate clearance for field placement of headed shear studs. After the attachment of edge bars, leveling devices, vertical form pans, and other components as described in the plans and specifications, the grid deck shall be galvanized in accordance with ASTM A123/A123M [or the relevant portions of the owner's Standard Specifications].

B. The dimensional tolerances for each steel grid panel shall be in accordance with the most recent version of BGFMA TS-01, "Fabrication Tolerances for Grid Decks", published by the Bridge Grid Flooring Manufacturers Association.

[Or]

B. The steel grid deck panels shall be fabricated within the following tolerances:

Panel Length (L)	±0.25"[6.4mm] (in the direction of main bar)
Panel Width (W)	+0, -0.125"[-3.2mm] (in the direction of distribution bar)
Squareness (Diagonals 'D1' and 'D2')	|D1-D2| ≤ 0.5"[12.7mm]

Longitudinal Camber	0.003*L
Transverse Camber	0.004*W
Sweep (side bow) ('L' in feet, tolerance in inches) ['L' in meters, tolerance in millimeters]	0.025*L (for L ≤ 40'-0") 0.00065*L^2 (for L > 40'-0") [20.83*L (for L ≤ 12.192m)] [0.178*L^2 (for L > 12.192m)]
Main Bar Verticality	0.04*H ('H' = full bar height) (See Note 1)
Distribution Bar Verticality	0.04*H ('H' = full bar height) (See Note 1)
Bar Spacing (Main Bar & Dist. Bar)	±0.125"[3.2mm] center to center (See Note 1)

Note 1: No more than 1% of all locations can violate specified tolerance.

C. Sheet metal forms shall be installed in such a manner as to minimize leakage.

D. Lifting locations and lifting procedures shall be included on the shop drawing submission. Care shall be taken to avoid twisting of the panels or bending of the panels in the weak (perpendicular to main bar) direction. [Use of multiple pick points is recommended.] Steel grid panels must be properly blocked with wood (with due regard to built-in panel camber) during transportation and storage in order to avoid distortion or other damage.

3.02 **Precast Concrete**

A. A concrete mix design, to be approved by the owner, shall be submitted along with the shop drawings prior to commencing work. The concrete mix provided shall produce concrete that shall attain a minimum 28-day compressive strength of 4000 psi [27.6 MPa] [or other design strength specified]. 3/8" [9.5 mm] maximum coarse aggregate shall be used in the mix.

B. Rebar layout shall consider the location of the leveling bolts, providing sufficient clearance for adjustment in the field using a socket wrench. Main (top) rebar, which runs in the same direction as the main bearing bars of the steel grid, shall be placed a minimum of 1" from the web of the main bearing bars. Minimum cover between rebar and exposed surfaces of precast concrete shall be 1" unless otherwise shown on the plans.

C. The top surface of the roadway shall be given a textured finish as designated by the Engineer.

D. The casting bed and forms shall have provisions for straightening and holding the steel grid panels flat and square prior to placing concrete. The steel grid panels shall be checked for conformity with the required dimensions as to cross slope, and must be supported to prevent displacement during precasting operations to obtain the proper concrete thickness.

E. Precast panels shall not be removed from the forms or moved until the concrete has reached the greater of 3500 psi [24.1 MPa] or 75% of the concrete design compressive strength.

F. Precast panels shall be properly cured until the concrete reaches its 28-day design strength.

G. The dimensional tolerances of a completed precast panel in any direction shall be ±1/4 inch [±6.4 mm].

H. After curing, all form release material and any other forming materials adhering to the vertical faces of concrete shall be removed. Precast concrete vertical faces shall be sandblasted, with care taken to avoid damage to the galvanized or epoxy coatings.

I. A rigid lifting frame should be used whenever the precast panels are moved. Lifting locations must be positioned to limit stresses in the panel and analysis should consider stresses caused by deflection of the lifting frame. Proposed handling methods must limit the actual concrete tensile stresses to the concrete modulus of rupture based upon the proposed support locations and expected dynamic loading during handling, storage, and transportation of the panels. Particular care shall be taken to avoid twisting of the panels or bending of the panels in the weak (perpendicular to the main bar) direction.

J. The completed panels shall be marked with their proper identification number. Panels shall be stored and shipped right side up, and wood lagging shall be used (with due regard to built-in panel camber) to prevent steel, concrete, sheet metal, or galvanized coating damage. At a minimum, lagging shall be placed immediately adjacent to the proposed lifting locations and at the ends of the panel. Preferably, blocking should be placed at all stringer (floor beam) block-outs and at the ends of the panel. Blocking between stacked panels must be in vertical alignment across the panel width. Stack no more than four precast panels high.

