SECTION 3 - DECK SYSTEMS *(Revised 9/12)*

3.0 – THRUWAY DECK SLAB AND OVERLAY POLICY

The following Thruway deck slab and overlay policy is to be applied to all Thruway mainline, Thruway ramp and non-Thruway overhead bridges built (new), replaced or rehabilitated by a NYSTA construction contract. The following policy can only be deviated from when a request to do so is made by the **DSD**, a Thruway Division Director, or a local municipality, and the request is approved by the **Assistant Chief Engineer** (**ACE**).

3.0.1 – NEW AND REPLACEMENT BRIDGES

The Thruway Authority allows the design and construction of both monolithic cast-in-place concrete bridge decks and two-course bridge decks; but a monolithic cast-in-place concrete bridge deck is the Thruway's preferred, and most commonly used, new deck design. However, designers are encouraged to thoroughly investigate other methods early in a project's scoping phase, a few alternate methods are presented in Subsection 3.2.

All new or replaced bridges shall be designed and detailed using monolithic cast-in-place concrete bridge deck details as the first option. (See Subsection 3.1.1.1)

A new two-course bridge deck can be considered for a new or replacement bridge project, but the use of a two-course bridge deck must be approved by the **ACE** during the scoping phase of a bridge project. A new two-course bridge deck may use a bonded cement concrete overlay or an asphalt concrete overlay over a cast-in-place concrete structural deck. An example; a request to use a two-course bridge deck may be based on: 1) bridge deck construction staging issues that could impact the cross-section and smoothness of the completed final wearing course, and/or 2) requests by

NYSDOT or a local municipality to provide a specific type of wearing surface. (See Subsection 3.1.2.1)

3.0.2 - REHABILITATED BRIDGES

A bridge rehabilitation project can include "non-protective" bridge deck repairs, a complete "protective" bridge deck rehabilitation, or a complete replacement of an existing failing bridge deck.

"Non-protective" bridge deck repairs are performed (in conjunction with other bridge project work) to eliminate premature isolated failures of an existing monolithic or two-course bridge deck, and are expected to allow the repaired bridge deck to reach its original designed service life age. "Non-protective" bridge deck repairs for isolated locations are to be designed, detailed and constructed with the same methods and details used for "protective" bridge deck rehabilitations of monolithic bridge decks (see Subsection 3.1.1.2) and two course bridge decks (see Subsection 3.1.2.2).

A "Protective" bridge deck rehabilitation is performed (in conjunction with other bridge project work) to eliminate extensive zone failures of an existing monolithic bridge deck (see subsection 3.1.1.2) or two-course bridge deck (see Subsection 3.1.2.2), and is designed to extend the service life of the existing bridge deck. Protective bridge deck rehabilitations can include: i) zone repairs of monolithic decks combined with the application of a protective penetrating deck sealer, ii) zone repairs of monolithic decks combined with a bonded concrete overlay and the application of a protective penetrating deck sealer, or iii)) zone repairs of monolithic decks combined with a waterproofing membrane and an asphalt concrete overlay.

All "Protective" bridge deck rehabilitations shall be designed and detailed for a bonded concrete overlay as the first option.

The use of a "Protective" waterproofing membrane and asphalt concrete overlay is to be requested and approved by the **ACE** during the scoping phase of a bridge project.

The complete replacement of a failing bridge deck (as part of a bridge rehabilitation project) is performed to meet the design and service life requirements of a new bridge deck (see Subsection 3.0.1).

3.0.3 – FUTURE WEARING SURFACE: For a New, Replaced, or Rehabilitated Bridge

New and Replacement Bridges - A 2 inch future asphalt concrete overlay design load of (25 psf) shall be included in the design of all new and replacement bridges; regardless of whether a project has Authority, NYSDOT and/or federal funding. This future wearing surface design load shall be in addition to the design load of the wearing surface applied to the deck at the time of construction (if applicable). The 2 inch future wearing surface design load shall be included in the Load Rating of all new and replacement bridges of projects with 100% Authority funding. This inclusion shall be stated on the title sheet of the contract drawings below the load rating table. On projects with NYSDOT and/or federal funding, the Load Rating on the Title Sheet shall not include the future wearing surface design load.

Rehabilitated Existing Bridges - A future asphalt concrete overlay design load is not to be included in the design of deck rehabilitations or deck replacements for existing bridge superstructures. A future asphalt concrete overlay design load shall be included in the Load Rating of deck rehabilitations or deck replacements for existing bridge superstructures if the additional load will not result in an inventory load rating of less than HL-93 and HS-20. The inclusion, or not, of the 2 inch future wearing surface design load in the Load Rating of the bridge shall be stated on the title sheet of the contract drawings below the Load Rating table on 100% Authority funded projects only. On projects with NYSDOT and/or federal funding, the Load Rating on the Title Sheet shall not include the weight of the future wearing surface.

3.0.4 – HOT MIX ASPHALT (HMA) DESIGN AND SPECIFICATION

For bridge deck overlays and bridge approach pavement; the designer shall design and specify 402 series HMA items; unless directed otherwise. The designer shall reference NYSTA Design Bulletins (DB 09-002) and (DB 09-003) in order to become familiar with the design requirements for Authority placed asphalt concrete pavement. For additional HMA design guidance see Subsection 3.1.2.4.

Although 403 series **HMA** items continue to be part of the NYSDOT Standard Specifications, 403 series **HMA** items will not be specified for Authority projects, except when approved by the **ACE**.

It is anticipated that Warm Mix Asphalt (**WMA**) designs (proposed 404 series) may become an asphalt concrete option to specify for deck overlays in the near future and guidance will be provided by the Design Support Services Bureau when that happens.

3.1 - CAST-IN-PLACE (CIP) CONCRETE DECK SLABS

3.1.1 – MONOLITHIC CIP CONCRETE DECKS

3.1.1.1 – NEW MONOLITHIC SUPERSTRUCTURE DECKS

3.1.1.1a – TYPICAL NEW MONOLITHIC SUPERSTRUCTURE DECK SECTION

New monolithic superstructure **CIP** concrete deck slabs shall have a thickness of 9 ½”, which includes a monolithic wearing surface. Where conditions permit, an isotropic reinforced type monolithic deck design is preferable to a “Traditional” reinforced beam type deck design (see

Subsection 3.1.3.1 – Guidelines for Isotropic Reinforced Bridge Decks). Otherwise, a "Traditional" monolithic deck shall be used (see Subsection 3.1.3.2 – Guidelines for "Traditionally" Reinforced Bridge Decks).

3.1.1.1b - GUIDELINES FOR MONOLITHIC SUPERSTRUCTURE DECK & APPROACH SLAB CONCRETE

The NYSDOT standard specifications for superstructure deck and approach slab concrete include friction requirements for both the coarse and fine aggregate. Subsection 5.1.11 of the NYSDOT Bridge Manual provides design guidance on the subject and has been modified here for our use on Authority bridge projects.

Aggregate Requirements for Concrete Superstructure Decks and Approach Slabs

To provide adequate wet weather friction, a concrete wearing surface must have sufficient macro-texture and micro-texture. Macro-texture is provided by the surface profile created by the coarse aggregate of a concrete mix (which is revealed as the cement paste wears away over time), and by manipulating the concrete surface profile during or after construction (e.g., saw cut grooving or diamond grinding). Micro-texture is the texture on both the surface of the exposed cement paste with embedded fine aggregates (which wears away over time) and on the surface of the exposed coarse aggregate particles. As concrete superstructure decks and approach slabs are subjected to traffic loads, the individual contributions of macro-texture and micro-texture to the available surface friction vary and are reduced; the cement paste abrades away, surface tining or grooving wears down, the surface of exposed coarse aggregates is smoothed/polished, and the surface profile from coarse aggregates is reduced. If the macro-texture of a concrete wearing surface is worn excessively smooth before a deck or slab reaches the end of its structural life, macro-texture can be improved through relatively inexpensive treatments such as diamond grinding or diamond grooving. However; once compromised, micro-texture cannot be restored through inexpensive treatments, and in most cases the only remedy is to overlay the surface.

Under traffic loads; the hardness of the aggregate determines its resistance to profile wearing with a loss of macro-texture, and to surface polishing with an unrecoverable loss of micro-texture. Therefore, it is essential that an aggregate with an appropriate hardness be used during the initial construction of the slab. Since the harder aggregates are more expensive and of limited supply, it is not appropriate to simply use the hardest aggregates in every situation.

The required aggregate hardness depends on the site geometry and available accident history. Braking traffic or turning traffic will polish aggregate more quickly than straight rolling traffic. The NYSDOT Standard Specifications Section 501 – “Portland Cement Concrete” contains the material requirements for four types of friction aggregates; Types 1, 2, 3 and 9. Each type is intended for use under specific traffic and geometric conditions. Increasing the macro-texture of a superstructure deck or approach slab with a surface texture treatment, such as saw cut grooving or diamond grinding, does not compensate for using an inappropriate aggregate that does not meet a specified friction aggregate requirement.

If the locations of all portions of a monolithic bridge superstructure deck and its approach slabs do not meet any of the criteria listed below, Type 9 friction aggregate shall be specified. If the location of any portion of a bridge’s monolithic superstructure deck(s) or approach slabs meet any one or more of the (6) criteria listed below, use the following “Aggregate Type Selection Table” (Table 3.1.1.1b) to determine the appropriate friction aggregate type to be used. The designer shall specify only one type of friction aggregate for each bridge and its approach slabs by selecting the appropriate superstructure slab and approach slab pay items.

i). The deck or approach slabs are ≤ 500 feet before a stop sign, traffic signal, or yield sign, as measured from the stop bar or yield sign.

ii). The deck or approach slabs are in a location where vehicles regularly queue regardless of distance from a traffic control device.

iii). The deck or approach slabs are ≤ 500 feet before an exit ramp, as measured from the initiation of the taper for the deceleration lane.

iv). The deck or approach slabs are ≤ 500 feet after an entrance ramp, as measured from the terminus of the taper for the acceleration lane.

v). The deck or approach slab is located on an entrance or exit ramp.

vi). Any location where the ratio of wet weather accidents to total accidents is greater than the state average for the same facility type.

PCC Friction Aggregate Type Selection Table – 3.1.1.1b

Highway System	Traffic	Location	Aggregate Type
NYSTA Mainline and Ramp Bridges	High or Low Volume (1)	New York Division	Type 1
	High or Low Volume (1)	Buffalo, Syracuse and Albany Divisions	Type 2
All Other Bridges	High Volume (1)	New York Division	Type 1
	High Volume (1)	Buffalo, Syracuse and Albany Divisions	Type 2
	Low Volume (1)	All Divisions	Type 3

(1) “High Volume” refers to single lane bridges with design year AADT over 4000, 2 or 3 lane bridges with two-way design year AADT over 8,000, or bridges with 4 or more lanes with two-way design year AADT over 13,000. ”Low Volume” refers to bridges not meeting the aforementioned criteria.

3.1.1.2 - REHABILITATION OF EXISTING MONOLITHIC DECKS

During project scoping, information should be obtained to determine whether or not an existing monolithic deck should receive "non-protective" bridge deck repairs, a complete "protective" bridge deck rehabilitation, or a complete replacement of an existing failing bridge deck (see Subsection 3.02). Making this determination begins with a deck evaluation. It is important to carefully determine how much of the concrete deck requires full and partial-depth repairs along with correcting any factors that are affecting its performance.

3.1.1.2a – BRIDGE DECK EVALUATION

Refer to the following Table 3.1.1.2 – "Thruway Bridge Deck Evaluation Summary Table" and the NYSDOT "Bridge Deck Evaluation Manual" for recommended deck evaluation methods and procedures for various deck sizes and conditions. In general, the evaluation methods shown in Table 3.1.1.2 shall take precedence over those shown in the NYSDOT Bridge Deck Evaluation Manual.

Bridge Deck Evaluation Methods:

A) Visual Deck Examination: Examine the top and underside of the deck carefully, paying particular attention to low areas where moisture accumulates; i.e. curb lines, joints, potholes, etc. If the bridge deck has **Stay-In-Place (SIP)** forms; an under-deck visual inspection will be limited to: a) visible signs of leakage or corrosion of the **SIP** forms, and b) visible signs of leakage and concrete deterioration in deck overhangs and/or closure pour placement areas. If necessary, **SIP** forms can be removed so that a more thorough visual inspection can be done.

Concrete decks usually deteriorate from top to bottom, especially where moisture has been allowed to sit for significant periods of time based on review of past inspections. Decks can also deteriorate from the underside by wicking action, a process in which roadway spray and ambient moisture can collect on the surface and then penetrate the concrete deck. Decks designed between the 1950's and early 1970's used less reinforcement cover and thinner decks than today, typically 1 ½ inches of cover on top and 1 inch on bottom. These decks also used uncoated reinforcing steel. Since many of the originally constructed bridges over the Thruway have vertical clearances of 14'-6" or less, the years of exposure to chloride saturated road spray coupled with thin concrete cover can cause corrosion of the bottom reinforcement mat creating a condition for greater underside concrete delaminating or spalling, than for the typical top to bottom deck deterioration. Newer bridges have more cover top and bottom and the reinforcing

THRUWAY BRIDGE DECK EVALUATION SUMMARY TABLE

Evaluation Method		Appropriate For	Deck Area ≤ 10,000 SF	10,000 SF >D.A. ≤ 25,000SF	Deck Area > 25,000 SF
Visual Deck Examination		Monolithic/2 Course	✓	✓	✓
Under Deck Sounding		Monolithic/2 Course	✓	✓	
Coring (See Notes 1 & 4)	Compressive Strength	Monolithic/2 Course	✓ (See Note 1)	✓	✓
	Air Content (See Note 5)	Monolithic/2 Course			✓
	Freeze-Thaw (See Note 5)	Monolithic/2 Course			✓
Chloride Measurement		Monolithic/2 Course		✓	✓
Electrical Potential		Monolithic			✓ (See Note 2)
		2 Course			✓ (See Note 2)
Thermography		Monolithic			✓ (See Note 3)

TABLE 3.1.1.2

Notes for Designer:

1) Deck cores shall only be taken for strength assessment if the designer is unsure of the quality of the concrete after the visual inspection and under deck sounding.

2) Electrical Potential tests criteria must be modified for decks that contain galvanized reinforcement to avoid erroneous half cell potential readings. This testing can only be done after any existing overlay has been removed.

3) Thermography is effective on monolithic decks only and thus is not appropriate for two course decks.

4) Deck cores for thickness may need to be taken if the actual thickness of the existing deck or overlay(s) is in question and is relevant to the type of rehabilitation work being performed.

5) Freeze-Thaw and Air Content tests should only be used on concrete known to have included air entrainment admixtures, generally used starting in the 1980's.

steel is coated (epoxy coating in the 1980"s & early 1990's, galvanized reinforcing since the early-mid 1990's). In any case, a visual examination, combined with a tactile hands-on inspection, will help to determine whether there is the need for other evaluation methods.

If visual and tactile examination reveals under-deck delamination and spalling in excess of 20% or more of the deck's underside, and the remaining concrete above theses areas is wet or loose (within the limits of these delaminations and spalls); then there is no need to continue with other evaluation procedures and the deck must be replaced.

B) Deck Sounding:

Top-of-Deck Sounding: If an overlay has not been installed, the top of the deck can be chain dragged to determine the amount of partial depth repairs to be made.

Under-deck Sounding: If visual and tactile examination reveals under-deck delamination and spalling over less than 20% of the deck's underside, the remaining concrete above theses areas is dry, damp, wet or loose (within the limits of these delaminations and spalls), and the total deck area is less than or equal to 25,000 sf, a complete underside deck inspection (sounding) shall be done to accurately determine the amount of full depth repairs required.

Spalled dry areas on the underside of the deck that are found to be solid from hands-on inspection are probably the result of inadequate cover. These areas usually do not require full depth repair from the top. Simply blast cleaning the concrete and reinforcing steel in the area and coating with an epoxy based primer and paint, is the recommended treatment on non-protective deck repair projects.

C) Deck Cores: Deck cores shall be taken to support the findings of the visual examination and sounding investigation of the deck in question as directed in Table 3.1.1.2.

Deck cores should also be taken to determine the actual thickness of the deck and any overlays, so that accurate removal and replacement quantities can be determined and accurate sections can be shown on the plans.

Core samples shall be obtained through both non-deteriorated and deteriorated sections of the deck. Designers should attempt to avoid locating cores over travel lanes, railroad **Right-Of-Way (ROW)**’s, structural members, and water whenever possible.

Requesting deck cores requires providing a plan view of the deck in question and showing specific full and partial depth cores and their locations, dimensioned with offsets from features such as curbs and joints.

Different laboratory tests can be performed on the cores. Compression testing provides a measure of the present strength, and when compared to the original specified strength can provide some insight into the remaining service life. Chloride tests performed at the level of reinforcement can provide insight to the potential for further corrosion of the reinforcement that will lead to hollow sounding concrete, delaminations, and spalls. Freeze-Thaw and Air Content tests should only be used on concrete known to have included air entrainment admixtures, generally used starting in the 1980’s. These tests provide insight to the present and remaining durability to the seasonal affects of our cold climate. These tests can also help to determine the magnitude of current and potential problems, and to support the amount and types of concrete removal or repair. The NYSDOT Bridge Deck Evaluation Manual provides additional details and information on the above tests.

On in-house projects; cores are requested through the Project Manager for the Material Testing Agreements in the Headquarters Office of Construction Management. On a consultant designed project, the consultant shall be responsible for taking the cores and performing the appropriate testing. Coring proposed on a bridge carrying a local or state road may require additional time for Division Maintenance personnel to obtain local or NYSDOT permission allowing Thruway traffic control on the local road. Additionally, coring during the winter months (November thru March) can lead to delays because the same Division Maintenance forces responsible for providing **Work Zone Traffic Control (WZTC)** are also responsible for daily snow and ice removal operations.

D) <u>Additional Testing</u>: On decks larger than 25,000 sf, other methods may be employed for bridge deck evaluation; including “Electrical Potential” and “Thermography”. Reference the NYSDOT Deck Evaluation Manual for further details.

E) <u>Deck Evaluation Follow-up and Documentation</u>: If the chloride tests for the top deck reinforcement are at or below corrosion development levels, an overlay or increased cover may help prolong the life of the structure. If the chloride levels are found to be above the corrosion development levels, the designer should consider the extent of this condition (including full depth deterioration conditions) relative to the planned remaining service life of the deck. The Designer should also compare the cost of a deck rehabilitation to that of a new deck; including any other relevant factors such as structure age, type, required **WZTC**, and location. These factors will help to determine whether the existing deck can be rehabilitated with full and/or partial depth concrete removal, or should be completely replaced.

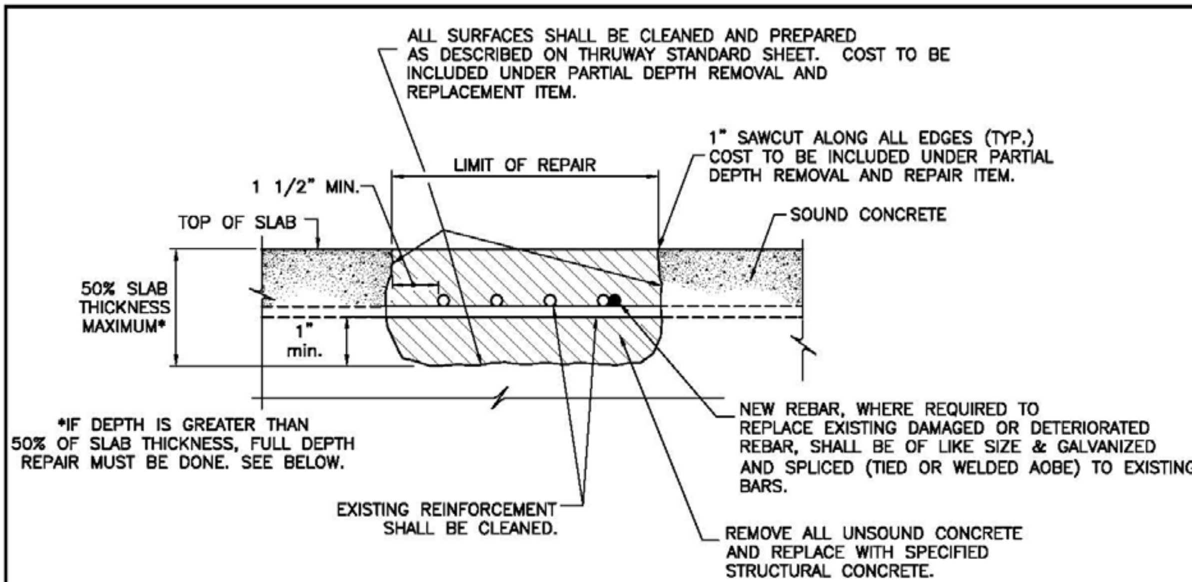
Deck areas determined to require full and/or partial depth concrete removals need to have these areas designated on the plans when possible. If the monolithic deck has an overlay, determining and showing partial depth repair areas will not be possible. The plans should also designate whether only delaminated concrete will be removed, or whether both delaminated and chloride saturated concrete will be removed. These removal areas will be verified by the Construction Project Engineer during construction via chain dragging and visual inspection after the existing overlay is removed. After the removal of any deteriorated deck concrete, any corroded or damaged reinforcement must be repaired or replaced with galvanized reinforcing steel. Based on the extent and type of concrete repairs required, the appropriate Thruway special specification deck repair items should be selected for inclusion in the contract.

3.1.1.2b – TYPICAL DECK REPAIR DETAILS

See Details 3.1.1.2.a and 3.1.1.2.b for typical repair details.

3.1.1.3 - MONOLITHIC DECK (RIDING) SURFACE TEXTURE TREATMENT

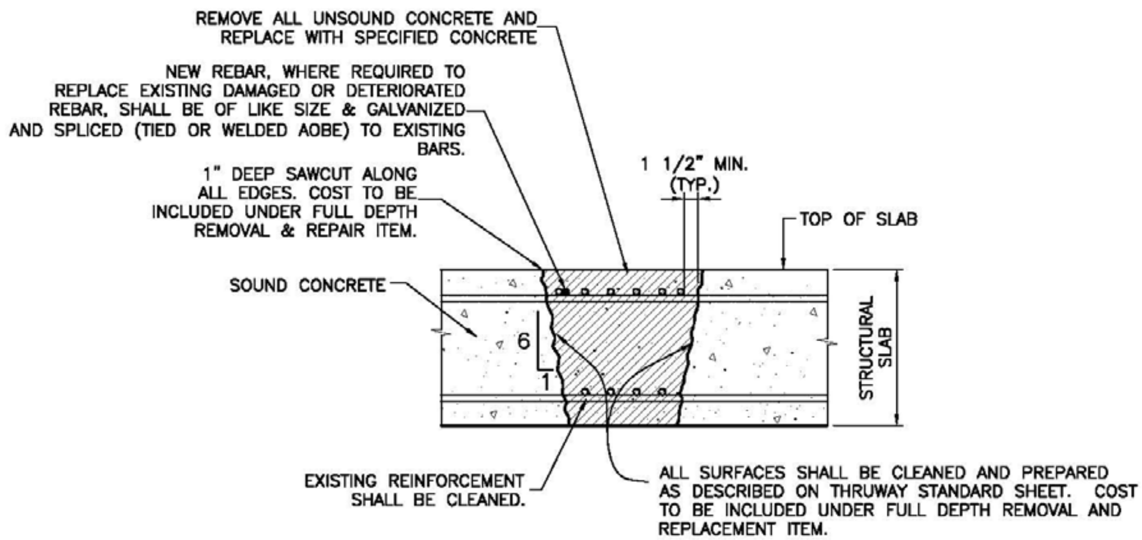
New Monolithic Deck Surface Texturing: The initial surface friction on new bridge decks and approach slabs is reduced by the cement paste coating on new deck surfaces, which wears off with age to expose aggregate surfaces. NYSDOT Standard Specifications Subsection 557-3.07 – "Finishing Integral Wearing Surfaces on Superstructure Slabs" requires an "artificial turf drag" surface texture to be constructed on all new superstructure deck slabs and approach slabs immediately following concrete placement and screeding.



PARTIAL DEPTH REMOVAL OF STRUCTURAL SLAB AND REPLACEMENT WITH CLASS 'D' CONCRETE

DETAIL 3.1.1.2.a

N.T.S.



FULL DEPTH REMOVAL OF STRUCTURAL SLAB AND REPLACEMENT WITH CLASS 'D' CONCRETE (MISC. LOCATIONS, FORMWORK REQUIRED)

DETAIL 3.1.1.2.b

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The “artificial turf drag” surface is a “construction finish”, does not remove the cement paste finish, and does not provide a desired “day-one” high-speed (>45 MPH) traffic surface friction. In addition; the longitudinal tining specified to be placed on new **PCC** highway pavement (immediately following the concrete pavement screeding) is perceived to corrupt the early surface concrete curing of a bridge superstructure deck slab. For this reason bridge deck and approach slab concrete riding surfaces must be reprofiled after adequate wet curing by longitudinal saw cut grooving or longitudinal diamond grinding.

By Thruway policy; longitudinal saw cut grooving shall be applied to all monolithic bridge decks in Albany, Syracuse, and Buffalo Divisions, and longitudinal diamond grinding shall be applied to all monolithic deck surfaces in New York Division. The limits of these applications are from begin to end of bridge (including approach slabs if applicable) to four inches from face of barrier/curb/swale.

3.1.2 – TWO-COURSE SUPERSTRUCTURE DECKS

3.1.2.1 - NEW TWO-COURSE SUPERSTRUCTURE DECKS

Two-course construction for new bridge decks shall only be used on bridges as described in Subsection 3.0.1 – ”NEW AND REPLACEMENT BRIDGES”.

A new two-course bridge deck may use a bonded cement concrete overlay atop a cast-in-place concrete structural deck, or a waterproofing membrane and asphalt concrete overlay over a cast-in-place concrete structural deck.

The concrete superstructure deck slab portion of a new two-course bridge deck shall be "traditionally" reinforced and shall have a thickness of 8 ½".

3.1.2.1a – BONDED CEMENT CONCRETE OVERLAY

The use of a new two-course bridge deck with a bonded cement concrete overlay shall be requested and approved by the **ACE** during a bridge project's scoping process.

New two-course bridge decks with bonded cement concrete overlays are not common, as they are typically more expensive to construct than an equivalent monolithic concrete bridge deck. However; there may be project requirements that can only be met by a two-course bridge deck with a bonded cement concrete overlay. Cement concrete wearing surfaces can withstand high stresses where an asphalt overlay might rut and shove, and construction staging requirements may require an overlay to be used to provide the desired final surface profile across a structure constructed in stages.

The typical bonded cement concrete overlay is 2 inches thick, unreinforced, and can utilize various optional types of concrete depending on thickness and/or design considerations. See NYSDOT Standard Specifications Section 584 – "SPECIALIZED OVERLAYS FOR STRUCTURAL SLABS" for additional work scope, material, and construction details.

3.1.2.1b –ASPHALT CONCRETE OVERLAY with DECK WATERPROOFING

The use of a new two-course bridge deck with an asphalt concrete overlay shall be requested and approved by the **ACE** during a bridge project's scoping process.

If an asphalt concrete overlay is requested and approved, the asphalt concrete overlay combined with a means of waterproofing the superstructure deck on top of which it is placed shall be one of the following three alternate systems:

Alternates:

A. **An Asphalt Concrete Overlay Over An Approved Sheet Membrane**

An approved sheet membrane waterproofing system (a polymer fabric coated with approximately 1/16” of highly modified bituminous material) shall be specified with an appropriate 2 inch asphalt concrete overlay top course. Sheet membranes, being of uniform thickness and documented good performance, are ideal for the protection of new and rehabilitated decks.

The Designer must keep in mind that sheet membranes require a smooth and relatively flat concrete deck surface to prevent punctures and tears during placement and overlaying. Refer to the sheet membrane manufacturer’s recommendations for surface smoothness requirements. The superstructure deck (being protected) must be dry when the sheet membrane is applied to prevent moisture from creating blisters during the subsequent placement of the **HMA** overlay. Clear directions should be included in the contract documents for sheet membrane installation at weep tubes, scuppers, bridge joints, vertical surfaces, etc., as well as overlap details. In addition; the designer must make sure that adequate clearance, between phased membrane and overlay construction stages, can be provided to allow the proper overlap of the membrane material during construction operations without damaging it.

Asphalt concrete overlays (over an approved sheet membrane) being constructed on Thruway mainline and ramp bridges shall be NYSDOT Standard Specifications Section 402 – “HOT MIX ASPHALT” items. For Additional **HMA** design guidance see Subsection 3.1.2.4.

If the asphalt concrete overlay (over an approved sheet membrane) is being constructed on an "overhead" bridge that will be maintained by NYSDOT or a local municipality, and the overhead roadway's **AADT** level does not exceed the maximums indicated in NYSDOT Standard Specification Section 403-1, Asphalt Concrete; if requested by NYSDOT or the municipality, a 2 inch thick "Marshal Mix" NYSDOT Standard Specifications Section 403 – "HOT MIX ASPHALT (HMA) PAVEMENTS FOR MUNICIPALITIES" item may be used.

B. **A Waterproofing Hot Mix Asphalt**

A paveable single layer Waterproofing Hot Mix Asphalt, that acts as an **HMA** top course and as a waterproofing layer/membrane, may be used for total single layer overlay thicknesses less than or equal to 2 inches.

Paveable single layer Waterproofing Hot Mix Asphalt generally consists of an admixture combined and mixed with either an **HMA** shim item, or **HMA** top course item, at the batch plant. Since the "waterproofing" properties of the waterproofing **HMA** mix are integrated into the **HMA** mix; it can be placed on rough surfaces, and can be installed rapidly in a one-step paving operation. Note; single layer Waterproofing **HMA** is more costly than a sheet membrane and asphalt overlay system; but it may be the only constructible deck waterproofing system if construction requires the use of temporary short duration lane closures to place an overlay .

C. **A Waterproofing Hot Mix Asphalt Base Layer With An Asphalt Concrete Overlay**

For total overlay thicknesses above 2 inches, a ¾ inch paveable single layer Waterproofing Hot Mix Asphalt may be placed on the deck as a base waterproofing membrane and finished with the necessary layer(s) of an appropriate asphalt overlay.

3.1.2.2 - REHABILITATION OF EXISTING TWO-COURSE DECKS

All bridge deck rehabilitations for existing two-course decks shall be designed and detailed for a bonded concrete overlay as the first option.

The rehabilitation of an existing two-course deck begins with a complete deck evaluation similar to that described in Subsection 3.1.1.2 – Rehabilitation of Existing Monolithic Decks. The differences between evaluating a monolithic bridge deck and a two-course bridge deck are due to the separate wearing surface of the two-course deck. The separate wearing surface prevents the direct inspection of the top of deck surface.

Two-course structural decks requiring more than 20% (assumed squared off value) full depth repairs **and** 70% partial depth repairs (for a total of 90% of the existing deck area) shall be replaced. Based on the level of deck deterioration; the decision to replace a two-course bridge deck (rather than rehabilitate it) is typically made during the scoping process of a bridge project following a full deck evaluation. Before pursuing a two-course deck rehabilitation, compare its cost to that of a new deck and any other relevant factors, such as structure age, substructure condition, etc. Refer to the NYSDOT Bridge Deck Evaluation Manual for making cost comparisons. Any decisions to replace a two-course deck rehabilitation with a full deck replacement that are made after construction has begun would create a significant contract cost increase.

Although visual inspection of an overlay can help in determining problem areas (continuously damp areas, puddles, disintegrated overlay material), chain dragging of the wearing surface is ineffective in determining accurate partial depth repair areas. Because of this, the area of partial depth repair must be approximated. Figure 3.1.2.2 is a valuable tool used to determine the approximate amount of partial depth repairs based on the amount of full depth repairs determined from the underside deck inspection.

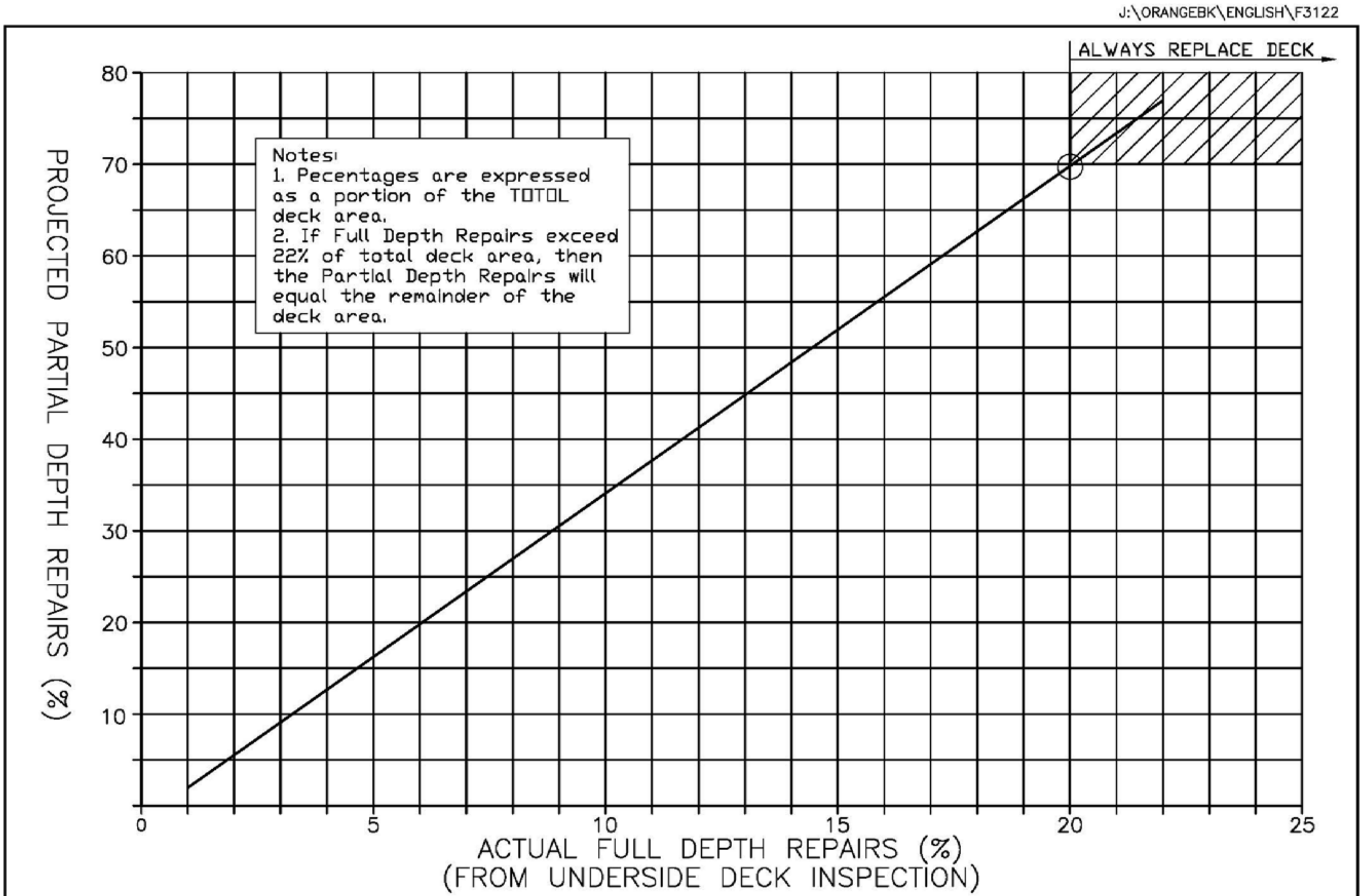
Upon removal of an existing wearing course; all deteriorated deck concrete must be removed, and corroded or damaged reinforcing steel must be repaired or replaced as needed. New concrete is placed in the repair areas and allowed to cure. See Details 3.1.1.2.a and 3.1.1.2.b for typical repair details. For additional information on concrete deck repairs refer to the Thruway Standard Sheet "CONCRETE REPAIR FULL & PARTIAL DEPTH.dwg".

A new wearing course overlay is installed over the rehabilitated deck surface using the same guidance and details provided for the overlay course of a new two-course deck as described in Subsection 3.1.2.1a – "BONDED CEMENT CONCRETE OVERLAY" or Subsection 3.1.2.1b – "ASPHALT CONCRETE OVERLAY with DECK WATERPROOFING".

Example Partial Depth Determination:

An underside deck inspection is done and it is determined that 9% of the total deck area requires full depth repairs. Referring to Figure 3.1.2.2; if 9% of the total deck area requires full depth repairs, then the expected partial depth repair area will be 30% of the total deck area. The total deck repairs for this structure will be 39% of the total deck area.

Before pursuing the rehabilitation, compare its cost to that of a new deck and any other relevant factors, such as structure age, substructure condition, etc. Refer to the NYSDOT Bridge Deck Evaluation Manual for making cost comparisons.



TWO-COURSE BRIDGE DECK REPAIR CORRELATION

FIGURE 3.1.2.2

3.1.2.3 – BONDED CEMENT CONCRETE OVERLAY (WEARING) SURFACE TEXTURE TREATMENT

Bonded cement concrete overlay wearing surfaces shall have the same surface texture treatment as monolithic decks. Refer to Subsection 3.1.1.3 - Monolithic Deck Riding Surface Treatment.

3.1.2.4 - HOT MIX ASPHALT OVERLAY DESIGN AND SPECIFICATION

Although the objective of the guidance given here is to allow the Designer to design and specify the correct Hot Mix Asphalt (**HMA**) items to construct an asphalt overlay over a concrete superstructure deck; the Designer must also consider the Hot Mix Asphalt items required for any highway paving work that will be included with the bridge **HMA** overlay work being specified.

Typically; a minimal number of **HMA** items are to be specified for a single construction contract, and the specified **HMA** items need to be appropriate for both the highway **HMA** paving portion of a contract and the bridge **HMA** overlay portion of a contract. When the quantity of **HMA** placed as highway pavement is significantly greater than the quantity placed as a bridge deck overlay(s) in a single project, the **HMA** items specified are typically governed by highway paving requirements. An **HMA** item chosen and specified as appropriate for both the highway paving and bridge overlay work in a single contract, may require additional **HMA** contract guidance notes and construction details to properly use that specific **HMA** item for both the highway paving and bridge overlay work detailed. Designers can contact the Bureau of Highway Design or the Design Support Services Bureau for assistance in choosing **HMA** items appropriate for a specific contract containing both highway paving and bridge overlay work.

The designer shall reference NYSTA Design Bulletins (DB 09-002) and (DB 09-003) in order to become familiar with the design requirements for Authority placed asphalt concrete pavement. Included in these design bulletins are design parameters that must be determined for the site to properly formulate the required PG binder notes to be inserted into the proposal.

3.1.2.4a – REQUIRED PROJECT DATA FOR PG BINDER AND HMA ITEM SELECTION

For bridge deck overlays and bridge approach pavement; the designer shall design and specify NYSDOT Standard Specification Section 402 series **HMA** items, or NYSDOT/NYSTA Special Specification Section 402 series **HMA** items; unless directed otherwise. Section 402 series items are based on "Superpave" Hot Mix Asphalt material specifications and design criteria; which can incorporate the variability of material properties, environmental (weather and traffic) conditions and construction quality into project specific **HMA** pavement designs.

In contrast; NYSDOT Standard Specification Section 403 series **HMA** items (which are being phased out from use) are "Marshal Mix" **HMA** items having specific fixed **HMA** mix designs (formulas), each created for a specific combination of broad design conditions. Past experiences with specific 403 **HMA** mixes created the current "fixed" mix designs, and rigidly govern their use.

To specify Section 402 **HMA** items for use as a bridge deck asphalt concrete overlay, the Designer must determine the following:

1) The project location establishes the environmental weather conditions to be designed for. For Thruway projects, only two categories establish a project's location, the project is either in the "New York Division" or in the combined limits of the "Buffalo, Syracuse and Albany Divisions".

2) Average Annual Daily Traffic Counts for each significantly different "zone" within a project's limits.

3) Truck Traffic percentages representing the percentage of the **AADT** made up of the combined average daily percentages of **FHWA** Class 4 though Class 14 vehicles, which are all of the "Commercial" vehicles in the daily **AADT** flow.

4) One or more **Equivalent Single Axle Loads (ESAL**s) count(s) must be established that represent traffic within the entire project limits, or that represent traffic within significantly different zones within the project limits.

   NYSTA Design Bulletin (DB 09-003) provides **ESAL**s Count calculation guidance, a "NYSTA Modified **ESAL**s Count Spreadsheet", and a source of **AADT** values and Truck Traffic Percentages within the limits of the entire Thruway, all of which can be used to estimate the **ESAL**s count(s) for a project.

5) Average annual traffic speeds for each significantly different "traffic zone" within the project limits. Assumed average annual traffic speeds only need to be accurate enough to establish which one of three "average speed ranges" includes the average annual traffic speed for each traffic zone within a project's limits.

6) The designer must categorize the asphalt overlay work as maintenance/repair work, rehabilitation work or new/replacement work. Maintenance/repair work and rehabilitation work are grouped together when the work to be performed will allow the overlayed bridge structure to function properly for the remaining service life of the bridge structure. Rehabilitation work and new/replacement work are grouped together when the work to be

performed will create an overlayed bridge structure with an extended service life, or the service life a new structure.

<u>3.1.2.4b – PG BINDER SELECTION AND PG BINDER SPECIAL NOTES FOR CONTRACT PROPOSALS</u>

Using the data collected in Subsection (3.1.2.4a) tasks (1) through (6) above; the Designer can used the guidance of NYSTA Design Bulletins (DB 09-002): "Hot Mix Asphalt: PG Binder Design, Selection & Special Note Guidance" and (DB 09-003): " REVISED Thruway TEFs, and A Modified Calculation of **ESAL**s for Thruway Pavement Design" to select an appropriate PG Binder grade and establish whether or not the PG binder will be "polymer-modified" for a project. This selection process must be done with the concurrence of the associated Thruway Division Highway Engineer to incorporate their division specific experiences with specific PG Binders.

When a PG Binder grade has been chosen and a decision whether or not to use a "polymer-modified" PG Binder has been made; the Designer must create a project specific "Special Note for Contract TA_xx-yy, Hot Mix Asphalt (**HMA**) Criteria" from one of the (2 sets of 2) division specific "Special Notes" the are appended to DB 09-002. The PG Binder "Special Note" that must be included in a project's Proposal document will identify: i) the PG Binder grade chosen, ii) the **ESAL**s count range to be used in a project's **HMA** mix design, iii) whether the PG Binder will or will not be "polymer-modified", and iv) whether the use of **Polyphosphoric Acid (PPA)** (see DB 09-002) will be prohibited (Buffalo, Syracuse & Albany Divisions) or conditionally allowed (New York Division only).

<u>3.1.2.4c – HMA BRIDGE DECK OVERLAY CROSS-SECTION</u>

Bridge deck asphalt overlays will typically consist of:

1. A 2-inch uniform thickness asphalt top course layer over an approved sheet membrane waterproofing system, placed atop an existing or new concrete bridge deck, with no modification of the bridge concrete superstructure deck cross-slope or vertical profile.

2. A Waterproofing Hot Mix Asphalt top course layer having a ¾-inch minimum and a 2-inch maximum uniform thickness, placed over an existing or new concrete bridge deck, with no modification of the bridge concrete superstructure deck cross-slope and a minimal correction in the bridge deck vertical profile

3. A 3/4-inch uniform Waterproofing Hot Mix Asphalt base layer with a uniform or varying thickness multiple course asphalt overlay can be placed to modify the bridge deck cross-slope and vertical profile to match the cross-slope and vertical profile of the adjoining highway section, that itself has been raised (possibly with a modified cross-slope) by one or more asphalt overlays. Over the waterproofing hot mix asphalt; the multiple course asphalt overlay could incorporate an initial truing and leveling course with a varying thickness to correct revised deck cross-slopes; followed by a uniform top course layer, or a combination single uniform top course layer atop a uniform binder layer, to correct and raise a bridge deck's vertical profile.

3.1.2.4d – HMA BRIDGE DECK OVERLAY ITEM NUMBER SELECTION

For bridge deck overlays and bridge approach pavement; the designer shall design and specify 402 series **HMA** items; unless directed otherwise.

The NYSDOT has included "Superpave" Section 402 Hot Mix Asphalt item design guidance in the NYSDOT "**Comprehensive Pavement Design Manual (CPDM)**" Subsection 6.2 – "Hot Mix

Asphalt".

After the PG Binder has been selected following the procedures included in NYSTA (DB 09-002): "Hot Mix Asphalt: PG Binder Design, Selection & Special Note Guidance", (DB 09-003): " REVISED Thruway TEFs, and A Modified Calculation of **ESAL**s for Thruway Pavement Design", and NYSDOT **CPDM** Subsection 6.2 – "Hot Mix Asphalt" ; by the choice of a Series 402 **HMA** item number, the Designer will be specifying the desired: i) aggregate size, ii) compaction method series, and friction aggregate requirements. In addition: a "Plant Production Quality Adjustment" item exists and is applied to all HMA items in a contract, and a "Pavement Density Quality Adjustment" item exists and is applied only to HMA items specifying a "50 Series" compaction (see NYSDOT **CPDM** Subsection 6.2.4 – "Interpreting **HMA** Item Numbers").

A) Aggregate Size: See NYSDOT **CPDM** Subsection 6.2.7 – "Gradation Considerations" for guidance on selecting the appropriate aggregate gradation size for each **HMA** layer of a bridge deck overlay.

For an **HMA** mix, the maximum coarse aggregate size of an aggregate blend is used to identify that aggregate blend. "Superpave" aggregate blends are detailed in Table 1 – "Design Controls Points" of NYSDOT Materials Method 5.16 – "SUPERPAVE HOT MIX ASPHALT MIXTURE DESIGN AND MIXTURE VERIFICATION PROCEDURES".

For bridge deck asphalt overlays; the choices for nominal maximum aggregate size for a **HMA** top course are 1/2 inch and 3/8 inch. The typical maximum aggregate size for a top course is 1/2 inch, which is considered more “rut resistant” that a 3/8 inch top course.

Required total overlay thicknesses can be governed by: i) the overlay thickness required to match an adjacent highway pavement surface, ii) the required minimum layer thickness limited by the maximum aggregate size used in each layer, or iii) the required maximum single layer thickness that can be properly compacted in one lift. See NYSDOT **CPDM** Subsection 6.2.11 – “Lift Thickness Limitations”.

B) <u>Compaction Series</u>: For NYSDOT **HMA** items four “compaction monitoring” levels exist, and they are identified as the “Series 50 Compaction Method”, the “Series 60 Compaction Method”, the “Series 70 Compaction Method” and the “Series 80 Compaction Method”. See NYSDOT Standard Specifications Section 402 – “HOT MIX ASPHALT (HMA) PAVEMENTS”, Subsection 402-3.07 “Compaction” for the details of each compaction monitoring “Series”, and NYSDOT **CPDM** Subsection 6.2.8 “Compaction Monitoring” for compaction “Series” choice guidance. The compaction “Series” chosen is directly identified in the chosen **HMA** item numbers (see NYSDOT **CPDM** Subsection 6.2.4 – “Interpreting **HMA** Item Numbers”).

For a bridge deck overlay that is part of a larger highway paving project; **HMA** item properties for the **HMA** top course and (possibly binder) layer(s), including the compaction monitoring “Series” to be applied to a layer, will be governed by, and the same as, the requirements of the adjacent highway pavement. For each compaction monitoring “Series”; NYSDOT Subsection 402-3.07 “Compaction” identifies that for bridge asphalt overlays the “Placement and compaction procedures will be satisfactory when the procedures used in these areas obtain pavement density similar to that obtained on the mainline pavement sections…. If a density gauge(s) is used to monitor mainline paving, use the same gauge(s) to monitor density of the above referenced areas".

Stand alone bridge projects; that include asphalt items to: i) overlay a bridge deck and approach slabs, ii) pave between a bridge's approach slabs and existing highway pavement, iii) reconstruct shoulders, and/or iv) construct temporary crossovers; should typically specify an HMA item requiring the use of an "Series 80 Compaction Method". Stand alone bridge projects typically use small quantities of **HMA** that do not provide the opportunity to execute the construction of pavement "test sections" as specified for the "Series 50 Compaction Method", the "Series 60 Compaction Method" or the "Series 70 Compaction Method".