[Or, For Cast-in-Place Decks]

3.02 **Concrete**

A. A concrete mix design, to be approved by the owner, shall be submitted for approval prior to commencing work. The concrete mix provided shall produce concrete which shall attain a 28-day compressive strength of 4000 psi [27.6 MPa] [or other design strength specified]. 3/8” [9.5 mm] maximum coarse aggregate shall be used.

B. The top surface of the roadway shall be given a non-skid texture as designated by the Engineer.

3.03 **Field Installation** [For Precast Panels]

A. Installation and installation tolerances shall be in accordance with this specification and the most recent version of BGFMA TS-03, "Installation Tolerances and Guidelines for Grid Reinforced Concrete Bridge Decks," published by the Bridge Grid Flooring Manufacturers Association.

[Or]

A. Installation shall be in accordance with this specification and the most recent version of BGFMA TS-03, "Installation Tolerances and Guidelines for Grid Reinforced Concrete Bridge Decks," published by the Bridge Grid Flooring Manufacturers Association. The steel grid deck panels shall be installed within the following tolerances:

1.) Alignment: Main bearing bar misalignment between adjacent grid deck panels shall be no more than 1/2" [12.7mm].
2.) Gap: Distance between main bearing bars between adjacent grid deck panels shall be as specified, ±1/2" [±12.7mm] but shall not exceed 8" [203.2mm].

B. Panels will be delivered to the job site free from any defects and bearing the proper identifying marks.

C. When rehabilitating a structure, and prior to deck panel installation, blast clean the top surfaces of beam flanges and the surfaces of concrete and uncoated reinforcing steel that will be in contact with new rapid-setting concrete according to [the relevant portions of the owner's Standard Specifications].

D. The panels shall be placed on the structure with careful consideration given to the alignment of each adjacent panel. Measure from fixed points to avoid cumulative error. Lifting panels from the leveling devices, rebar, or distribution bars is prohibited.

E. Adjustment to proper elevation shall be made through the use of the built-in leveling bolts if specified, or shims or other means.

F. After all panels have been adjusted to their proper elevation, and all haunch and miscellaneous forms have been installed, the contractor shall install the welded headed shear studs to the steel stringers, girders, and/or floor beams as detailed on the plans through the openings provided in the deck panels. Alternatively, with careful layout, studs may be installed prior to placing deck panels. A separate welding generator shall be used to furnish power to each stud gun in order to assure acceptable welds.

G. After all studs have been installed, the Contractor shall clean the top surface of all flanges before any concrete is placed, including breaking the ceramic ferrules around the welded studs.

H. At haunches and areas of full-depth concrete, the contractor shall seal the openings in the main bars using duct tape or other similar material prior to concrete placement. Seal the openings from the haunch or full-depth side.

I. Rapid setting concrete for field closure pours shall be placed, finished, and cured in accordance with [the relevant portions of the owner's Standard Specifications]. Maximum coarse aggregate size shall be 3/8" [9.5 mm]. A pencil vibrator shall be used in the haunch and transverse panel connection areas to assure good consolidation.

[Or, For Cast-in-Place Decks]

3.03 **Field Installation**

A. Installation and installation tolerances shall be in accordance with this specification and the most recent version of BGFMA TS-03, "Installation Tolerances and Guidelines for Grid Reinforced Concrete Bridge Decks," published by the Bridge Grid Flooring Manufacturers Association.

[Or]

A. Installation shall be in accordance with this specification and the most recent version of BGFMA TS-03, "Installation Tolerances and Guidelines for Grid Reinforced Concrete Bridge Decks," published by the Bridge Grid Flooring Manufacturers Association. The steel grid deck panels shall be installed within the following tolerances:

1.) Alignment: Main bearing bar misalignment between adjacent grid deck panels shall be no more than 1/2" [12.7mm].
2.) Gap: Distance between main bearing bars between adjacent grid deck panels shall be as specified, ±1/2" [±12.7mm] but shall not exceed 8" [203.2mm].

B. Panels will be delivered to the job site free from any defects and bearing the proper identifying marks. Check the panels for defects and identification. Repair or replace the grid panels or metal forms damaged during shipment and storage, to the satisfaction of the Engineer.

C. When rehabilitating a structure, and prior to deck panel installation, blast clean the top surfaces of existing beam flanges and the surfaces of concrete and uncoated reinforcing steel that will be in contact with new concrete according to [the relevant portions of the owner's Standard Specifications].

D. Position panels on the beams and align with adjacent panels. Measure from fixed points to avoid cumulative error. Adjustment to proper elevation shall be made through the use of the built-in leveling bolts if specified, or shims or other means. Square up panels as necessary.

E. After all haunch and miscellaneous forms have been installed, the contractor shall install the welded headed shear studs to the steel stringers, girders, and/or floor beams as detailed on the plans through the openings provided in the deck panels. Alternatively, with careful layout and the Engineer's permission, studs may be installed prior to placing deck panels. A separate welding generator shall be used to furnish power to each stud gun in order to assure acceptable welds.