NOTE: NYSDOT Subsection 402-3.07 "Compaction", as modified by the current NYSTA Addendum to the NYSDOT Standard Specifications specifically prohibits the use of vibratory compaction of all **HMA** items on structural bridge decks.

C) Hot Mix Asphalt (HMA) Friction Requirements:

Within a project's limits; the most stringent friction aggregate requirements for any location within the project's limits shall be applied to all top course **HMA** items.

The designer shall use the (Table – 3.1.2.4d) below to establish the **HMA** friction aggregate requirements for a project.

HMA Friction Aggregate Type Selection Table – 3.1.2.4d			
Highway System	**Traffic**	**Location**	**Aggregate Type**
NYSTA Mainline and Ramp Bridges	High or Low Volume (1)	New York Division	Type F1
	High or Low Volume (1)	Buffalo, Syracuse and Albany Divisions	Type F2
All Other Bridges	High Volume (1)	New York Division	Type F1
	High Volume (1)	Buffalo, Syracuse and Albany Divisions	Type F2
	Low Volume (1)	All Divisions	Type F3

(1) "High Volume" refers to single lane bridges with design year AADT over 4000, 2 or 3 lane bridges with two-way design year AADT over 8,000, or bridges with 4 or more lanes with two-way design year AADT over 13,000. "Low Volume" refers to bridges not meeting the aforementioned criteria.

<u>**NOTE**</u>: NYSDOT Standard Specification Section 400 – "Hot Mix Asphalt" Subsection 401-2.02D; **HMA** aggregates identified as "Coarse Aggregate: Type F9 Conditions" are specifically prohibited from being used in an **HMA** top course item that will permanently carry highway traffic during its service life. In addition; highway shoulder pavement and highway cross-over pavement, that will temporarily carry highway-speed traffic during the construction stages of a project, are also prohibited from using **HMA** aggregates identified as "Coarse Aggregate: Type F9 Conditions".

NOTE TO THE DESIGNER: The "friction aggregate" material requirements for Portland Cement Concrete Section 501 items are different than the "friction aggregate" material requirements for Hot Mix Asphalt Section 401 items. The names identifying friction aggregate "Types" are <u>similar</u> for concrete and **HM**A items, but the aggregate gradation requirements for the "friction aggregates" for concrete superstructure deck and approach slab items are different from the aggregate gradation requirements for the "friction aggregates" for **HMA** pavement items.

D) **<u>HMA “Plant Production Quality” Item</u>**:

For stand alone bridge projects; the designer shall include the appropriate Section 402 “Plant Production Quality Adjustment” item associated with each **HMA** item specified. “Plant Production Quality Adjustment” items are used with <u>all</u> compaction method “Series”.

3.1.2.4e – HOT MIX ASPHALT , VIBRATORY ROLLER COMPACTION PROHIBITION ON BRIDGE SUPERSTRUCTURE DECKS:

NYSDOT Subsection 402-3.07 “Compaction”, as modified by the current NYSTA Addendum to the NYSDOT Standard Specifications **<u>specifically prohibits the use of vibratory compaction of all HMA items on structural bridge decks</u>**.

3.1.3 - REINFORCEMENT IN BRIDGE DECKS

Steel reinforcement in bridge decks shall be used to provide flexural, shear, and tensile strength to the deck. Four mats (one each of longitudinal top and bottom and one each of transverse top and bottom) of galvanized steel reinforcement shall be provided in all new bridge decks. Reinforcement in new Thruway bridge decks shall be of the isotropic design where ever possible (see Subsection 3.1.3.1 below for use restrictions). Where conditions restrict the use of an isotropic deck, a “Traditional” reinforced beam type deck shall be used and designed in accordance with the **LFD** provisions of the **AASHTO 17th Edition**. See Subsection 3.1.3.2.

3.1.3.1 - GUIDELINES FOR ISOTROPIC REINFORCED BRIDGE DECKS

New bridge decks shall use isotropic reinforcement if <u>all</u> of the following criteria are met. If not, the deck must be designed “Traditionally”.

A. Deck Replacement or Bridge Replacement

B. The maximum spacing center-to-center of stringers shall be 10.0 feet.

C. The minimum spacing center-to-center of stringers shall be 5.0 feet.

D. There must be five or more stringers in the cross-section to allow for future staged construction.

E. Monolithic deck thickness of 9 ½”. (8” design slab + 1 ½” Monolithic Wearing Surface). See Detail 7.21.1.c.

F. Maximum live load deflection must be less than or equal to L/1000.

The following are detail requirements for isotropic bridge decks:

A. The reinforcement shall consist of two mats composed of #4 bars on 8 inch centers with the longitudinal bars on top of both mats.

B. Cover above top longitudinal bars is 2 ½”. Cover below bottom transverse bars shall be 1 ½”.

C. Both rebar mats shall be galvanized. Welded splices are not permitted.

D. The minimum fascia overhang from the centerline of the fascia girder shall be 2.0 feet with permanent concrete barrier, and 2.5 feet with any of the various types of steel bridge rail.

E. Fascia overhang reinforcement shall be provided as indicated in Subsection 3.1.4.

F. Longitudinal bars are placed parallel to stringers. Transverse bars shall be placed parallel the skew angle for skew angles up to and including 30˚. The transverse reinforcement shall be placed normal to the stringers when the skew angle is greater than 30˚. When reinforcement is placed on the skew, the 8 inch nominal perpendicular bar spacing shall be reduced by the cosine squared of the skew angle.

G. Additional longitudinal reinforcement in negative moment areas shall be provided as required by Subsection 10.38.4.3 of the **AASHTO 17th Edition**.

H. The top and bottom reinforcing mats shall be staggered in both directions so that bars are not directly over each other.

I. The depth of slab at the edge of the fascia should not be less than 10 ½" to allow for cover for the railing/barrier anchorage.

3.1.3.2 - GUIDELINES FOR "TRADITIONALLY" REINFORCED BRIDGE DECKS

Where an isotropic type deck cannot be used, a "Traditional" beam type designed deck shall be used. Tables have been included in this manual supplying design reinforcement criteria for most circumstances in accordance with the **LFD** provisions of the **AASHTO 17th Edition**. For new monolithic deck designs (9 ½" thick), Table 3.1.3.2.a or 3.1.3.2.b may be used. See Detail 7.21.1.c for a typical new monolithic deck section. For new two-course deck designs (8 ½" thick deck w/ 2" overlay), Table 3.1.3.2.c or 3.1.3.2.d may be used. See Details 7.21.1.a for a typical new two-course deck section. The depth of slab at the edge of the fascia should not be less than 10 ½" to allow for cover for the railing/barrier anchorage. For skews up to and including 30˚, the reinforcement shall be placed parallel to the skew angle. For skews over 30˚, the reinforcement shall be placed normal to the stringers. Refer to the appropriate **BD** Sheet for slab corner reinforcement for skews over 30˚. The skewed reinforcement shall be detailed with the spacing along the stringers; not perpendicular to the bars. Design span is defined as the perpendicular distance between stringers less one-half the width of the top flange. Transverse reinforcing steel shall not be detailed with shop bends for deck cross-slope changes. All bends of this nature shall be field bent as required by cover criteria. Longitudinal distribution reinforcement in top of slab shall be no less than #5 bars at 18 inch centers.

SLAB REINFORCEMENT
THRUWAY MONOLITHIC DECK
LOAD FACTOR DESIGN FOR 3000 psi CONCRETE

SLAB DIMENSIONS:

DESIGN THICK.	8.000	IN.
EFFECTIVE DEPTH	6.125	IN.
INTEGRAL W.S.	1.500	IN.
FUT WEARING SURF.	2.000	IN.
MAX. COVER	1.500	IN.
TOP COVER (DES.)	1.500	IN.
BOT. COVER	1.500	IN.

L.L. MOMENT PER AASHTO 3.24.3 (PLUS IMPACT)
(SLAB CONTINUITY INCLUDED)

D.L. MOMENT BASED ON A CONTINUOUS SPAN

LOADING:

LIVE LOAD	HS	25
DEAD LOAD	0.1438	K/FT

LOAD FACTORS:

	BETA FACTOR	GAMMA FACTOR
L.L.	1.67	1.30
D.L.	1.00	1.30

CONCRETE STRENGTH: 3000 PSI

FACTOR (z) FOR CRACK CONTROL: 170

USE 130 FOR SEVERE EXPOSURE (DECKS W/O MEMBRANE)
USE 170 FOR MODERATE EXPOSURE (DECKS WITH MEMBRANE)
(PER AASHTO 8.16.8.4)

FOR MAIN REINFORCEMENT PERPENDICULAR TO TRAFFIC:

DESIGN SPAN (FT.)	UNFACTORED MOMENTS L.L. (K-FT)	UNFACTORED MOMENTS D.L. (K-FT)	TOTAL FACTORED MOMENTS (K-FT)	As REQ'D (IN^2)	SPACING REQ'D #5 (IN.)	SPACING REQ'D #6 (IN.)	USE BAR SIZE -	USE BAR SPACING (IN.)	ACTUAL As (IN^2)	ACTUAL STRESS (KSI)
6.00	5.2000	0.5175	11.9620	0.4695	7.8409	11.2911	5	7.75	0.4750	26.0829
6.25	5.3625	0.5615	12.3720	0.4871	7.5580	10.8837	5	7.50	0.4909	26.1914
6.50	5.5250	0.6073	12.7843	0.5049	7.2916	10.5001	5	7.25	0.5078	26.2487
6.75	5.6875	0.6550	13.1990	0.5229	7.0404	10.1383	5	7.00	0.5259	26.2538
7.00	5.8500	0.7044	13.6160	0.5412	6.8030	9.7965	5	6.75	0.5454	26.2059
7.25	6.0125	0.7556	14.0354	0.5597	6.5783	9.4730	5	6.50	0.5664	26.1041
7.50	6.1750	0.8086	14.4571	0.5784	6.3654	9.1664	5	6.25	0.5891	25.9474
7.75	6.3375	0.8634	14.8811	0.5973	6.1634	8.8754	5	6.00	0.6136	25.7349
8.00	6.5000	0.9200	15.3075	0.6165	5.9713	8.5989	5	5.75	0.6403	25.4657
8.25	6.6625	0.9784	15.7362	0.6360	5.7886	8.3357	5	5.75	0.6403	26.2238
8.50	6.8250	1.0386	16.1672	0.6557	5.6144	8.0849	5	5.50	0.6694	25.8714
8.75	6.9875	1.1006	16.6006	0.6757	5.4483	7.8457	5	5.25	0.7013	25.4598
9.00	7.1500	1.1644	17.0363	0.6960	5.2897	7.6172	5	5.25	0.7013	26.1721
9.25	7.3125	1.2300	17.4744	0.7165	5.1380	7.3988	5	5.00	0.7363	25.6732
9.50	7.4750	1.2973	17.9148	0.7374	4.9928	7.1897	6	7.00	0.7574	25.6690
9.75	7.6375	1.3665	18.3575	0.7585	4.8537	6.9894	6	6.75	0.7854	25.4541
10.00	7.8000	1.4375	18.8026	0.7800	4.7203	6.7974	6	6.75	0.7854	26.1142
10.25	7.9625	1.5103	19.2499	0.8017	4.5923	6.6130	6	6.50	0.8156	25.8388
10.50	8.1250	1.5848	19.6997	0.8238	4.4692	6.4358	6	6.25	0.8482	25.5201
10.75	8.2875	1.6612	20.1517	0.8462	4.3509	6.2655	6	6.25	0.8482	26.1479
11.00	8.4500	1.7394	20.6061	0.8689	4.2371	6.1015	6	6.00	0.8836	25.7659
11.25	8.6125	1.8193	21.0629	0.8920	4.1274	5.9436	6	5.75	0.9220	25.3387
11.50	8.7750	1.9011	21.5219	0.9154	4.0217	5.7913	6	5.75	0.9220	25.9320
11.75	8.9375	1.9846	21.9834	0.9393	3.9197	5.6444	6	5.50	0.9639	25.4388
12.00	9.1000	2.0700	22.4471	0.9635	3.8212	5.5026	6	5.50	0.9639	26.0160

FOR SKEWED REINFORCEMENT:

1. DETERMINE THE REQUIRED REBAR SPACING FOR THE EFFECTIVE PERPENDICULAR SPAN FROM THE TABLE.
2. REDUCE THE SPACING DETERMINED IN STEP 1 BY THE COSINE SQUARED OF THE SKEW ANGLE. THIS SPACING IS A LONGITUDINAL DIMENSION.
3. FOR THE PERPENDICULAR DIMENSION BETWEEN REBARS, REDUCE THE SPACING AGAIN BY THE COSINE SQUARED OF THE SKEW ANGLE.

TABLE 3.1.3.2.a

SLAB REINFORCEMENT
THRUWAY MONOLITHIC DECK
LOAD FACTOR DESIGN FOR 3000 psi CONCRETE

SLAB DIMENSIONS:

DESIGN THICK.	8.000	IN.
EFFECTIVE DEPTH	6.125	IN.
INTEGRAL W.S.	1.500	IN.
FUT WEARING SURF.	2.000	IN.
MAX. COVER	1.500	IN.
TOP COVER (DES.)	1.500	IN.
BOT. COVER	1.500	IN.

L.L. MOMENT PER AASHTO 3.24.3 (PLUS IMPACT)
(SLAB CONTINUITY INCLUDED)

D.L. MOMENT BASED ON A CONTINUOUS SPAN

LOAD FACTORS:

	BETA FACTOR	GAMMA FACTOR
L.L.	1.67	1.30
D.L.	1.00	1.30

LOADING:

LIVE LOAD	HS	25
DEAD LOAD	0.1438	K/FT

CONCRETE STRENGTH: 3000 PSI

FACTOR (z) FOR CRACK CONTROL: 130

USE 130 FOR SEVERE EXPOSURE (DECKS W/O MEMBRANE)
USE 170 FOR MODERATE EXPOSURE (DECKS WITH MEMBRANE)
(PER AASHTO 8.16.8.4)

FOR MAIN REINFORCEMENT PARALLEL TO TRAFFIC:

DESIGN SPAN (FT.)	UNFACTORED MOMENTS L.L. (K-FT)	UNFACTORED MOMENTS D.L. (K-FT)	TOTAL FACTORED MOMENTS (K-FT)	As REQ'D (IN^2)	SPACING REQ'D #5 (IN.)	SPACING REQ'D #6 (IN.)	USE BAR SIZE -	USE BAR SPACING (IN.)	ACTUAL As (IN^2)	ACTUAL STRESS (KSI)
6.00	7.0200	0.5175	15.9132	0.6441	5.7160	8.2311	5	5.50	0.6694	24.7986
6.25	7.3125	0.5615	16.6054	0.6760	5.4465	7.8431	5	5.25	0.7013	24.7859
6.50	7.6050	0.6073	17.3000	0.7083	5.1975	7.4845	5	5.00	0.7363	24.6811
6.75	7.8975	0.6550	17.9969	0.7413	4.9665	7.1518	6	7.00	0.7574	25.0256
7.00	8.1900	0.7044	18.6962	0.7748	4.7516	6.8425	6	6.75	0.7854	25.1442
7.25	8.4825	0.7556	19.3978	0.8089	4.5512	6.5539	6	6.50	0.8156	25.1986
7.50	8.7750	0.8086	20.1017	0.8437	4.3638	6.2839	6	6.00	0.8836	24.2340
7.75	9.0675	0.8634	20.8080	0.8791	4.1880	6.0309	6	6.00	0.8836	25.1123
8.00	9.3600	0.9200	21.5166	0.9152	4.0229	5.7931	6	5.75	0.9220	24.9699
8.25	9.6525	0.9784	22.2275	0.9520	3.8673	5.5691	6	5.50	0.9639	24.7604
8.50	9.9450	1.0386	22.9408	0.9895	3.7205	5.3576	6	5.25	1.0098	24.4829
8.75	10.2375	1.1006	23.6564	1.0279	3.5816	5.1577	6	5.00	1.0603	24.1365
9.00	10.5300	1.1644	24.3743	1.0671	3.4500	4.9681	7	6.50	1.1101	23.8402
9.25	10.8225	1.2300	25.0946	1.1072	3.3251	4.7882	7	6.50	1.1101	24.5702
9.50	11.1150	1.2973	25.8172	1.1483	3.2062	4.6170	7	6.25	1.1545	24.3864
9.75	11.4075	1.3665	26.5422	1.1903	3.0929	4.4538	7	6.00	1.2026	24.1511
10.00	11.7000	1.4375	27.2695	1.2335	2.9847	4.2981	7	5.75	1.2549	23.8638
10.25	11.9925	1.5103	27.9991	1.2778	2.8813	4.1491	7	5.50	1.3120	23.5239
10.50	12.2850	1.5848	28.7310	1.3233	2.7821	4.0063	7	5.25	1.3745	23.1305
10.75	12.5775	1.6612	29.4653	1.3702	2.6870	3.8693	7	5.25	1.3745	23.7457

FOR EFFECTIVE SPANS GREATER THAN 10.75 FEET, A THICKER DECK SLAB IS REQUIRED.

FOR SKEWED REINFORCEMENT:

1. DETERMINE THE REQUIRED REBAR SPACING FOR THE EFFECTIVE PERPENDICULAR SPAN FROM THE TABLE.
2. REDUCE THE SPACING DETERMINED IN STEP 1 BY THE COSINE SQUARED OF THE SKEW ANGLE. THIS SPACING IS A LONGITUDINAL DIMENSION.
3. FOR THE PERPENDICULAR DIMENSION BETWEEN REBARS, REDUCE THE SPACING AGAIN BY THE COSINE SQUARED OF THE SKEW ANGLE.

TABLE 3.1.3.2.b

SLAB REINFORCEMENT
THRUWAY 2-COURSE DECK
LOAD FACTOR DESIGN FOR 3000 psi CONCRETE

SLAB DIMENSIONS:

DESIGN THICKNESS	8.500	IN.
EFFECTIVE DEPTH	6.125	IN.
INTEGRAL W.S.	0.000	IN.
OVERLAY THICKNESS	2.000	IN.
MAXIMUM COVER	2.000	IN.
TOP COVER (DESIGN)	2.000	IN.
BOTTOM COVER	1.500	IN.

L.L. MOMENT PER AASHTO 3.24.3 (PLUS IMPACT)
(SLAB CONTINUITY INCLUDED)

D.L. MOMENT BASED ON A CONTINUOUS SPAN

LOAD FACTORS:

	BETA FACTOR	GAMMA FACTOR
L.L.	1.67	1.30
D.L.	1.00	1.30

LOADING:

LIVE LOAD	HS	25
DEAD LOAD	0.1313	K/FT

CONCRETE STRENGTH: 3000 PSI

FACTOR (z) FOR CRACK CONTROL: 170

USE 130 FOR SEVERE EXPOSURE (DECKS W/O MEMBRANE)
USE 170 FOR MODERATE EXPOSURE (DECKS WITH MEMBRANE)
(PER AASHTO 8.16.8.4)

FOR MAIN REINFORCEMENT PERPENDICULAR TO TRAFFIC:

DESIGN SPAN (FT.)	UNFACTORED MOMENTS L.L. (K-FT)	UNFACTORED MOMENTS D.L. (K-FT)	TOTAL FACTORED MOMENTS (K-FT)	As REQ'D (IN^2)	SPACING REQ'D #5 (IN.)	SPACING REQ'D #6 (IN.)	USE BAR SIZE -	USE BAR SPACING (IN.)	ACTUAL As (IN^2)	ACTUAL STRESS (KSI)
6.00	5.2000	0.4725	11.9035	0.4670	7.8828	11.3515	5	7.75	0.4750	25.8776
6.25	5.3625	0.5127	12.3085	0.4844	7.6006	10.9450	5	7.25	0.5078	25.1480
6.50	5.5250	0.5545	12.7157	0.5019	7.3348	10.5623	5	7.00	0.5259	25.1654
6.75	5.6875	0.5980	13.1250	0.5197	7.0841	10.2012	5	6.75	0.5454	25.1309
7.00	5.8500	0.6431	13.5364	0.5377	6.8472	9.8601	5	6.50	0.5664	25.0435
7.25	6.0125	0.6899	13.9500	0.5559	6.6230	9.5373	5	6.50	0.5664	25.8506
7.50	6.1750	0.7383	14.3657	0.5743	6.4105	9.2313	5	6.25	0.5891	25.6861
7.75	6.3375	0.7883	14.7835	0.5930	6.2089	8.9409	5	6.00	0.6136	25.4666
8.00	6.5000	0.8400	15.2035	0.6118	6.0172	8.6649	5	5.75	0.6403	25.1911
8.25	6.6625	0.8933	15.6256	0.6310	5.8348	8.4022	5	5.50	0.6694	24.8589
8.50	6.8250	0.9483	16.0498	0.6503	5.6610	8.1519	5	5.50	0.6694	25.5743
8.75	6.9875	1.0049	16.4762	0.6700	5.4951	7.9131	5	5.25	0.7013	25.1585
9.00	7.1500	1.0631	16.9047	0.6899	5.3367	7.6850	5	5.00	0.7363	24.6835
9.25	7.3125	1.1230	17.3353	0.7100	5.1853	7.4670	5	5.00	0.7363	25.3518
9.50	7.4750	1.1845	17.7681	0.7304	5.0404	7.2582	6	7.00	0.7574	25.3389
9.75	7.6375	1.2477	18.2030	0.7511	4.9015	7.0583	6	6.75	0.7854	25.1182
10.00	7.8000	1.3125	18.6401	0.7721	4.7683	6.8665	6	6.50	0.8156	24.8561
10.25	7.9625	1.3789	19.0792	0.7934	4.6404	6.6823	6	6.50	0.8156	25.4806
10.50	8.1250	1.4470	19.5205	0.8149	4.5176	6.5054	6	6.25	0.8482	25.1579
10.75	8.2875	1.5168	19.9639	0.8368	4.3994	6.3353	6	6.00	0.8836	24.7920
11.00	8.4500	1.5881	20.4095	0.8590	4.2857	6.1716	6	5.75	0.9220	24.3824
11.25	8.6125	1.6611	20.8572	0.8816	4.1762	6.0139	6	5.75	0.9220	24.9545
11.50	8.7750	1.7358	21.3070	0.9044	4.0706	5.8618	6	5.50	0.9639	24.4807
11.75	8.9375	1.8121	21.7590	0.9276	3.9688	5.7151	6	5.50	0.9639	25.0368
12.00	9.1000	1.8900	22.2131	0.9512	3.8704	5.5735	6	5.25	1.0098	24.4972

FOR SKEWED REINFORCEMENT:

1. DETERMINE THE REQUIRED REBAR SPACING FOR THE EFFECTIVE PERPENDICULAR SPAN FROM THE TABLE.
2. REDUCE THE SPACING DETERMINED IN STEP 1 BY THE COSINE SQUARED OF THE SKEW ANGLE. THIS SPACING IS A LONGITUDINAL DIMENSION.
3. FOR THE PERPENDICULAR DIMENSION BETWEEN REBARS, REDUCE THE SPACING AGAIN BY THE COSINE SQUARED OF THE SKEW ANGLE.

TABLE 3.1.3.2.c

SLAB REINFORCEMENT
THRUWAY 2-COURSE DECK
LOAD FACTOR DESIGN FOR 3000 psi CONCRETE

SLAB DIMENSIONS:

DESIGN THICKNESS	8.500	IN.
EFFECTIVE DEPTH	6.125	IN.
INTEGRAL W.S.	0.000	IN.
OVERLAY THICKNESS	2.000	IN.
MAXIMUM COVER	2.000	IN.
TOP COVER (DESIGN)	2.000	IN.
BOTTOM COVER	1.500	IN.

L.L. MOMENT PER AASHTO 3.24.3 (PLUS IMPACT)
(SLAB CONTINUITY INCLUDED)

D.L. MOMENT BASED ON A CONTINUOUS SPAN

LOADING:

LIVE LOAD	HS	25
DEAD LOAD	0.1313	K/FT

LOAD FACTORS:

	BETA FACTOR	GAMMA FACTOR
L.L.	1.67	1.30
D.L.	1.00	1.30

CONCRETE STRENGTH: 3000 PSI

FACTOR (z) FOR CRACK CONTROL: 170

USE 130 FOR SEVERE EXPOSURE (DECKS W/O MEMBRANE)
USE 170 FOR MODERATE EXPOSURE (DECKS WITH MEMBRANE)
(PER AASHTO 8.16.8.4)

FOR MAIN REINFORCEMENT PARALLEL TO TRAFFIC:

DESIGN SPAN (FT.)	UNFACTORED MOMENTS L.L. (K-FT)	UNFACTORED MOMENTS D.L. (K-FT)	TOTAL FACTORED MOMENTS (K-FT)	As REQ'D (IN^2)	SPACING REQ'D #5 (IN.)	SPACING REQ'D #6 (IN.)	USE BAR SIZE -	USE BAR SPACING (IN.)	ACTUAL As (IN^2)	ACTUAL STRESS (KSI)
6.00	7.0200	0.4725	15.8547	0.6414	5.7398	8.2654	5	5.50	0.6694	24.6505
6.25	7.3125	0.5127	16.5419	0.6730	5.4703	7.8774	5	5.25	0.7013	24.6322
6.50	7.6050	0.5545	17.2313	0.7051	5.2212	7.5187	5	5.00	0.7363	24.5224
6.75	7.8975	0.5980	17.9229	0.7378	4.9902	7.1860	6	7.00	0.7574	24.8590
7.00	8.1900	0.6431	18.6166	0.7710	4.7753	6.8765	6	6.75	0.7854	24.9710
7.25	8.4825	0.6899	19.3124	0.8047	4.5749	6.5879	6	6.50	0.8156	25.0194
7.50	8.7750	0.7383	20.0103	0.8391	4.3874	6.3180	6	6.00	0.8836	24.0562
7.75	9.0675	0.7883	20.7104	0.8741	4.2116	6.0649	6	5.75	0.9220	23.9396
8.00	9.3600	0.8400	21.4126	0.9098	4.0465	5.8270	6	5.50	0.9639	23.7568
8.25	9.6525	0.8933	22.1169	0.9462	3.8909	5.6030	6	5.50	0.9639	24.5623
8.50	9.9450	0.9483	22.8234	0.9833	3.7441	5.3916	6	5.25	1.0098	24.2816
8.75	10.2375	1.0049	23.5320	1.0212	3.6052	5.1916	6	5.00	1.0603	23.9327
9.00	10.5300	1.0631	24.2427	1.0599	3.4736	5.0021	7	6.50	1.1101	23.6338
9.25	10.8225	1.1230	24.9556	1.0994	3.3487	4.8222	7	6.25	1.1545	23.4692
9.50	11.1150	1.1845	25.6706	1.1399	3.2298	4.6510	7	6.00	1.2026	23.2540
9.75	11.4075	1.2477	26.3877	1.1813	3.1165	4.4879	7	5.75	1.2549	22.9878
10.00	11.7000	1.3125	27.1070	1.2238	3.0084	4.3322	7	5.75	1.2549	23.6368
10.25	11.9925	1.3789	27.8283	1.2673	2.9050	4.1833	7	5.50	1.3120	23.2951
10.50	12.2850	1.4470	28.5519	1.3121	2.8060	4.0407	7	5.25	1.3745	22.9007
10.75	12.5775	1.5168	29.2775	1.3581	2.7109	3.9038	7	5.00	1.4432	22.4530

FOR EFFECTIVE SPANS GREATER THAN 10.75 FEET, A THICKER DECK SLAB IS REQUIRED.

FOR SKEWED REINFORCEMENT:

1. DETERMINE THE REQUIRED REBAR SPACING FOR THE EFFECTIVE PERPENDICULAR SPAN FROM THE TABLE.
2. REDUCE THE SPACING DETERMINED IN STEP 1 BY THE COSINE SQUARED OF THE SKEW ANGLE. THIS SPACING IS A LONGITUDINAL DIMENSION.
3. FOR THE PERPENDICULAR DIMENSION BETWEEN REBARS, REDUCE THE SPACING AGAIN BY THE COSINE SQUARED OF THE SKEW ANGLE.

TABLE 3.1.3.2.d

Spacing of the longitudinal (distribution) reinforcement at the bottom of slab shall be as described in **AASHTO 17th Edition** Subsections 3.24.10 and 10.38.4.3. For existing monolithic and two-course decks, reinforcement in repair areas shall be replaced in-kind. See Details 7.21.1.b and 7.21.1.d for typical existing two-course and monolithic deck sections.

3.1.4 - REINFORCEMENT IN OVERHANG REGIONS

The amount of deck slab reinforcement required in the structural slab in overhang regions is a function of rail/barrier type and Test Level Requirements. The actual length of overhang is not a factor in the design of TL-4 and TL-5 overhang reinforcement up to 6.0 feet in length. This is due to the transverse impact loading controlling the reinforcement design. For overhangs greater than 6.0 feet, the reinforcement shall be designed as described herein. The provisions of Section 13 - Railings of the **AASHTO LRFD 5th Edition** have been used in determining Test Level Requirements for Thruway structures (refer to Table 3.1.4). The provisions of Subsection A13.4 Deck Overhang Design in the **AASHTO LRFD 5th Edition** shall be used in designing bridge deck overhangs (see Reference 3.1.4).

TABLE 3.1.4

BRIDGE RAIL & DECK OVERHANG DESIGN CRITERIA

RAIL/BARRIER TYPE	TEST LEVEL REQUIREMENTS
Current/New Single Slope Concrete Barrier\Parapet	TL-5
Current/New Two Rail Square Box Beam Steel Railing with curb	TL-4
Current/New Four or Five Rail Steel Railing with/without Sidewalk	TL-4
Existing Four or Five Rail Rectangular Box Beam Steel Railing with curb	TL-2*
Existing Two Rail Rectangular Box Beam Steel Railing with curb	TL-2*
Existing Two Rail Square Box Beam Upgrade on Discontinuous Rail	TL-2*
Existing Single Rail Square Box Beam Upgrade on Discontinuous Rail	TL-2*
Existing Thrie Beam Upgrade on Discontinuous Rail	TL-2*

* - Indicates TA has accepted the strength of existing structurally sound rail system and deck fascia/overhang to meet the requirements of TL-2.

Design Forces and Designations	Railing Test Levels					
	TL-1	TL-2	TL-3	TL-4	TL-5	TL-6
F_t Transverse (kips)	13.5	27.0	54.0	54.0	124.0	175.0
F_L Longitudinal (kips)	4.5	9.0	18.0	18.0	41.0	58.0
F_v Vertical (kips) Down	4.5	4.5	4.5	18.0	80.0	80.0
L_t and L_L (ft.)	4.0	4.0	4.0	3.5	8.0	8.0
L_v (ft.)	18.0	18.0	18.0	18.0	40.0	40.0
H_e (min) (in.)	18.0	20.0	24.0	32.0	42.0	56.0
Minimum H Height of Rail (in.)	27.0	27.0	27.0	32.0	42.0	90.0

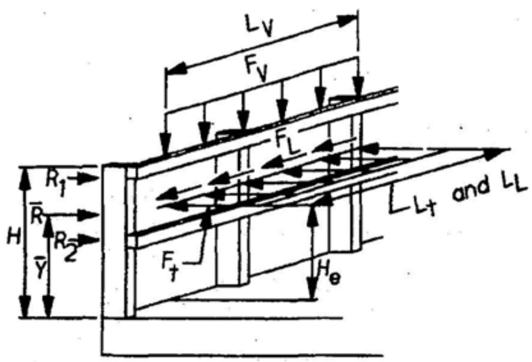


Figure A13.2-1 Metal Bridge Railing Design Forces, Vertical Location, and Horizontal Distribution Length.

Figure A13.2-1 shows the design forces from Table 1 applied to a beam and post railing. This is for illustrative purposes only. The forces and distribution lengths shown apply to any type of railing.

<u>REFERENCE 3.1.4</u>

<u>DEFINITIONS:</u>

<u>Short Term Rehabilitation:</u> Bridge rehabilitation work that is only intended to make minor or emergency repairs to a single element or various elements of the structure until the structure is programmed for major rehabilitation or replacement within the next 10 to 15 years.

<u>Long Term Rehabilitation:</u> Bridge rehabilitation work that includes major repairs or replacement of structural elements and the timeframe for major bridge rehabilitation or replacement is beyond 15 years.

<u>SRSO's</u> – **SRSO**'s (**<u>S</u>**trip overlay, **<u>R</u>**epair deck, **<u>S</u>**eal deck, replace **<u>O</u>**verlay) cannot be universally categorized as long term or short term work. The future work expected on the bridge and life expectancy of its main components must be considered in order to determine the appropriate rail upgrade treatment on an SRSO project. The designer must look at several factors when determining what rail treatment will be appropriate for an SRSO project. An original bridge that is nearing the end of its life may be extended by performing an SRSO which may yield 10 or more years until complete replacement. In this case, replacement is imminent. Treating a project like this as long term, and performing extensive fascia/overhang and rail upgrades would not be warranted if the bridge is intended to be replaced within the next 10 to 15 years. In this situation, short term rail upgrades would be appropriate. However, on a previously replaced structure an SRSO may be required to a deck that's 20 or more years old. The structure as a whole and deck specifically should still have several decades of useful life before replacement. In this case, the rail system should be addressed within the SRSO project as described below as a long term repair.

Warrants - Railing treatment on rehabilitation projects is a complex subject with many project specific considerations. The engineer shall review the list of warrants below and consider the applicability of each in order to determine the best solution. Numerous considerations factor into selecting the appropriate bridge railing treatment on a rehabilitation project. Evaluation of the following contributing factors should provide sufficient information to identify the criteria that define the logic on which the engineer's decision is based:

A. Existing Bridge Railing - age, condition, original design criteria, materials, anchorage, snagging characteristics, vault-causing features, discontinuities, transitions, fascia/overhang characteristics, maintenance concerns and other contributing factors. See **"Considerations Regarding the Repair of Existing Rail Systems"** on page 43.

B. Design Service Level – As described in Section 13 - Railings of the **AASHTO LRFD 5th Edition**

C. Roadway System - Mainline, ramp, local, functional class, design speed, urban, rural, pedestrians, bicycles, etc.

D. Roadway Characteristics - Horizontal and vertical geometry, visibility, AADT, DHV, percent trucks, width, sidewalk, curb, median/median barrier, feature crossed, structure length, approaches and any other contributing characteristics.

E. Safety/Accident Evaluation - Number and severity of accidents and their cause, indications of bridge rail hits. Also, the type and extent of damage to the bridge railing shall be investigated. **Two or more accidents resulting in severe damage to the existing rail system would constitute an "accident history".**

F. Historic/Aesthetic Considerations - Community input, SHPO input, Divisional discretion.

G. Drainage - Ability of system to accommodate roadway drainage and snow storage.

H. Safety Walks – Face-of-rail to face-of-curb dimension and curb height for vaulting considerations.

I. Scope of Work - consider the railing upgrade/replacement in view of the rehabilitation project from the perspective of appropriateness of work and increase in project cost.

J. Desired Service Life of the Repair - a "short term fix" may be appropriate in anticipation of future work strategies.

K. Traffic - in some cases temporary traffic control considerations may greatly influence the scope and type of bridge railing work that is feasible.

L. Transitions - Current and past Standard Railing systems also have an approved transition to the highway guide railing. (See Subsection 3.1.4.3 – Bridge Transition Rail Selection Criteria)

M. Deck Overhangs/fascias – Overall condition, percent full depth repairs required, depth of concrete, amount and location of transverse overhang reinforcement. See “**Considerations Regarding the Repair/Upgrade of Deck Fascia/Overhang Concrete**” on page 44.

N. Bridge Dead Load Capacity - Superstructure’s capacity to carry a heavier barrier system versus an existing rail system. This may be a particular issue if fascia girders are lighter than interior girders.

During the scoping process, sound engineering judgment will be required to develop an appropriate railing treatment justification for each structure to be rehabilitated. The following is general guidance for the various applications that may be encountered on the Thruway system of bridges. It is meant to assist the engineer with the scope of available and/or required upgrades depending on certain conditions. Refer to Section 6 – Bridge Railing, of the NYSDOT Bridge Manual and the Thruway Roadside Safety Specialist for additional information. **In any case, the appropriate bridge rail/barrier/parapet treatment for a given project shall be documented and explained in the “Design Approval Document”.**

Considerations Regarding the Repair of Existing Rail Systems: In the descriptions below, reference is made to whether the existing rail system is “structurally sound” or not. During the scoping of bridge rehabilitation projects, the Metals Engineering Unit will inspect existing rail systems and make the determination whether a rail system is structurally sound or not. A rail system that is without damage or deterioration will be considered structurally sound. A rail system with damage or deterioration that, in the determination of the Metals Unit, can be repaired, will be considered structurally sound after appropriate repairs are performed. If, in the determination of the Metals Unit, a deteriorated or damaged rail system cannot reasonably and effectively be repaired, it will be considered not being structurally sound and must be replaced.

<u>Considerations Regarding the Repair/Upgrade of Deck Fascia/Overhang Concrete:</u> In the descriptions below, reference is made to the repair/upgrade of fascia/overhang concrete. When an existing rail system is to be retained, fascia and overhang repairs shall be limited to removal of unsound concrete, replacement of deteriorated or damaged reinforcing steel with like-sized, galvanized reinforcing, and replacement of concrete using standard Authority details and construction practices. **When a rail system is to be replaced with a new TL-4 or TL-5 system, one of the following deck fascia and overhang upgrades shall be performed:**

For **<u>Short Term Rehabilitation</u>**, the deck fascia and overhang shall be repaired as needed and a monodeck removal and replacement shall be completed regardless of the amount of deterioration. The monodeck removal shall be to a depth of 2.0 inches below the bottom of the top mat of existing reinforcement to a width from the fascia to 2’-6” beyond the centerline of the fascia girder toward the first interior girder and be supplemented with required partial and full depth repairs and the appropriate amount of replacement and additional galvanized overhang reinforcement for the TL-4 rail system prior to placing the new concrete.

For **<u>Long Term Rehabilitation</u>**, if the deck concrete in the overhang region is not structurally sound (equal to or greater than 20% full depth repairs expected), it shall not be repaired. The deck overhang shall be removed and replaced to a width from the fascia to 2’-6” beyond the centerline of the fascia girder toward the first interior girder and include the appropriate amount of replacement and overhang reinforcement for the barrier/rail system used. If the deck concrete in the overhang region is structurally sound (less than 20% full depth repairs expected), the deck fascia and overhang shall be repaired as needed with full and partial depth deck repairs and a monodeck removal shall be completed to remove all concrete to a depth of 2.0 inches below the bottom of the top mat of existing reinforcement to a width from the fascia to 2'-6" beyond the centerline of the fascia girder toward the first interior girder and be supplemented with the appropriate amount of replacement and additional galvanized overhang reinforcement for the TL-4 or TL-5 barrier/rail system used prior to placing the new concrete. Refer to Details 3.1.4.2.a through 3.1.4.2.f. for typical TL-4 and TL-5 overhang reinforcement size and spacing requirements.

3.1.4.1 – THRUWAY RAIL/BARRIER AND OVERHANG DESIGN POLICY

3.1.4.1.1 – NEW AND REPLACEMENT MAINLINE AND RAMP BRIDGES

All **Mainline and Ramp Thruway Bridges** to be replaced shall be designed and detailed using the Thruway standard 3'-6" high TL-5 single sloped concrete bridge barrier system at both the left and right fascias. See Details 3.1.4.2.b and 3.1.4.2.f for typical TL-5 barrier and overhang reinforcement size and spacing requirements.

3.1.4.1.2 – REHABILITATED MAINLINE AND RAMP BRIDGES – Short Term

Existing Discontinuous Four Rail with no Upgrade, with Thrie Beam Upgrade, or Single Box Beam Upgrade:

Mainline and Ramp Bridges to receive a short term rehabilitation…

Shall Install Two Rail Box Beam Upgrade IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound

Shall Install New TL-4 Bridge Rail System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, or
- Fascia concrete IS NOT structurally sound

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair criteria and details.

Existing Discontinuous Four Rail with Two Rail Box Beam Upgrade:

Mainline and Ramp Bridges to receive a short term rehabilitation…

May Retain Existing Rail System IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound

Shall Install New TL-4 Bridge Rail System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, or
- Fascia concrete IS NOT structurally sound

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair criteria and details.

Existing Continuous Two Rail Curb/Curbless or Four Rail Curb/Curbless:

Mainline and Ramp Bridges to receive a short term rehabilitation…

May Retain Existing Rail System IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound

Shall Install New TL-4 Bridge Rail System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, or
- Fascia concrete IS NOT structurally sound

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair criteria and details.

3.1.4.1.3 – REHABILITATED MAINLINE AND RAMP BRIDGES – Long Term

Existing Discontinuous Four Rail with no Upgrade, Thrie Beam Upgrade, or Single Box Beam Upgrade:

Mainline and Ramp Bridges to receive a long term rehabilitation…

Shall Install Two Rail Box Beam Upgrade IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and
- No Accident History Exists

Shall Install New TL-5 Barrier System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, and

- Fascia concrete IS structurally sound
- With or without accident history

Shall Install New TL-5 Barrier System with New Deck Fascias IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound
- With or without accident history

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair and replacement criteria and details.

Existing Discontinuous Four Rail with Two Rail Box Beam Upgrade:

Mainline and Ramp Bridges to receive a long term rehabilitation…

May Retain Existing Rail System IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and
- No Accident History Exists

Shall Install New TL-5 Barrier System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS structurally sound
- With or without accident history

Shall Install New TL-5 Barrier System with New Deck Fascias IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound
- With or without accident history

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair and replacement criteria and details.

Existing Continuous Two Rail Curb/Curbless:

Mainline and Ramp Bridges to receive a long term rehabilitation…

May Retain Existing Rail System IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and

- No Accident History Exists

Shall Install New TL-5 Barrier System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS structurally sound
- With or without accident history

Shall Install New TL-5 Barrier System with New Deck Fascias IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound
- With or without accident history

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair and replacement criteria and details.

Existing Continuous Four Rail Curb/Curbless:

Mainline and Ramp Bridges to receive a long term rehabilitation…

May Retain Existing Rail System IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and
- No Accident History Exists

Shall Install New TL-5 Barrier System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS structurally sound
- With or without accident history

Shall Install New TL-5 Barrier System with New Deck Fascias IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound
- With or without accident history

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair and replacement criteria and details.

3.1.4.1.4 – NEW AND REPLACEMENT OVERHEAD BRIDGES

All **Overhead Bridges** to be replaced shall be designed and detailed using a Thruway standard TL-5 concrete barrier/parapet system. Although some overhead bridges may not have the heavy truck traffic that a mainline or ramp bridge may have, it is prudent to protect the mainline below overhead bridges with the stronger TL-5 system rather than the TL-4 system. The cost differential is minimal on a replacement project, and the TL-5 system would not require upgrading if truck traffic or accident history were to change over the long expected service life of a new structure. Bridge shoulders without sidewalks shall use the Thruway standard 3'-6" high single sloped concrete barrier system. See Details 3.1.4.2.b and 3.1.4.2.f for typical TL-5 barrier and overhang reinforcement size and spacing requirements. Bridge shoulders that include a sidewalk shall use the Thruway standard 3'-6" high vertical faced concrete parapet at the deck fascia/overhang. See Details 3.1.4.2.c and 3.1.4.2.f for typical TL-5 parapet and overhang reinforcement size and spacing requirements. Sight distance requirements at the site shall be reviewed during the scoping phase of the project. If the appropriate concrete barrier system will create unsafe sight distance conditions, an approved four or five rail TL-4 steel railing system may be used. See Details 3.1.4.2.d through 3.1.4.2.f for typical TL-4 overhang reinforcement size and spacing requirements.

3.1.4.1.5 – REHABILITATED OVERHEAD BRIDGES – Short Term

Existing Discontinuous Four-Rail with no Upgrade:

Overhead Thruway Bridges to receive a short term rehabilitation…

Shall Install Thrie Beam Upgrade IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and
- Posted speed is 35 MPH or lower

Shall Install Two Rail Box Beam Upgrade IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and

- Posted speed is above 35 MPH

Shall Install New TL-4 Rail System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, or
- Fascia concrete IS NOT structurally sound

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair criteria and details.

Existing Discontinuous Four-Rail with Thrie Beam Upgrade or Single Box Beam Upgrade:

Overhead Thruway Bridges to receive a short term rehabilitation…

May Retain Existing Rail System IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and
- Posted speed is 35 MPH or lower

Shall Install Two Rail Box Beam Upgrade IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and
- Posted speed is above 35 MPH

Shall Install New TL-4 Rail System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, or
- Fascia concrete IS NOT structurally sound

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair criteria and details.

Existing Discontinuous Four-Rail with existing Two Rail Box Beam Upgrade:

Overhead Thruway Bridges to receive a short term rehabilitation…

May Retain Existing Rail System IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound

Shall Install New TL-4 Rail System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, or
- Fascia concrete IS NOT structurally sound

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair criteria and details.

Existing Continuous Two-Rail Curb/Curbless or Four Rail Curb/Curbless:

Overhead Thruway Bridges to receive a short term rehabilitation…

May Retain Existing Rail System IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound

Shall Install New TL-4 Rail System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, or
- Fascia concrete IS NOT structurally sound

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair criteria and details.

3.1.4.1.6 – REHABILITATED OVERHEAD BRIDGES – Long Term

Existing Discontinuous Four-Rail with no Upgrade, Thrie Beam Upgrade, or Single Box Beam Upgrade:

Overhead Thruway Bridges to receive a long term rehabilitation…

Shall Install Two Rail Box Beam Upgrade IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and
- No accident history exists

Shall Install New TL-4 Rail System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS structurally sound, and
- No accident history exists

Shall Install New TL-4 Rail System with New Deck Fascias IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound, and
- No accident history exists

Shall Install New TL-5 Barrier/Parapet System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS structurally sound, and
- Accident history exists

Shall Install New TL-5 Barrier/Parapet System with New Deck Fascias IF:

- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound, and
- Accident history exists

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair and replacement criteria and details.

Existing Discontinuous Four-Rail with Two Rail Box Beam Upgrade:

Overhead Thruway Bridges to receive a long term rehabilitation…

May Retain Existing Rail System IF:

- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and
- No accident history exists

Shall Install New TL-4 Rail System with Monodeck Fascia Upgrades IF:

- Existing rail IS NOT structurally sound, and
- Fascia concrete IS structurally sound, and
- No accident history exists

Shall Install New TL-4 Rail System with New Deck Fascias IF:

- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound, and
- No accident history exists

Shall Install New TL-5 Barrier/Parapet System with Monodeck Fascia Upgrades IF:

- Existing rail IS NOT structurally sound, and
- Fascia concrete IS structurally sound, and
- Accident history exists

Shall Install New TL-5 Barrier/Parapet System with New Deck Fascias IF:

- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound, and
- Accident history exists

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair and replacement criteria and details.

Existing Continuous Two-Rail Curb/Curbless:

Overhead Thruway Bridges to receive a long term rehabilitation…

May Retain Existing Rail System IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and
- No accident history exists

Shall Install New TL-4 Rail System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS structurally sound, and
- No accident history exists

Shall Install New TL-4 Rail System with New Deck Fascias IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound, and
- No accident history exists

Shall Install New TL-5 Barrier/Parapet System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS structurally sound, and
- Accident history exists

Shall Install New TL-5 Barrier/Parapet System with New Deck Fascias IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound, and
- Accident history exists

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair and replacement criteria and details.

Existing Continuous Four-Rail Curb/Curbless:

Overhead Thruway Bridges to receive a long term rehabilitation…

May Retain Existing Rail System IF:
- Existing rail IS structurally sound, and
- Fascia concrete IS structurally sound, and
- No accident history exists

Shall Install New TL-4 Rail System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS structurally sound, and

- No accident history exists

Shall Install New TL-4 Rail System with New Deck Fascias IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound, and
- No accident history exists

Shall Install New TL-5 Barrier/Parapet System with Monodeck Fascia Upgrades IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS structurally sound, and
- Accident history exists

Shall Install New TL-5 Barrier/Parapet System with New Deck Fascias IF:
- Existing rail IS NOT structurally sound, and
- Fascia concrete IS NOT structurally sound, and
- Accident history exists

Refer to Subsection 3.1.4 (page 44) for deck fascia monodeck repair and replacement criteria and details.