F. After all studs have been installed, the Contractor shall clean the top surface of all flanges before any concrete is placed, including breaking the ceramic ferrules around the welded studs.

G. Gaps between the main bars and the horizontal form pans shall be field sealed by the contractor with silicone caulk as required to prevent excessive concrete and grout leakage.

H. At haunches and areas of full-depth concrete, the contractor shall seal the openings in the main bars using duct tape or other similar material prior to concrete placement. Seal the openings from the haunch or full-depth side.

I. No concrete shall be placed until all grid panels are in place on the bridge, and secured in proper position and all welded [and bolted, if any] headed shear studs and reinforcing steel is installed in accordance with [the relevant portions of the owner's Standard Specifications]. Main (top) rebar, which runs in the same direction as the main bearing bars of the steel grid, shall be placed a minimum of 1" from the web of the main bearing bars.

J. Concrete shall be placed, finished, and cured in accordance with [the relevant portions of the owner's Standard Specifications]. A pencil vibrator shall be used in the haunch and full depth areas between grid panels to assure good consolidation.

K. The vertical surfaces of any construction joints shall be thoroughly coated with a Portland cement mortar bonding grout [or other suitable material].

L. Where feasible, a worker with a high-pressure water hose shall be stationed under the deck during all concrete pouring and finishing to wash any drips off of the structural steel. Care must be taken not to disturb the form pans in the grid deck with the high-pressure stream.

M. Damaged or defective concrete shall be repaired or replaced in accordance with [the relevant portions of the owner's Standard Specifications].

4. METHOD OF MEASUREMENT

4.01 Precast Exodermic® panels shall be measured as the total gross square footage of the deck slab panel installed and inspected in accordance with the plans and specifications. Measurements shall be taken from the outside edge to outside edge of the top surface of the deck slab in both directions. No deduction shall be made for joints, block-outs, or openings.

[Or, For Cast-in-Place Decks]

4.01 Exodermic® panels shall be measured as the total gross square footage of the grid deck panel installed and inspected in accordance with the plans and specifications. Measurements will be taken from the outside edge to outside edge of the grid panel in both directions. No deduction will be made for joints, block-outs, or openings.

5. BASIS OF PAYMENT

5.01 The unit bid price shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work, including the furnishing and installation of all deck panels, which also includes the cost of transportation, storage, and protection from damage to the deck panels.

COMMENTARY TO SPECIFICATION FOR EXODERMIC® DECK SYSTEMS

C2.05 Aggregate size greater than 3/8" could potentially prevent consolidation of concrete in and around fabrication punches critical for the development of composite action with the grid. Additionally, as the clearance between the bottom of the WT main bearing bar and top flange of the supporting steel decreases; it becomes more difficult to obtain full consolidation of concrete under the WT. The recommended minimum design haunch is 1-1/2". However, this is not always achievable, and site conditions will dictate the height. For haunch heights less than the minimum, it is suggested that a high strength grout be poured to the bottom of the WT main bars over the supporting member prior to placement of field placed concrete. In this way, complete transfer of the load is ensured.

C2.07 ASTM A780 allows for three methods of repair: Zinc-Based Solders (Hot-Stick), Paints Containing Zinc Dust, or Sprayed Zinc (Metalization). Although some states include repair procedures within construction specifications, fabricators should have the ability to select which method of repair in accordance with A780 is most convenient.

C2.10 Due to the inherent cold joints associated with precast panel construction, an overlay is always recommended to reduce the potential for intrusion of harmful brine from deicing salts. If an overlay is not specified, a "plaid" appearance is expected from the different shades of concrete. This is the result of different materials that were used to batch the precast and closure pour concretes at separate locations and times. An exact match is impossible to obtain, however, a close match is possible if samples of both precast and closure pour concrete are submitted in advance.

C3.02A The strength of a grid reinforced concrete deck system is determined by the transformed area method. Although 28-day compressive strength requirements vary among owners, 4000 psi is generally the lowest strength specified for concrete bridge decks. Therefore, fabricators have developed design tables and literature for their systems using a concrete design compressive strength of 4000 psi. Specification of compressive strengths less than 4000 psi could alter the modular ratio and therefore affect the strength of the composite system and deviate from published design tables.

In general, when specifying concrete for bridge decks, a low W/C (< 0.4) is preferred. Low W/C ratios result in higher strength, low permeability concrete. Low W/C ratios and air entrainment increase the durability of the concrete. Although a low W/C ratio results in a lower slump and therefore reduced workability, plasticizers have been used successfully to increase the workability without sacrificing strength.

C3.02F (Precast only) Allowable curing methods vary among owners; however, water curing is certainly the most widely accepted method. Continued hydration through water curing allows a supply of water to react with the cement for the concrete to gain strength. A minimum period of seven days is often specified.