3.1.4.2 – OVERHANG REINFORCEMENT DESIGN CRITERIA

For the TL-4 and TL-5 barrier/parapet/rail types listed in Table 3.1.4, the following design assumptions are made:

A. Three cases (fascia/overhang configurations) are investigated:

1. Single Slope Concrete Barrier\Concrete Parapet w/sidewalk (TL-5)
2. Two Rail Steel Railing with curb (TL-4)
3. Four Rail Steel Railing with/without sidewalk/curb (TL-4)

B. Assumptions made in investigating the above-mentioned cases are:

1. Critical section for imbedment length = centerline of fascia stringer. (Overhang reinforcement should be extended at least 2'-4" or imbedment length [whichever is greater] beyond this point toward first interior stringer.)
2. Design overhang = Overhang - (25% of Top Flange Width).

3. Overhang slab thickness (including haunch) = 10 ½” or 12”.

4. Wheel Load = 16 kips x 1.25.

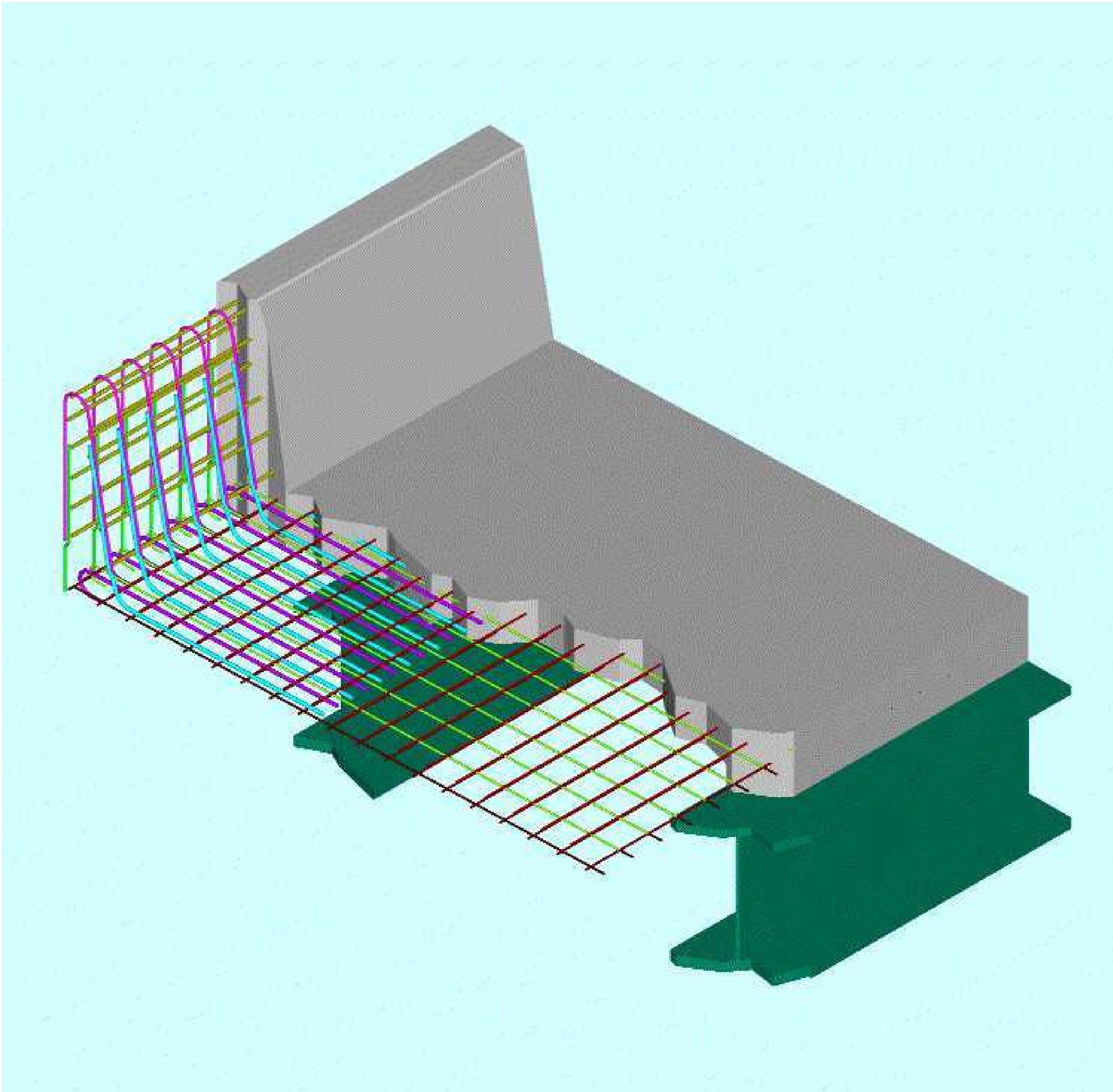
5. Transverse Impact Load = 124 kips (TL-5), 54 kips (TL-4)

6. Bar Reinforcement = Grade 60 (F_y = 60 ksi).

7. F'_c = 3,000 psi.

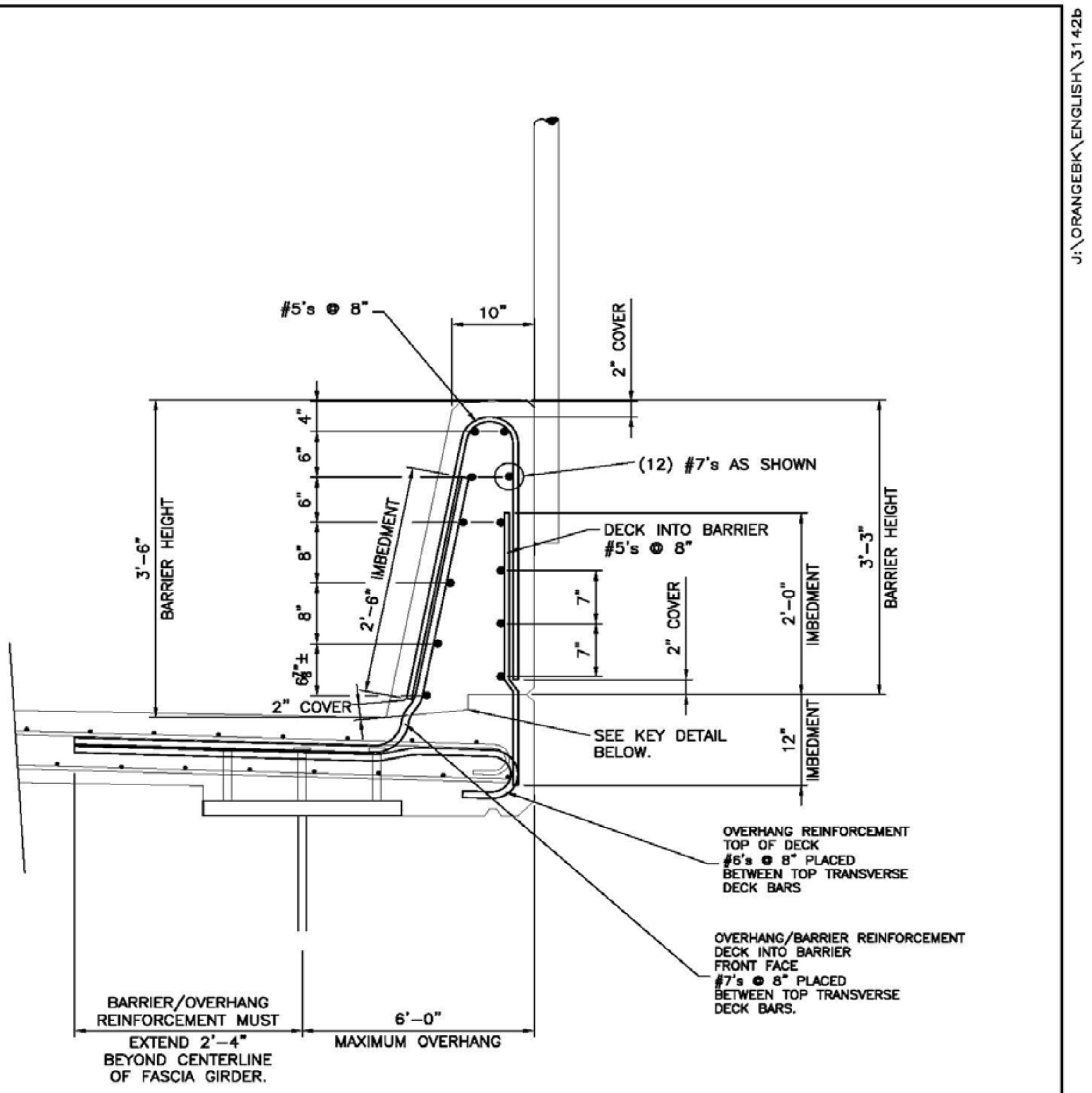
8. Design Depth (d) = 8” or 9 ½”.

Top overhang reinforcement shall be provided with a hook to develop the required reinforcement within 1’-0” from the fascia. This may be accomplished by either: a) providing additional hooked reinforcement between the design slab reinforcement; b) hooking the design slab reinforcement; and/or c) lapping additional hooked reinforcement to the design slab reinforcement within the first interior bay. For new construction laps shall be staggered by placing them at the slab inflection points, such that no two consecutive bars are spliced in the same bay or inflection point. The Thruway Authority has developed typical overhang design reinforcement details that may be used on all overhangs less than or equal to 6’-0”. See Details 3.1.4.2.a thru 3.1.4.2.f on the following sheets.



ISOMETRIC VIEW OF TYPICAL OVERHANG REINFORCEMENT

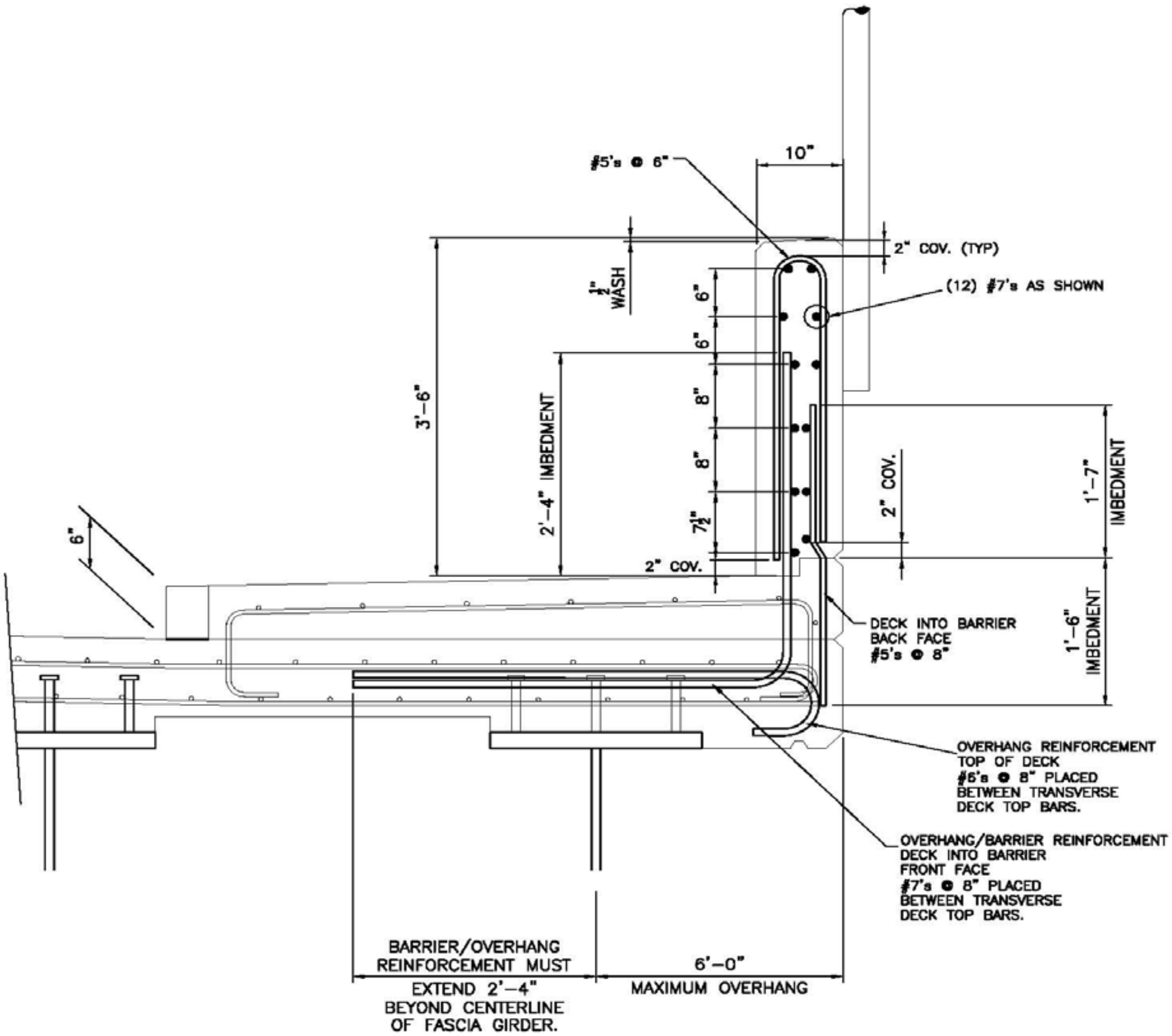
DETAIL 3.1.4.2.a



TRANSVERSE
OVERHANG REINFORCEMENT SECTION
WITH TL-5 CONCRETE BARRIER

DETAIL 3.1.4.2.b

N.T.S.



TRANSVERSE
OVERHANG REINFORCEMENT SECTION
WITH TL-5 CONCRETE PARAPET

DETAIL 3.1.4.2.c

N.T.S.

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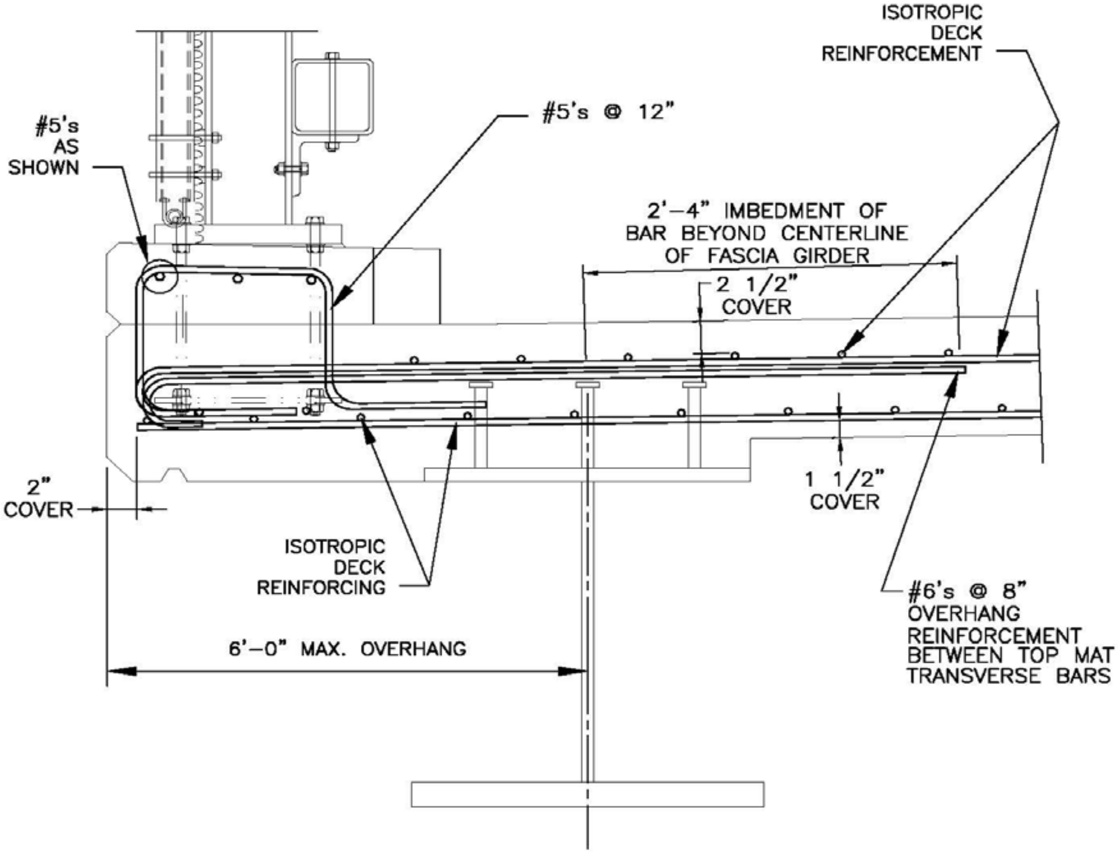
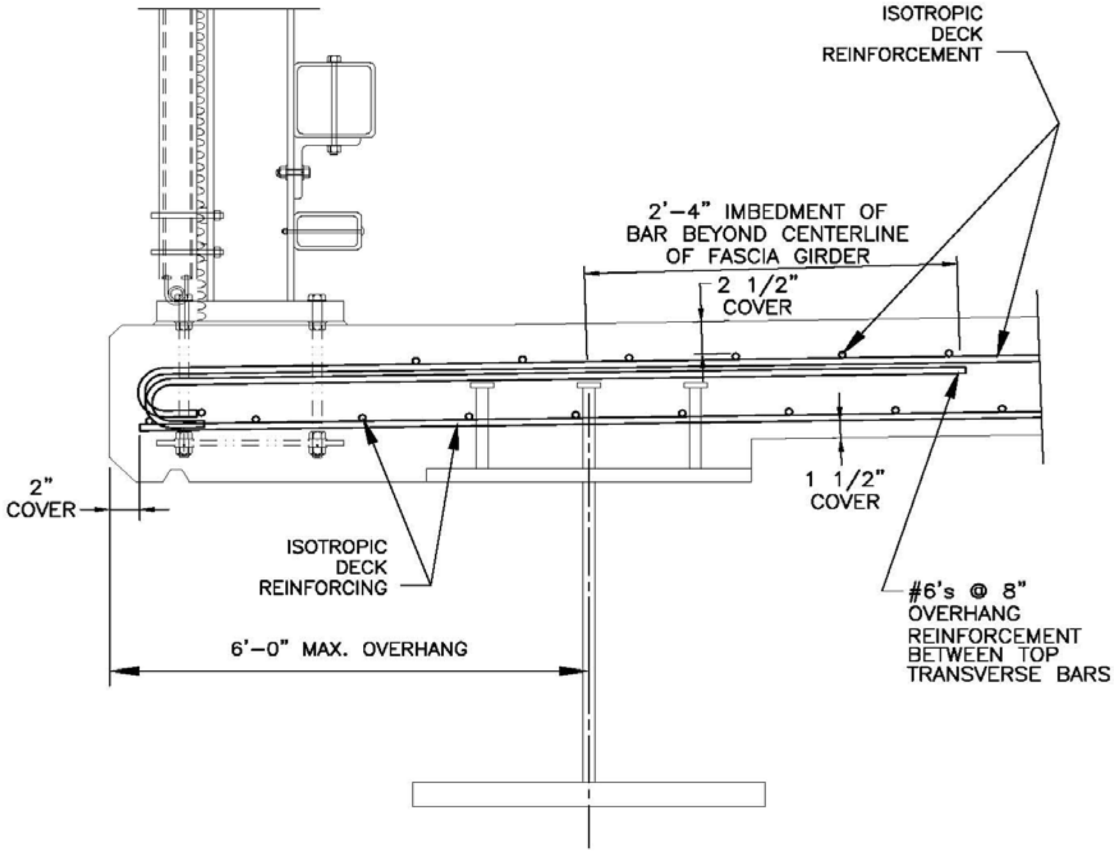


TRANSVERSE
OVERHANG REINFORCEMENT SECTION
WITH TL-4 2-RAIL BRIDGE RAIL

DETAIL 3.1.4.2.d

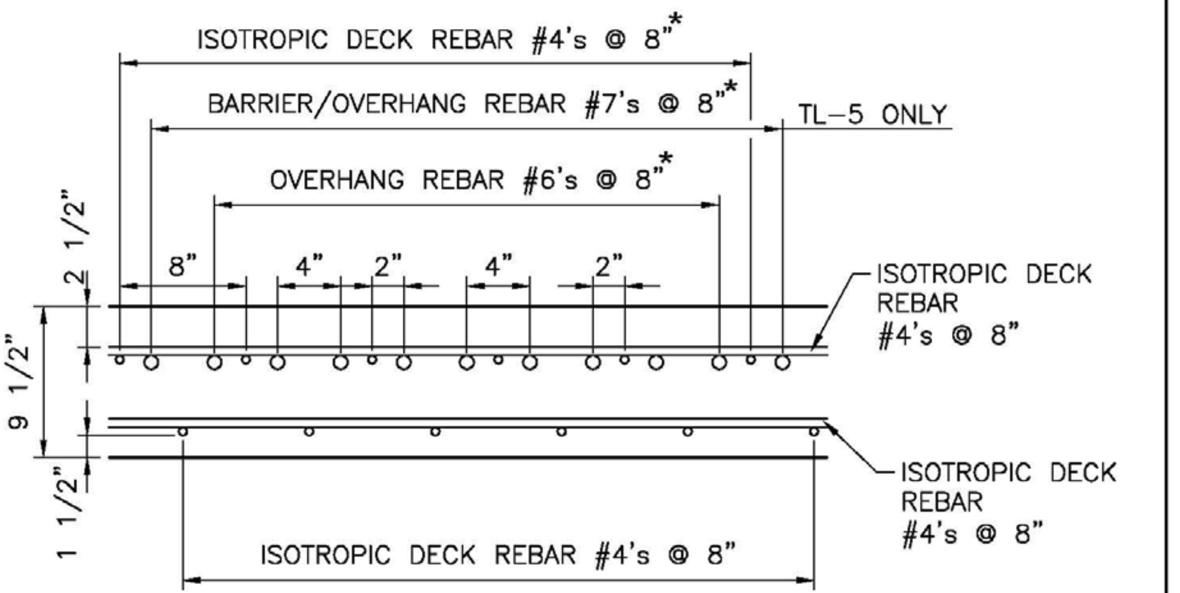
N.T.S.



TRANSVERSE
OVERHANG REINFORCEMENT SECTION
WITH TL-4 4-RAIL BRIDGE RAIL

DETAIL 3.1.4.2.e

N.T.S.



* - Spacing of top transverse bars in overhang reagion is theoretical. Contractor may adjust to allow for proper concrete placement.

LONGITUDINAL SECTION
TRANSVERSE OVERHANG REINFORCEMENT

DETAIL 3.1.4.2.f

N.T.S.

3.1.4.3 – BRIDGE TRANSITION RAIL SELECTION CRITERIA

The bridge rail transition type to use is dependent on the bridge rail/barrier type and the approach rail type. The appropriate transition types for the various bridge and approach rail configurations are as follows:

1. **Discontinuous four rail bridge rail with a thrie beam upgrade** shall use a thrie beam transition. This will transition directly into any type of corrugated beam guide rail. If the approach rail is box beam, then a corrugated to box beam transition will also be required.
2. **Discontinuous four rail bridge rail with a single box beam upgrade** shall use a single box beam transition. This will transition directly into box beam guide rail. If the approach rail is corrugated beam, then a box beam to corrugated beam transition will also be required.
3. **Discontinuous four rail bridge rail with a two rail box beam upgrade** shall use a two rail box beam transition. This will transition directly into box beam guide rail. If the approach rail is corrugated beam, then a box beam to corrugated beam transition will also be required.
4. **Two rail bridge rail** shall use a two rail box beam transition. This will transition directly into box beam guide rail. If the approach rail is corrugated beam, then a box beam to corrugated beam transition will also be required.
5. **Four and five rail bridge** rail shall use a two rail box beam transition. This will transition directly into box beam guide rail. If the approach rail is corrugated beam, then a box beam to corrugated beam transition will also be required.
6. **On the approach ends of single slope concrete barrier**, a face mounted two rail box beam transition shall be used if the approach rail is box beam. If the approach rail is corrugated,

then the thrie beam transition shall be used. **On the trailing ends of single slope concrete barrier**, an end mounted two rail box beam transition shall be used if the approach rail is box beam. If the approach rail is corrugated, then the thrie beam transition shall be used.

7. **Vertical concrete parapet with sidewalks** shall use an end mounted two rail box beam transition on approach and trailing ends. This will transition directly into box beam guide rail. If the approach rail is corrugated beam, then a box beam to corrugated beam transition will also be required.
8. <u>**"Tuning Fork" transitions on any structure shall be removed on all short term and long term projects and replaced with the two rail box beam transition.**</u>

Thruway Authority Standard Plan Sheets for the thrie beam transition, face mounted two rail box beam transition, and the end mounted two rail box beam transition are located in ProjectWise. Standard details for transitions between corrugated beam guide rail (weak post & heavy post block out) and box beam guide rail are located on current NYSDOT Standard Sheets.

<u>3.1.5 - HAUNCHES</u>

All steel stringer bridges with cast-in-place concrete deck slabs shall be provided with a concrete haunch over each stringer, placed monolithically with the slab. This haunch is provided as a construction tolerance for stringer camber. For flange widths under 16 inches, the minimum depth of haunch at the supports shall be 2 inches as measured along the centerline of web from the top of steel to the theoretical bottom of slab. For top flange widths of 16 inches or more, the 2 inch minimum shall be measured from the edge of flange. In these cases a deeper minimum haunch at the centerline of web may result due to the roadway cross slope. The haunch depth between supports will vary depending on the accuracy of the girder final camber. The allowable camber tolerance for girders is +3/4”, -0”. In no case shall the girder steel be allowed to protrude into the deck (negative haunch). See Girder Haunch Detail on sheet C6-2 of Appendix C. If the top flange is of varying thickness or includes a cover plate, the 2 inch shall be measured at the point of maximum top flange thickness (i.e., with a 3 inch thick top flange at the pier and a 2 inch thick top flange at the abutment, the minimum haunch shall be 2 inches thick at the pier and 3 inches thick at the abutment).

For bridges with a crest vertical curve or no vertical curve, the depth of the haunch at the centerline of bearings shall be the minimum depth, plus the difference in thickness between the maximum and minimum top flange plates, plus the correct allowance for horizontal curvature. For sag vertical curves, the girders shall be straight whenever possible. The point of minimum haunch shall be at some point between the supports. Refer to Subsection 7.3 – Camber, for additional information.

Fascia beams of non-continuous multi-span bridges shall be set so that the top of the webs of fascia beams in adjacent spans line up vertically. This will ensure a constant fascia depth for the entire length of the structure. See Subsection 7.21 – Shear Connectors, for information on shear studs and reinforcement in haunches.

3.1.6 - FORMING

Removable or stay-in-place (corrugated metal) forms shall be used on all Thruway Authority structures. If the structure has an expansion joint, and stay-in-place forms are used, one transverse line of forms at the low end of each span at the joint will be required to be removed for future inspection purposes. The detail shown on sheet C6-9 of Appendix C shall be shown on the contract plans. This detail shows the cross section of a typical deck with stay-in-place forms. When stay-in-place forms are used, the corrugations shall be filled with Styrofoam. The weight of the stay-in-place forms including Styrofoam shall be taken as 4.0 psf.

3.1.6.1 – TEMPORARY OVERHANG BRACKET DESIGN

The current **AASHTO LRFD 5th Edition** advises that the effects of temporary overhang brackets be analyzed for the effects on the structural steel members. These effects will primarily cause differential deflection and torsional stresses in the fascia girders. The girders, diaphragms, lateral bracing (if necessary), and connections need to be designed/analyzed to handle these temporary loads. To this end, the Designer shall follow the overhang bracket design procedures in the 1995 AASHTO CONSTRUCTION HANDBOOK FOR TEMPORARY WORKS - APPENDIX B. The designer shall ensure that the bridge steel has been designed to resist the maximum loads and moments calculated. There is a Thruway Structures Standard Sheet in ProjectWise titled “Deck Fascia Overhang Bracket Details & Notes” that shall be included in the project plans.

3.1.7 - CONCRETE PLACEMENT

The effects of concrete placement must be analyzed during design and any relevant information shall be placed in the contract documents. The analysis will give the designer an understanding of the potential structural behavior during placement and help to minimize undesirable results such as deck cracks. Based on the results of this analysis, the contract documents can either offer or restrict the contractor's placement options. The following definitions will be used:

<u>Continuous Placement</u> - A placement that starts at one end of a structural deck and finishes at the opposite end with no construction joints. Generally, the ends are at bridge joints or at the abutments**.** See Details 3.1.7.a and 3.1.7.b.

<u>Sequential Placement</u> - A series of individual placements. Generally, positive dead-load moment areas are placed first, allowed to cure for 72 hours, then the negative dead-load moment areas are placed. See Details 3.1.7.c and 3.1.7.d.

<u>Alternate Placement</u> - An alternative proposed by the contractor or Engineer as an improvement or a modification of the other methods.

Improved placement practices have increased the number of contractors requesting to place more bridge deck concrete continuously rather than sequentially. The use of set retarding admixtures allows the concrete to remain plastic for up to 6 hours.

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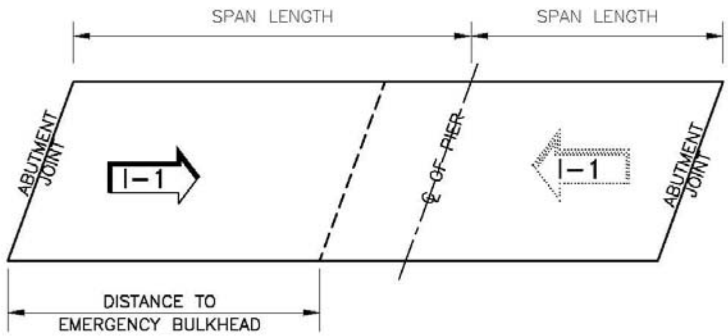

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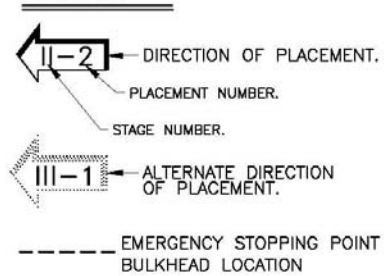

NOTES:

1. FOR DECK PLACEMENT NOTES SEE APPENDIX B.
2. APPROACH SLAB PLACEMENTS SHOULD BE SHOWN AS REQUIRED.
3. EMERGENCY BULKHEADS SHOULD BE LOCATED AS CLOSE AS POSSIBLE TO THE DEAD LOAD POINT OF CONTRAFLEXURE.

CONTINUOUS DECK CONCRETE PLACEMENT PLAN
(TYPICAL TWO SPAN CONTINUOUS AT CREST VERTICAL CURVE)
(SINGLE STAGE CONSTRUCTION)

NOT TO SCALE

DETAIL 3.1.7.a

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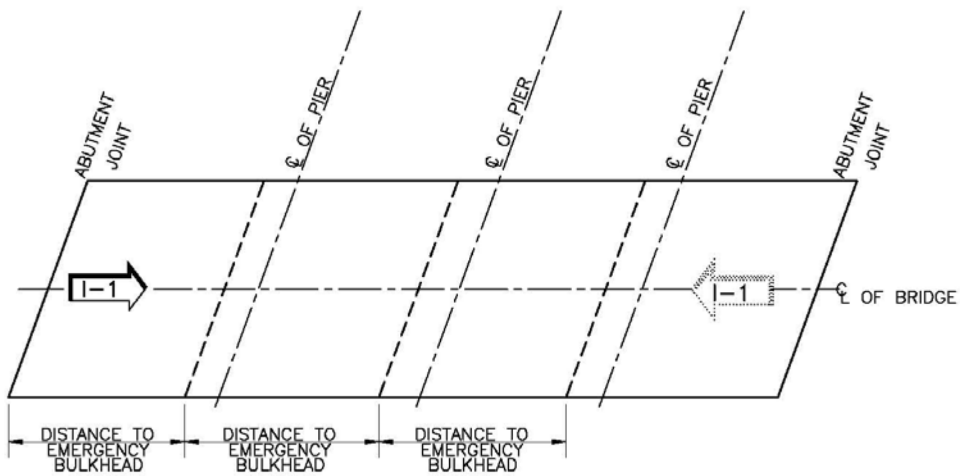

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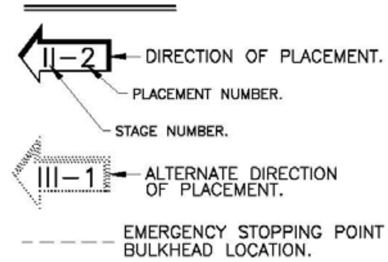

NOTES:

1. FOR DECK PLACEMENT NOTES SEE APPENDIX B.
2. APPROACH SLAB PLACEMENTS SHOULD BE SHOWN AS REQUIRED.
3. EMERGENCY BULKHEADS SHOULD BE LOCATED AS CLOSE AS POSSIBLE TO THE DEAD LOAD POINT OF CONTRAFLEXURE.

CONTINUOUS DECK CONCRETE PLACEMENT PLAN
(TYPICAL FOUR SPAN CONTINUOUS AT CREST VERTICAL CURVE)
(SINGLE STAGE CONSTRUCTION)

NOT TO SCALE

DETAIL 3.1.7.b

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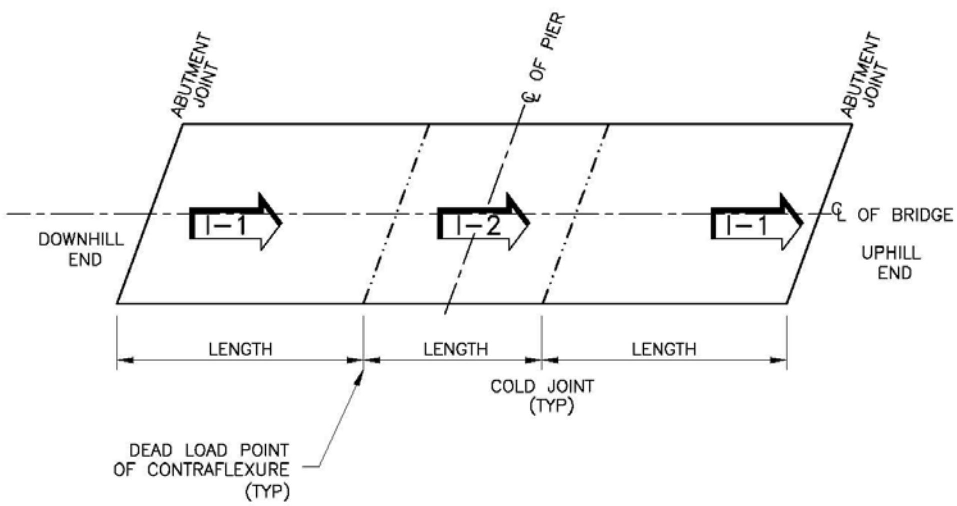

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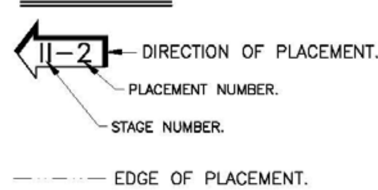


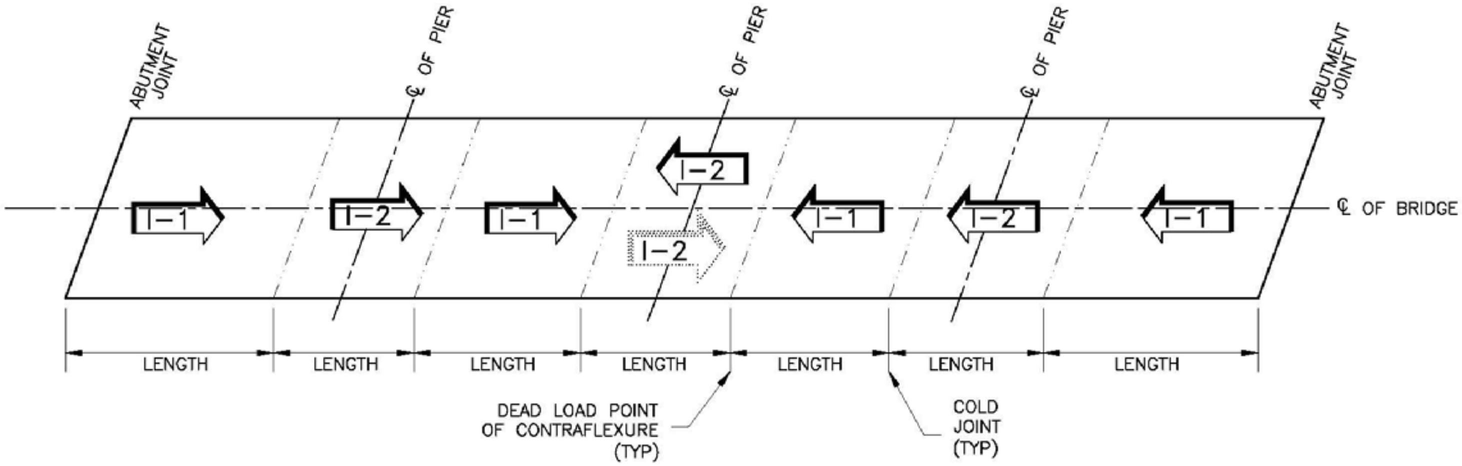
NOTES:

1. FOR DECK PLACEMENT NOTES SEE APPENDIX B.
2. APPROACH SLAB PLACEMENTS SHOULD BE SHOWN AS REQUIRED.

SEQUENTIAL DECK CONCRETE PLACEMENT PLAN
(TYPICAL TWO SPAN CONTINUOUS AT STRAIGHT GRADE)
(SINGLE STAGE CONSTRUCTION)

NOT TO SCALE

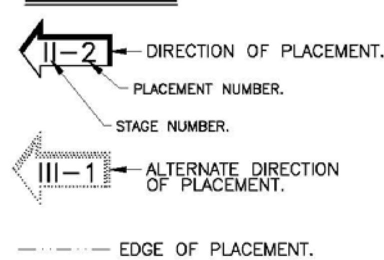
DETAIL 3.1.7.c



NOTES:

1. FOR DECK PLACEMENT NOTES SEE APPENDIX B.
2. APPROACH SLAB PLACEMENTS SHOULD BE SHOWN AS REQUIRED.

LEGEND:



SEQUENTIAL DECK CONCRETE PLACEMENT PLAN
(TYPICAL FOUR SPAN CONTINUOUS AT CREST VERTICAL CURVE)
(STAGED CONSTRUCTION)

NOT TO SCALE

DETAIL 3.1.7.d

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Ready-mix batch plants can generally produce 60 yd^3/HR or more, so placement rates of 30 yd^3/HR/finishing machine are attainable. Concrete pump trucks also contribute to this placement rate by keeping fresh concrete deposited in front of the advancing finishing machine. These pump trucks can deposit fresh concrete 200 feet or more away from where they are parked. With this in mind, the designer must calculate the volume of concrete in a particular placement and decide whether it can be done continuously or only sequentially. Next, the effects on the structure must be investigated, such as beam stability and uplift at supports. The use of shallow depth continuous beams to maintain vertical under clearance and elimination of shoulder piers of overhead bridges will contribute to increased deflections and potential uplift. Simple span bridges present less of a problem than continuous bridges, but should be checked just the same. The completed analysis will serve to support the decisions made should questions arise in the future.

Both methods should be offered in the contract documents unless continuous placement is restricted from use based on the results of the analysis. Regardless, the contractor will be required to submit a detailed plan for review and approval stating the following:

A. How the concrete will be placed using the equipment, personnel, and any other required resources.

B. The quantity, type, and rate of placement features of the equipment to be used in this work.

C. Contingencies for changes in weather, equipment breakdowns, batch plant delays, or any other factors that could delay or stop this work.

D. How placement operations will be stopped if required and how the end of placement will be finished.

E. An anticipated rate of concrete volume placed per hour.

This is just a basic list. Additional information should be requested based on the results of the analysis. An example would be if uplift were anticipated during placement, the contractor must describe how it will be addressed. See Appendix B for sample notes.

3.1.7.1 - CONTINUOUS PLACEMENT

This is generally the method used during construction. But before this option is placed in the plans, the analysis must consider factors that would preclude it. These factors include the structure type, volume of placement, the time to complete placement, structural effects, and any others that would restrict this method. Otherwise, if it is feasible, it should be included as an option.

The following are some useful things to consider in the analysis:

Placement time - 6 hours is generally an upper limit that set retarding admixtures will keep the mix plastic. Limit the amount of time based on the volume to be placed so that the operation takes place in a reasonably quick period of time. Calculate the placement time using 30 yd^3/HR/finishing machine and limit that time, rounded up to the next nearest half hour. If the placement is much larger, show an acceptable stopping point where a placement operation can end without increasing the probability of cracking.

Direction of placement - Analyze this effect and if necessary, limit the direction of placement. Placement should always be done uphill unless structural limitations prevent it.

Acceptable stopping points - Determine and show points to allow for both a planned and unplanned placement stops. These points are usually located at the dead load points of contraflexure.

Effects on Structure - Consideration should be given to the amount of dead load deflections as fresh concrete is placed. The girders should also be analyzed for the need for additional bracing during concrete placement.

A longitudinal section of the deck must be shown with allowable placement stopping points and the allowed direction of placement. The time allowed for continuous placements shall also be noted. Any other relevant information shall be included as necessary. If this method cannot be used, the Designer shall clearly note on the plans that "continuous placement shall not be allowed”.

3.1.7.2 - SEQUENCED PLACEMENT

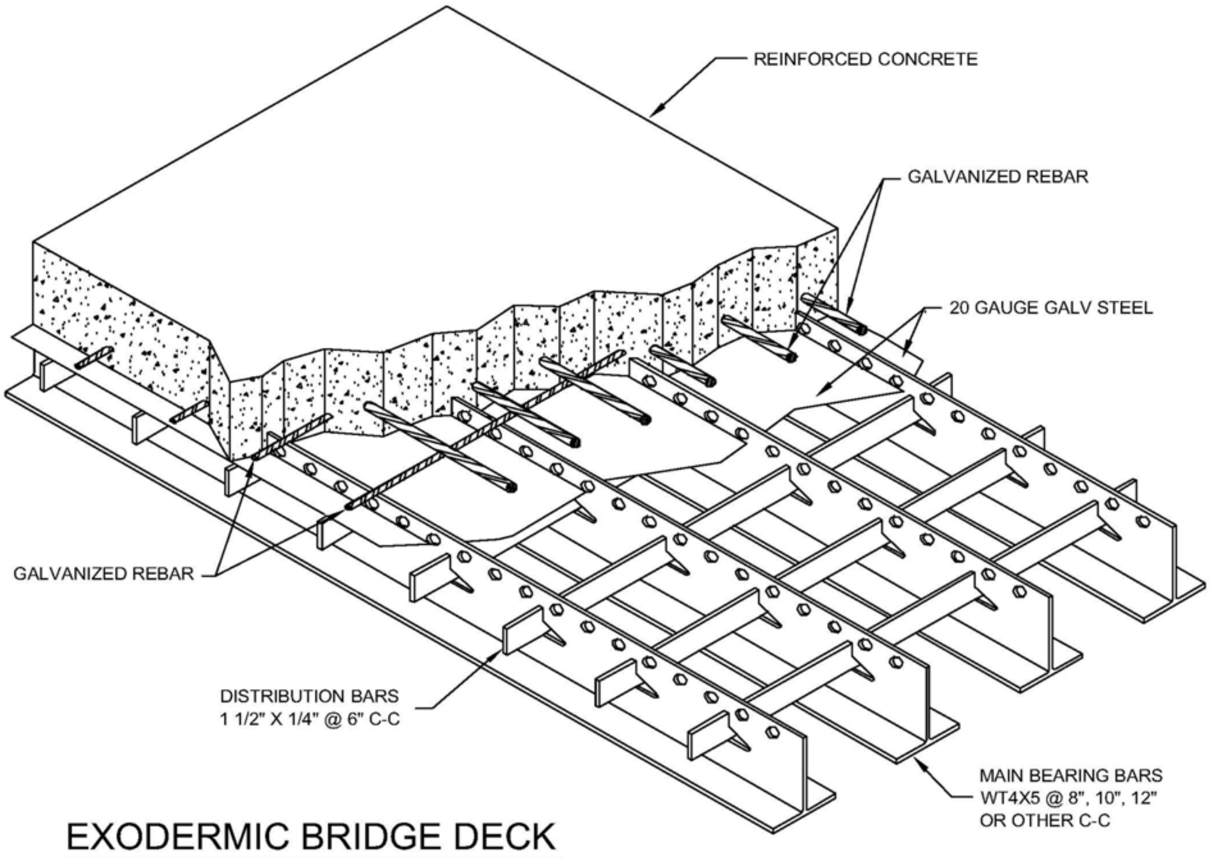
This method will be used when the continuous method is prohibited due to the above criteria. As with the continuous placement method, an analysis should be made for the effects on the structure and to determine the sequences and their boundaries. Much of the analysis for continuous placement will be useful in detailing this method. Therefore, refer to the previous section. A plan view of the deck must be shown with a sequence schedule. Any other relevant information shall be included as necessary.

3.2 - PREFABRICATED DECK SYSTEMS

The Authority has successfully constructed numerous projects using prefabricated deck systems. These types of systems are especially appropriate when factors such as traffic and time constraints come into play. As previously stated, because of the ever evolving nature of the construction industry, designers are encouraged to investigate alternative systems early in the design phase. In addition to generic, precast slabs and filled grids, two proprietary systems have been used successfully to date. They are Exodermic™ Bridge Deck and the Inverset™ Bridge System.

3.2.1 - EXODERMIC™ BRIDGE DECK

Exodermic™ deck systems shall only be used with prior approval from the **Director of Structures Design (DSD)**. An Exodermic™ deck is comprised of a reinforced concrete slab on top of, and composite with, an unfilled steel grid that spans between girders. This deck system maximizes the use of the compressive strength of concrete and the tensile strength of steel. Horizontal shear transfer is developed through the partial concrete imbedment of the main bearing bars (WT's). These main bearing bars are fabricated with ¾" diameter holes at 2 inch centers along the top of the web (See Detail 3.2.1). The deck concrete flows through these holes and hardens to provide the shear transfer path. Overall thickness of the system ranges from 6 inches to 9 ½ inches; weights range from 40 to 80 pounds per square foot. Exodermic™ decks can span 18.0 feet or more; larger main bearing bars and thicker concrete slabs can be specified for longer spans. The concrete component of an Exodermic™ deck can be pre-cast before the panels are placed on the bridge, or cast-in-place.

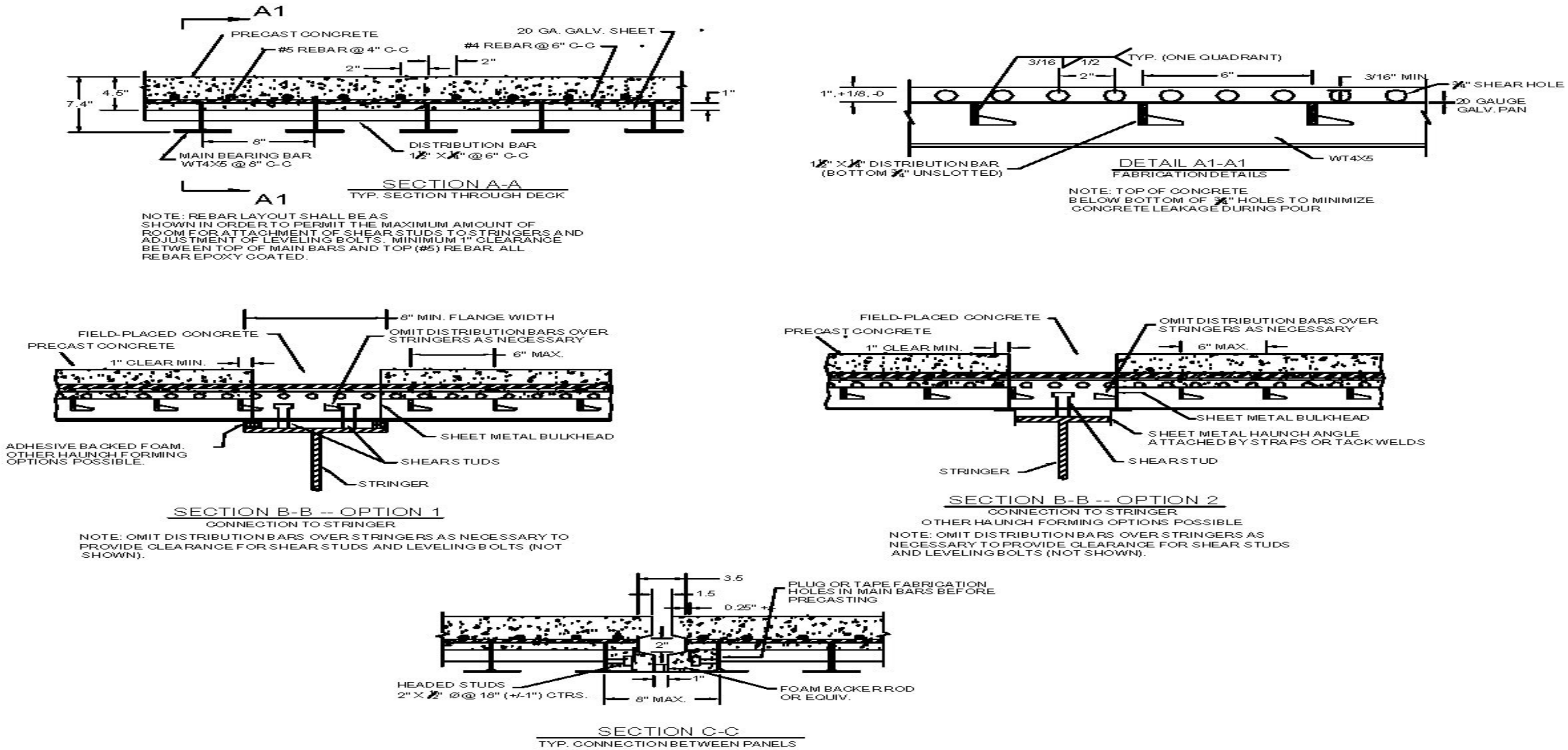


DETAIL 3.2.1

Where the concrete is cast-in-place, the steel grid component acts as a form, the strength of which permits elimination of the bottom half of a standard reinforced concrete slab. Exodermic™ decks are made composite with the steel superstructure by using headed studs welded to stringers, floor beams, and main girders as appropriate, and embedding these headed studs in a concrete haunch area. The haunch area is poured at the same time as the reinforced concrete deck where the deck is cast-in-place, or separately with a pre-cast deck. Exodermic™ decks require no field welding other than that required for the placement (with an automatic tool) of the headed shear studs. See Detail 3.2.1.1.a.

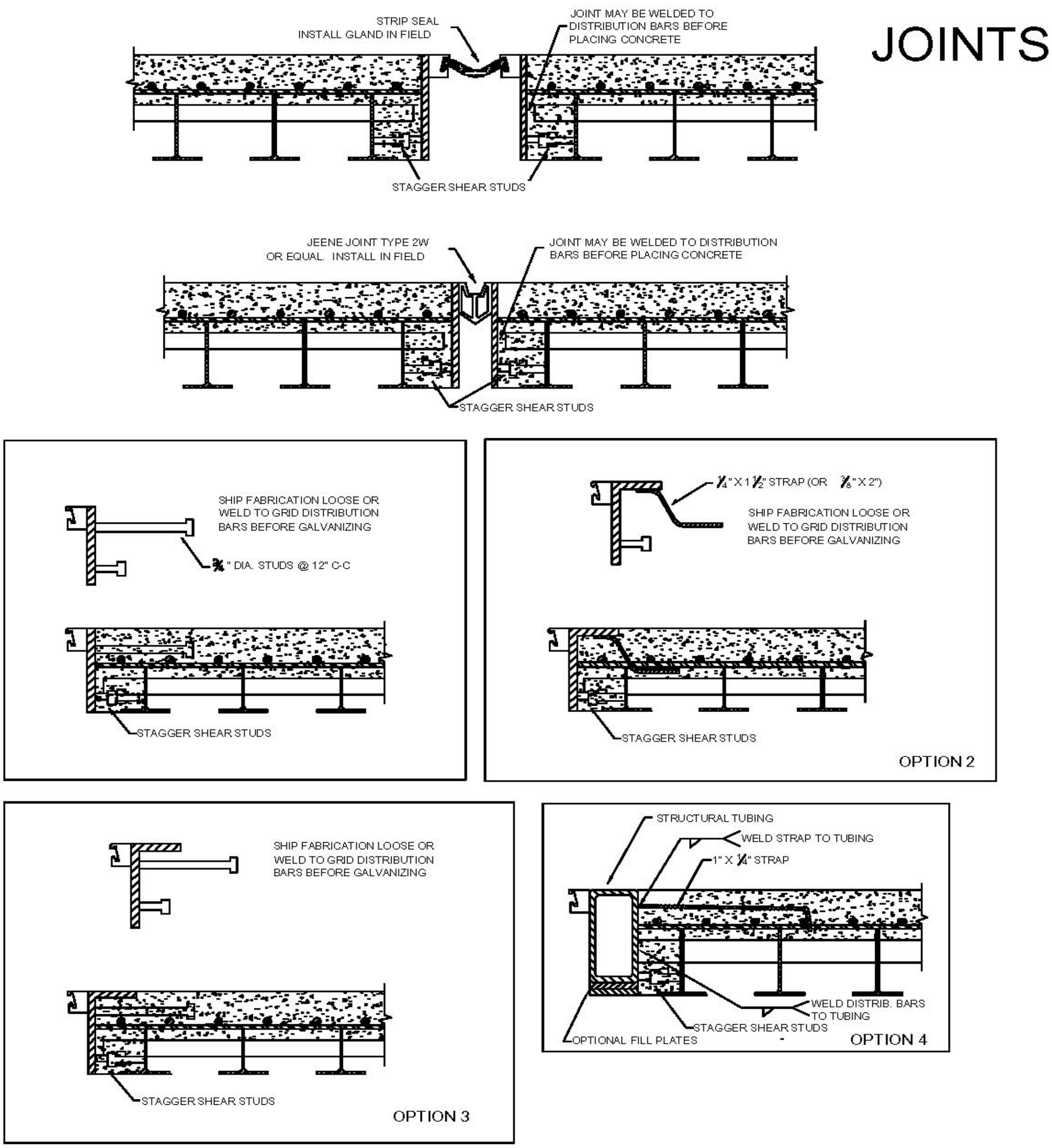
3.2.1.1 - CHARACTERISTICS OF EXODERMIC™ DECK CONSTRUCTION

Reducing the deadload on a structure can often mean increasing the liveload carrying capacity. An Exodermic™ deck can be much lighter without sacrificing strength, stiffness, ride quality, or expected life. An Exodermic™ deck typically weighs 50% to 65% of a reinforced concrete deck of the same overall thickness. Pre-cast Exodermic™ decks can be erected during a nighttime work window, allowing a bridge to be kept fully open to traffic during the busy daytime hours. Cast-in-place Exodermic™ decks also permit savings in construction time - the steel grid panels come to the site essentially ready for concrete. The steel grid component of an Exodermic™ deck acts as a pre-cut, pre-formed, stay-in-place form. Panels are quickly placed, and layout of the single mat of rebar is simple and straightforward, without the need for chairs or other aids. An Exodermic™ deck is easily maintained with standard materials and techniques. The top portion of an Exodermic™ deck is basically the same as the top half of a standard reinforced concrete deck. If desired, any overlay compatible with concrete can be used; including latex modified concrete, micro silica concrete, or a membrane with asphaltic concrete overlay. Typical expansion joint connections are shown on Detail 3.2.1.1.b.



PRECAST EXODERMIC DECK DETAILS

DETAIL 3.2.1.1.a



DETAIL 3.2.1.1.b

3.2.1.2 - EXODERMIC™ DECK DESIGN

A design manual is available from the Exodermic™ Bridge Deck Institute. The design methodology and criteria for both the **AASHTO 17th Edition** and **AASHTO LRFD 5th Edition** are included on the following pages.

The Designer has a number of choices to make in choosing an Exodermic™ deck configuration: Main bar type and spacing, rebar size and spacing, and concrete thickness. A number of Exodermic™ decks have used a 4 ½” concrete thickness in order to provide a standard 2 3/8” of cover over rebar. Achieving desired total deck thickness and weight may require reducing the concrete thickness. Exodermic™ decks have been constructed with concrete thickness of 3 inches to 5 inches. Lightweight concrete can be specified where weight is especially critical.

While any steel grid can be used in constructing an Exodermic™ deck, use of industry standard grid configurations is advised to avoid costs associated with new tooling. The standard types are referred to by the type of main bearing bar employed. Standard spacing of main bearing bars and configuration of other components are given in tables available from the Exodermic™ Bridge Deck Institute.

Exodermic Bridge Deck -- Design Methodology & Criteria

Standard Specification

- AASHTO 17th Edition (2002) or 16 th Edition (with interims)
- Transformed Area Method (3.27.2.2)
- Service Load (working stress) Design

Materials

- A709 Grade 36 Steel $f_b = 0.55\ F_y = 20$ksi (10.32.1)
- A709 Grade 50 Steel $f_b = 27$ ksi (10.32.1)
- Steel Weight 490 lbs./cu.ft.
- Concrete weight 145 lbs/cu.ft. without rebar (10.38.1.3)

(115 lbs/cu.ft. lightweight)

- $f'_c = 4000$ psi; $n = 8$ (10.38.1.3) (8.15.3.4)
- $f_c = 0.4f'_c$ (8.15.2.1.1)
- Deduct top 0.5" of concrete for future grooving or wear.
- Concrete not considered in tension regions.

Loads and Moments

- Impact 30% (3.8.2.1)
- Continuity factor: 0.8 for dead and live load (3.24.3.1)
- Dead load moment, precast: full composite section (n=24, if higher stresses result) (10.38.1.4)
- Dead load moment: cast-in-place: grid section only
- Live load: full composite section positive and negative moment
- Main Bearing Bars transverse to traffic:
  - $M_{DL} = WS^2/8$ (x 0.8 if continuous)
  - $M_{LL} = \{(S+2)/32\}$ P (2 .8 if continuous) (3.24.3.1)
    For HS-20, P = 16 x 1.3 x 0.8, where 1.3 is the factor for impact and 0.8 for continuity
    For HS-25, P = 20 x 1.3 x 0.8, where 1.3 is the factor for impact and 0.8 for continuity
- Main Bearing Bars parallel to traffic:
  - $M_{DL} = WS^2/8$ (2 0.8 if continuous)
  - $M_{LL} = 900S$ (2 0.8 if continuous) (3.24.3.2)
- Distribution Factor S/5.5 (3.23.2.2)
  S = distance between edges of stringer flanges + 1/2 flange width (3.24.1.2.b)
- Deflection limited to L/800 (10.6.2)
- Check welds for fatigue resistance (Category C)

Exodermic Bridge Deck -- Design Methodology & Criteria

LRFD Specification

Introduction

Until recently, all Exodermic designs were based on the AASHTO Standard Specification, using Allowable Stress Design (ASD), also known as Working Stress Design.

In May of 2002, The AASHTO Subcommittee on Bridges and Structures approved a number of changes to the LRFD Bridge Design Specifications affecting concrete filled grids and "unfilled grid decks composite with reinforced concrete slabs" as the Exodermic design is called in the specification. Both concrete filled grid decks and Exodermic decks are subject to the same design criteria. To summarize the changes:

- Moment equations (based on orthotropic plate theory) replaced for all grid types other than open grids. The existing equations were unconservative, particularly for longer spans.

- Equations provided for deflection and fatigue moment based on orthotropic plate theory.

- Serviceability checks required for deflection and fatigue.

- Stiffness (i.e. moment of inertia) is to be calculated using the transformed area method; omit any effect of concrete acting in tension.

- All intersections in open grid decks, partially filled grid decks, and "unfilled grid decks composite with reinforced concrete slabs" (Exodermic decks) are to be welded (in accordance with previously published grid industry literature).

- Minor changes such as requiring that the thickness of an integral concrete overlay be reduced for future wear or resurfacing when computing properties, and minimum structural overfill for filled and partially filled grids changed from 1½" to 1¾" (in accordance with grid industry literature).

Although these changes were much needed, it appears that the moment equation for the fatigue load may have been excessively conservative for negative moment. AASHTO's T-14 Technical Committee (Steel Design) is looking into this further. See LRFD design criteria.

LRFD Design Criteria

AASHTO LRFD Bridge Design Specifications, Second Edition, with annual "interims". Significant changes to the LRFD specification pertaining to "unfilled grid decks composite with reinforced concrete slabs" (Exodermic decks) and concrete filled grids were approved at AASHTO Bridge Engineers meeting in Atlantic City, May, 2002 for the 2003 Interim.

Materials

Steel: AASHTO M 270, Grade 36 (ASTM A709 Grade 36) or
AASHTO M 270, Grade 50 (ASTM A709 Grade 50) or
AASHTO M 270, Grade 50W (ASTM A709 Grade 50W) (6.4.1)
Steel weight 490 lbs/cu.ft.
Concrete weight 145 lbs./cu.ft. without rebar (115 lbs/cu.ft. lightweight).

F'_c = 4000 psi; n=8 (5.4.2.1)

LIVELOAD MOMENT (4.6.2.1.8)

- Main bars transverse to traffic:

$$M(L \le 120\text{in.}) = C\ 1.28\ D^{0.197}\ L^{0.459} \quad (4.6.2.1.8\text{-}1)$$

$$M(L > 120\text{in.}) = C\frac{D^{0.188}(3.7\ \ L^{1.35} - 956.3)}{L} \quad (4.6.2.1.8\text{-}2)$$

- Main bars parallel to traffic:

$$M(L \le 120\text{in.}) = C\ 0.73\ D^{0.123}\ L^{0.64} \quad (4.6.2.1.8\text{-}3)$$

$$M(L > 120\text{in.}) = C\frac{D^{0.138}(3.1\ \ L^{1.429} - 1088.5)}{L} \quad (4.6.2.1.8\text{-}4)$$

where:

L = span length (IN) from center-to-center of supports

C = continuity factor; 1.0 for simply supported and 0.8 for continuous spans

$D = D_X / D_Y$

D_X = flexural rigidity of deck in main bar direction (KIP-IN^2/IN)

D_Y = flexural rigidity of deck perpendicular to main bar direction (KIP-IN^2/IN)

For grid decks, D_X and D_Y should calculated as EI_X and EI_Y where E is the modulus of elasticity and I_X and I_Y are the moment of inertia per unit width of deck, considering the section as cracked and using the transformed area method for the main bar direction and transverse to main bar direction respectively.

For Fatigue: "Moments for fatigue assessment may be estimated for all span lengths by reducing Eq. 4.6.2.1.8-1 for main bars transverse to traffic or Eq. 4.6.2.1.8-3 for main bars parallel to traffic by a factor of 3." (4.6.2.1.8)

DEFLECTION (4.6.2.1.8.1)

Deflection in units of IN due to vehicular live load may be determined as:

- Main bars transverse to traffic:

$$\text{DEFLECTION}_{\text{transverse}} = \frac{0.0052 D^{0.19} L^3}{D_X} \qquad (4.6.2.1.8.1\text{-}1)$$

- Main bars parallel to traffic:

$$\text{DEFLECTION}_{\text{parallel}} = \frac{0.0072 D^{0.11} L^3}{D_X} \qquad (4.6.2.1.8.1\text{-}2)$$

Where variables are as defined above for Moment.

RESISTANCE:

- Moments of Inertia and Section properties derived using the transformed area method. No concrete included on the tension side of the neutral axis. Deduct 0.5" from top of concrete slab as a provision for future wear or resurfacing. Properties calculated separately for positive and negative bending.
- Deadload moment, precast: resisted by full composite section (n=24, if higher stresses result).
- Deadload moment, cast-in-place: resisted by steel grid only.
- Liveload Moment: resisted by fully composite section.

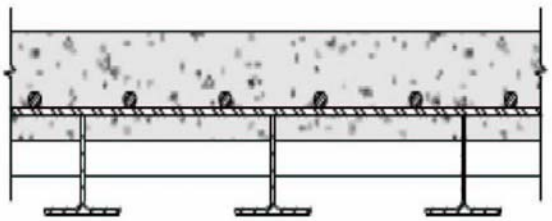
- Nominal Moment Capacity: Use cracked section properties, and lower of moment capacity calculated for $f_s = f_y$ steel or $f_c = f'_c$ concrete
- Fatigue check: Check fatigue prone details for Category C. Stress = Constant Amplitude Fatigue Threshold = 5 ksi (6.6.1.2.5) (Table 6.6.1.2.5-3)
- Deflection check: Use equations to determine deflection. Check against (9.5.2):
  L/800 for decks with no pedestrian traffic
  L/1000 for decks with limited pedestrian traffic
  L/1200 for decks with significant pedestrian traffic

Choice of main bearing bar type is generally determined by desired total deck thickness. Where there are no deck thickness constraints, the 5.2 inch grid main bearing bars are the most efficient. Depending on span, the 3 inch "T" grid should provide the lightest (and least expensive) option, as the amount of full depth concrete over supports, and the full depth transverse joint between panels is minimized. On the following sheets are example Exodermic™ deck sections as well as Table 3.2.1.3 the designer can use as a tool in determining various component sizes. The use of a proposed section should always be verified with the completion of design calculations.

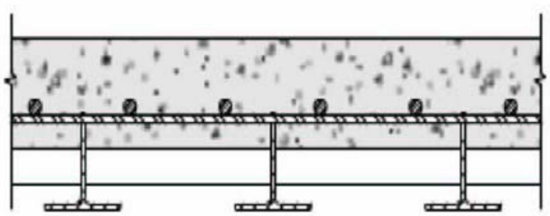
3.2.1.3 – EXAMPLE EXODERMIC™ DECK SECTIONS

Choice of main bearing bar type is generally determined by desired deck thickness and span. Depending on span, the WT4x5 grid should provide the lightest option, minimizing the amount of full depth concrete over supports and the full depth transverse connection between panels. With deeper main bars, main bar spacing can be increased, potentially reducing the deck cost.

The designer is encouraged to contact D. S. Brown for assistance in choosing a deck configuration.

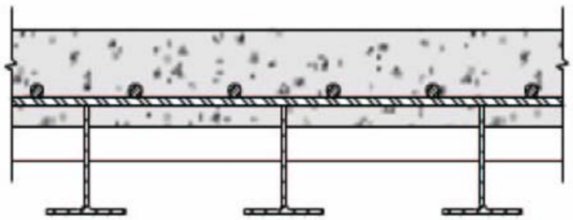


WT4x5 Main Bars
Overall Deck Thickness: 6" to 8"
Weight*: Lightweight concrete: From 39 lbs to 59 lbs
Standard weight concrete: From 47 to 70 lbs
Spans** to: 12 ft. (HS-20); 11 ft. (HS-25), main bars transverse to traffic.
10 ft. (HS-20); 8 ft. (HS-25), main bars parallel to traffic.
Main bearing bar spacing: 8", 10", or 12"
Distribution bar: 1 1/2" 2 1/4" @ 6" c-c
Rebar as required.

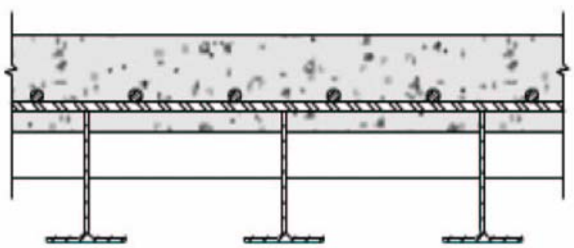


WT4x5 Main Bars with dropped distribution bar (for reduced deck thickness)
Overall Deck Thickness: 5 1/2" to 7 1/2"
Weight*: Lightweight concrete: From 40 psf to 57 psf
Standard weight concrete: From 47 psf to 68 psf
Spans** to: 10.7 feet (HS-20); 10.7 feet (HS-25), main bars transverse to traffic
9.9 feet (HS-20); 8.2 feet (HS-25), main bars parallel to traffic

Main bearing bar spacing: 8", 10", 12"
Distribution bar: 1 1/2" x 1/4" @ 6" c-c
Rebar as required



WT5x6 Main Bars
Overall Deck Thickness: 7" to 9"
Weight*: Lightweight concrete: From 40 psf to 61 psf
Standard weight concrete: From 48 psf to 72 psf
Spans** to: 14.5 feet (HS-20); 14.5 feet (HS-25), main bars transverse to traffic
12.9 feet (HS-20); 11.6 feet (HS-25), main bars parallel to traffic
Main bearing bar spacing: 8", 10", 12"
Distribution bar: 1/2" x 1/4" @ 6" c-c
Rebar as required



WT6x7 Main Bars
Overall Deck Thickness: 8" to 10"
Weight*: Lightweight concrete: From 42 lbs to 63 lbs
Standard weight concrete: From 51 lbs to 74 lbs
Spans to: 18 ft. (HS-20); 16 ft. (HS-25), main bars
transverse to traffic.
16 ft. (HS-20); 13 ft. (HS-25), main bars
parallel to traffic.
Main bearing bar spacing: 8", 10", or 12"
Rebar as required.

**Note on weights: Weights shown include grid, typical rebar, and concrete. Add weight for full depth haunches over stringers and for shear keys or full depth connections between panels. Concrete weight without rebar is 145 lbs/cu.ft. (normal weight) (10.38.1.3) or 115 lbs/cu.ft. (light weight).*

*** Allowable strength, deflection, or fatigue may control*

Deck Properties & Spans

			Weight (lbs/sf)		Moment of Inertia (in^4)		SECTION MODULUS (in^3)					MAXIMUM SPANS (ft.)							
							Positive Bending		Negative Bending			Main Bars Transverse To Traffic				Main Bars Parallel To Traffic			
												Cast in Place		Precast		Cast in Place		Precast	
Overall Depth (in.)	Concrete Thickness (in.)	Top Rebar & Spacing (in.)	Normal Concrete	Lightweight Concrete	I_{pos}	I_{neg}	Top of Concrete	Bottom of Main Bar	Top Rebar	Top of Distrib Bar	Bottom of Main Bar	HS-20	HS-25	HS-20	HS-25	HS-20	HS-25	HS-20	HS-25
Grid: WT4x5 @ 8" C-C (weight of grid w/ pans = 11.4 lbs/sf)																			
7.4	4.5	#6 @ 3	69.9	59.2	41.41	16.33	111.51	-9.35	-8.02	-53.89	6.29	12	11	12	11	10	8	10	8
7.4	4.5	#6 @ 4	68.8	58.0	41.40	14.23	111.08	-9.37	-6.13	-24.17	6.15	12	11	12	11	9	8	10	8
7.4	4.5	#5 @ 4	67.8	57.0	41.36	11.39	110.32	-9.40	-4.35	-11.96	5.85	12	9	10	8	8	6	7	6
7.4	4.5	#5 @ 8	66.7	55.8	41.35	7.58	109.92	-9.42	-2.41	-5.12	5.34	6	4	5	4	4	3	4	3
6.4	3.5	#6 @ 3	57.8	49.6	30.05	16.33	95.35	-7.75	-8.02	-53.89	6.29	10	9	10	9	10	8	10	8
6.4	3.5	#6 @ 4	56.7	48.4	29.82	14.23	93.04	-7.77	-6.13	-24.17	6.15	10	9	10	9	10	8	10	8
6.4	3.5	#5 @ 4	55.8	47.4	29.50	11.39	90.25	-7.79	-4.35	-11.96	5.85	10	9	10	8	8	6	7	6
6.4	3.5	#5 @ 8	54.7	46.2	29.23	7.58	87.73	-7.83	-2.41	-5.12	5.34	6	4	5	4	4	3	4	3
Grid: WT4x5 @ 10" C-C (weight of grid w/ pans = 10.0 lbs/sf)																			
7.4	4.5	#6 @ 5	66.8	56.0	35.50	11.38	102.07	-7.69	-4.90	-19.33	4.92	11	9	11	9	8	6	8	7
7.4	4.5	#5 @ 5	66.1	55.1	35.50	9.12	101.81	-7.70	-3.48	-9.57	4.68	9	7	8	6	6	5	6	5
7.4	4.5	#5 @ 10	65.2	54.2	35.50	6.07	101.89	-7.70	-1.93	-4.10	4.27	4	3	4	3	3	3	3	2
6.4	3.5	#6 @ 5	54.7	46.4	25.38	11.38	84.51	-6.35	-4.90	-19.33	4.92	9	8	9	8	8	6	8	7
6.4	3.5	#5 @ 5	54.0	45.5	25.21	9.12	82.62	-6.37	-3.48	-9.57	4.68	9	7	8	6	6	5	6	5
6.4	3.5	#5 @ 10	53.1	44.6	25.08	6.07	81.01	-6.39	-1.93	-4.10	4.27	4	3	4	3	3	3	3	3
Grid: WT4x5 @ 12" C-C (weight of grid w/ pans = 9.0 lbs/sf)																			
7.4	4.5	#6 @ 6	65.4	54.5	31.23	9.48	95.26	-6.54	-4.09	-16.11	4.10	9	7	10	8	6	5	7	5
7.4	4.5	#5 @ 4	65.5	54.6	31.25	9.41	94.98	-6.55	-4.19	-16.35	4.05	9	7	10	8	6	5	7	5
7.4	4.5	#5 @ 6	64.8	53.8	31.23	7.60	95.29	-6.54	-2.90	-7.98	3.90	7	5	7	5	5	4	5	4
6.4	3.5	#6 @ 6	53.4	45.0	22.21	9.48	78.24	-5.38	-4.09	-16.11	4.10	9	7	9	8	7	5	7	5
6.4	3.5	#5 @ 4	53.4	45.1	22.17	9.41	77.89	-5.38	-4.19	-16.35	4.05	9	7	9	8	6	5	7	5
6.4	3.5	#5 @ 6	52.7	44.3	22.12	7.60	76.91	-5.39	-2.90	-7.98	3.90	7	5	7	5	5	4	5	4
Grid: WT6x7 @ 8" C-C (weight of grid w/ pans = 15.3 lbs/sf)																			
9.4	4.5	#6@3	73.7	63.0	84.20	37.60	184.12	-14.68	-11.82	-26.27	10.87	18	16	18	16	15	13	17	14
9.4	4.5	#6@4	72.7	61.9	83.87	32.61	181.51	-14.72	-9.20	-18.19	10.52	18	16	18	16	15	13	15	12
9.4	4.5	#5@4	71.7	60.8	83.44	26.46	178.51	-14.76	-6.77	-11.91	9.91	17	15	16	13	10	9	10	9
9.4	4.5	#5@8	70.6	59.6	83.08	18.34	175.69	-14.81	-4.07	-6.51	8.84	8	8	8	8	6	6	6	5
8.4	3.5	#6@3	61.6	53.4	66.43	37.60	165.31	-12.83	-11.82	-26.27	10.87	16	14	16	14	16	13	16	14
8.4	3.5	#6@4	60.6	52.3	65.56	32.61	159.87	-12.83	-9.20	-18.19	10.52	16	14	16	14	16	13	15	12
8.4	3.5	#5@4	59.6	51.2	64.54	26.46	154.04	-12.81	-6.77	-11.91	9.91	16	14	16	13	10	9	10	9
8.4	3.5	#5@8	58.5	50.0	63.54	18.34	148.24	-12.80	-4.07	-6.51	8.84	8	8	8	8	6	6	6	5
Grid: WT6x7 @ 10" C-C (weight of grid w/ pans = 13.2 lbs/sf)																			
9.4	4.5	#6@5	70.0	59.1	71.64	26.09	166.10	-12.06	-7.36	-14.55	8.42	17	15	17	14	13	10	12	10
9.4	4.5	#5@5	69.2	58.3	71.44	21.17	164.20	-12.09	-5.41	-9.53	7.93	13	12	13	10	8	8	8	7
9.4	4.5	#5@10	68.3	57.3	71.29	14.67	162.53	-12.12	-3.26	-5.21	7.07	6	6	6	6	4	4	4	4
8.4	3.5	#6@5	57.9	49.6	55.65	26.09	144.91	-10.46	-7.36	-14.55	8.42	14	13	14	13	13	10	12	10
8.4	3.5	#5@5	57.1	48.7	55.03	21.17	140.69	-10.45	-5.41	-9.53	7.93	13	12	13	11	8	8	8	7
8.4	3.5	#5@10	56.2	47.8	54.44	14.67	136.60	-10.46	-3.26	-5.21	7.07	6	6	6	6	4	4	4	4
Grid: WT6x7 @ 12" C-C (weight of grid w/ pans = 11.8 lbs/sf)																			
9.4	4.5	#6@6	68.2	57.3	62.83	21.74	154.56	-10.23	-6.14	-12.12	7.01	14	13	15	12	11	9	10	8
9.4	4.5	#5@4	68.3	57.4	62.79	21.79	154.24	-10.24	-6.31	-12.34	6.97	14	13	15	12	11	9	10	8
9.4	4.5	#5@6	67.6	56.6	62.74	17.64	153.32	-10.25	-4.51	-7.94	6.61	11	9	11	9	7	6	7	6
8.4	3.5	#6@6	56.1	47.7	48.59	21.74	133.92	-8.85	-6.14	-12.12	7.01	13	12	13	12	11	9	10	8
8.4	3.5	#5@4	56.2	47.8	48.52	21.79	133.64	-8.84	-6.31	-12.34	6.97	13	12	13	12	11	9	10	8
8.4	3.5	#5@6	55.5	47.0	48.19	17.64	130.73	-8.85	-4.51	-7.94	6.61	11	9	11	9	7	6	7	6

Notes:

- Spans are centerline support to centerline support, with 7" flange width assumed. 4000 psi concrete, n=8 (n=24 for sustained deadload).
- Weights shown are exclusive of "haunch" concrete (between top of beams and top of distribution bars), additional full depth concrete at connections between panels, and any additional deck overlay. Negative section modulus indicates tension.
- For other deck configurations, or for other information, please contact EBDI.

Table 3.2.1.3

3.2.2 - INVERSET™ BRIDGE SYSTEM

Inverset™ deck systems shall only be used with approval from the **DSD**. Inverset™ is a prefabricated concrete and steel composite bridge superstructure system. The system utilizes a unique upside-down casting method that uses the force of gravity to prestress steel beams. The typical bridge superstructure is created using a series of panels, either longitudinally or transversely.

3.2.2.1 - OVERVIEW OF THE INVERSET™ BRIDGE SYSTEM

A typical unit consists of two beams made composite with a concrete deck. Each Inverset™ module is manufactured with relatively short overhangs (usually 18 inches or less) to promote an efficient slab design and to facilitate load transfer. The units are connected by a series of field-installed steel diaphragms that distribute load to adjacent units. Joints between units are filled with non-shrink grout and/or elastomeric concrete to prevent leakage.

3.2.2.2 - CHARACTERISTICS OF THE INVERSET™ BRIDGE SYSTEM

The primary advantages to using the Inverset™ Bridge System are:

A. Each unit is inherently stable and is essentially ready for use upon erection. If required, a traffic stoppage to set an Inverset™ unit takes approx. 15 minutes.

B. Due to the modular nature of the prefabricated units, an entire bridge superstructure can be manufactured "off-site" and be ready for installation prior to closing a bridge for rehabilitation.

C. Installation of Inverset™ superstructure modules is not temperature sensitive. Units have been installed in sub-freezing weather

D. Inverset™ bridge modules are manufactured under plant controlled conditions with a minimum design concrete strength of 5,000 psi. Casting the deck upside-down provides a deck with its best quality concrete at the wearing surface. Additionally, due to precompression in the concrete deck, deck cracking is minimized.

The Inverset™ bridge system can be used either longitudinally or transversely. See Detail 3.2.2. Used longitudinally, Inverset™ units are designed and erected as the main superstructure elements. Typical longitudinal Inverset™ uses are:

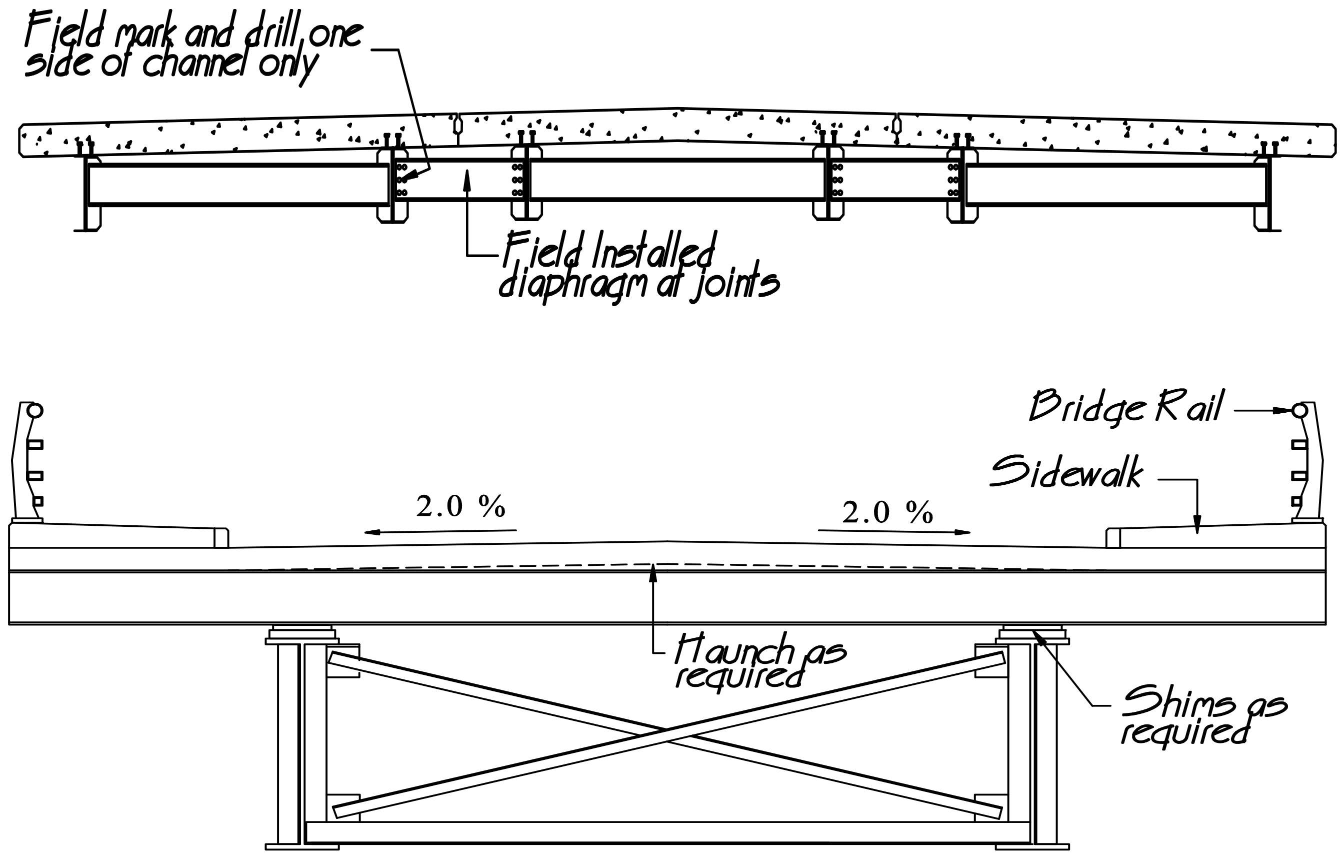
A. Simple span elements up to 100 feet on single span bridges;

B. Erected as simple span elements up to 100 feet on multiple span bridges and subsequently made continuous over one or more supports;

C. Erected as one unit that is continuous over one or more supports (up to 100 feet overall span);

D. Simple span elements spanning between transverse floor beams on long-span trusses or girders.

INVERSET™ BRIDGE SYSTEM DETAILS



DETAIL 3.2.2

Transverse Inverset™ units are supported by other main structural members, typically longitudinal plate girders or trusses. The units can be made composite (or non-composite) with the main structural members. Typical uses for transverse Inverset™ units are: long span deck trusses; long span through trusses; long girder spans; and curved decks supported by straight girders or trusses.

3.2.2.3 - DESIGN OF THE INVERSET™ BRIDGE SYSTEM

Inverset™ bridges are designed using standard composite construction design methodology using either **AASHTO** specification, supplemented by the NYSDOT Blue Pages and this manual. Applicable sections of these references are used to determine live load distribution, allowable stresses, shear stud requirements, etc.

A. Design Considerations:

1. Width of Units: 8 feet to 12 feet (Due to shipping constraints)
2. Deflection: Highway Only L/1000

   Pedestrian Traffic L/1000
3. Live Load: Highway: HS-20, HS-25, or 1.25x(HL-93)

   Railroad: Cooper E-80
4. Impact: As per AASHTO specifications

B. Design Methodology:

1. Allowable Stress Design
2. Load Factor Design
3. Load and Resistance Factor Design (LRFD)

Structure dead load is carried by the composite superstructure, unlike conventional cast-in-place design. Superimposed dead loads are distributed to the composite superstructure in the same manner as conventional composite construction. Highway live loads are distributed across the bridge using the guidelines set forth in **AASHTO 17th Edition** Table 3.23.1, "Concrete on Steel I-Beam Stringers". The wheel load distribution is S/1.676 where (S) is taken as the average stringer spacing in meters. Grid analysis and product testing have proven that the S/1.676 distribution with the average stringer spacing is conservative.

The standard deck thickness including an integral wearing surface for an Inverset™ deck is 7 ½”. Reinforcement cover is 2 ½” for the top mat and 1 inch for the bottom mat. Reinforcement is designed in accordance with the **AASHTO 17th Edition** requirements for concrete bridge decks.

Virtually any bridge that can be built by conventional composite construction can be built with Inverset™ superstructure modules. Practical limitations on shipping restrict piece sizes to approximately 100 feet long and 75 tons. Shipping width should also be considered. The following features can be built into Inverset™ units: skews; horizontal curves; width transitions; vertical curves; superelevated decks; superelevation transitions; crowns; staged construction; rail systems; and utilities.

By using a family of geometric shapes, the horizontal geometry of most bridges can be accommodated. Because the form is "hung" from the beams and the beams are set at their bearing elevations, most any superelevation or superelevation transition can be manufactured. A crown is easily achieved by placing the crown line along a joint. If this is not possible, a crown can be built into an individual unit. Cambering the beams the appropriate amount so that the beam is parallel to the grade accommodates crest vertical curves. Sag vertical curves are achieved using variable depth haunches.

When designing an Inverset™ bridge carrying utilities, it is important to determine the section widths so that utilities fall between the beams of a unit and the respective diaphragms and not in the area of the field-installed diaphragms. The beams should also be deeper than the utility conduit.

Inverset™ can be manufactured with an integral wearing surface or smooth to accept a waterproofing membrane and asphalt overlay. Integral wearing surfaces are made by casting the deck against a form liner to produce a roughened surface. If longitudinal saw grooves are required, it is recommended that they be cut in the field once all the units are in place and grouted. If an overlay is used, a waterproofing membrane is applied to the deck once all the units are erected and the joints are grouted. After that, an asphalt wearing course is applied. Because the deck can be manufactured to meet the exact design deck, no truing and leveling course is required. While there is almost no vertical movement at the joint, small rotations and shrinkage can cause cracking in rigid overlays. For this reason, rigid overlays are not recommended. Joints are filled with grout for sealing purposes only and are not intended for load transfer to adjacent units. When constructing a bridge without an overlay, the joints are filled with non-shrink grout to within 1 inch of the top of the joint. Once this grout sets, the remaining 1 inch is filled with elastomeric concrete to seal the joint. If an overlay is used, the entire joint is filled with non-shrink grout.

3.3 - CONCRETE SEALANTS APPLIED TO STRUCTURAL DECKS

Concrete sealant shall be applied to all exposed cement concrete surfaces of structural decks except the underside between fascia drip edges. Thruway approved concrete sealants come in two types; clear penetrating sealer, and solid color protective sealer. Approved item numbers for sealants can be found on the Structures Estimate Template found in ProjectWise.

3.3.1 – DRIVING AND SIDEWALK SURFACES

Clear penetrating sealer shall be used on the surface of all cement concrete driving and sidewalk surfaces. No sealer shall be applied to cement concrete surfaces that are covered with an asphalt concrete overlay.

3.3.2 – FASCIA SURFACES

Fascia surfaces, which extend from the face-of-rail on the top of the deck/sidewalk, over the side to the drip edge on the underside of the deck, shall be protected with a concrete sealant. On existing structures, the proposed sealant type used shall match the existing on the structure (solid or clear). Where no previous sealer has been used, clear penetrating sealer shall be applied. On new structures, clear penetrating sealer shall be used unless solid protective sealer is requested by the **DBE**.

3.4 - STAGE CONSTRUCTION

Stage Construction is a method used to replace bridge decks, superstructures, or entire bridges when one or more travel lanes must remain in service throughout construction. The use of stage construction will result in one or more longitudinal joints in the deck and therefore is not the preferred method of construction. The designer should make every effort to close the structure during construction and employ the use of offsite detours or crossovers wherever possible. See Details 3.4.a and 3.4.b.

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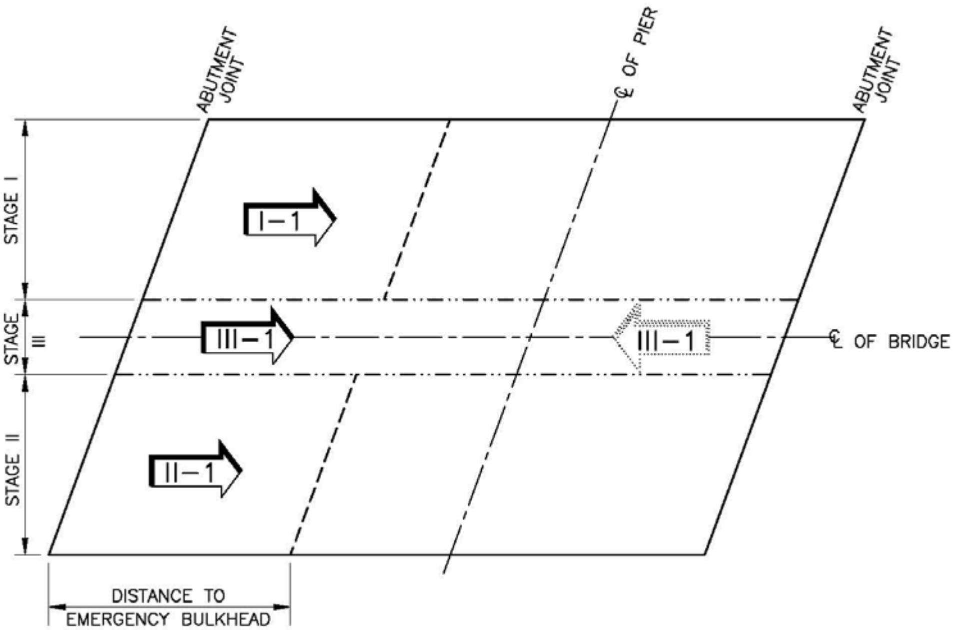

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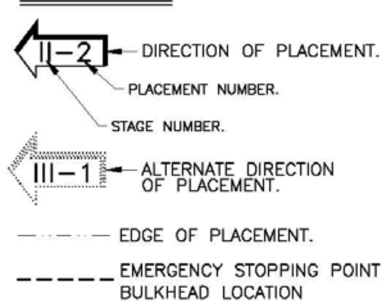


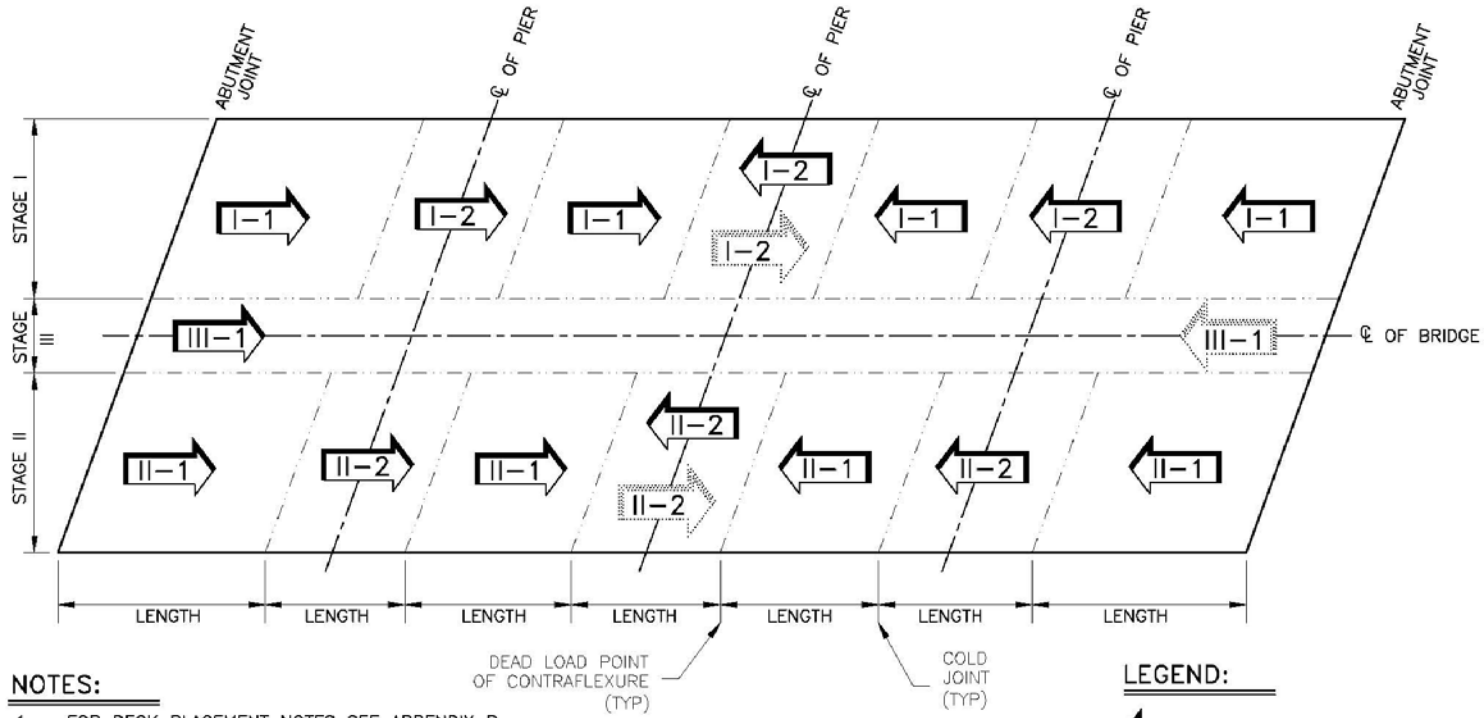
NOTES:

1. FOR DECK PLACEMENT NOTES SEE APPENDIX B.
2. APPROACH SLAB PLACEMENTS SHOULD BE SHOWN AS REQUIRED.
3. EMERGENCY BULKHEADS SHOULD BE LOCATED AS CLOSE AS POSSIBLE TO THE DEAD LOAD POINT OF CONTRAFLEXURE.

CONTINUOUS DECK CONCRETE PLACEMENT PLAN
(TYPICAL TWO SPAN CONTINUOUS AT CREST VERTICAL CURVE)
(STAGED CONSTRUCTION)

NOT TO SCALE

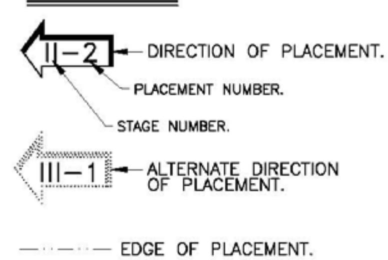
DETAIL 3.4.a



NOTES:

1. FOR DECK PLACEMENT NOTES SEE APPENDIX B.
2. APPROACH SLAB PLACEMENTS SHOULD BE SHOWN AS REQUIRED.

LEGEND:



SEQUENTIAL DECK CONCRETE PLACEMENT PLAN
(TYPICAL FOUR SPAN CONTINUOUS AT CREST VERTICAL CURVE)
(STAGED CONSTRUCTION)

NOT TO SCALE

DETAIL 3.4.b

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3.4.1 - GUIDELINES FOR STAGE CONSTRUCTION OF DECK SLABS ON STEEL STRINGERS

The following guidelines will help to ensure that steel stringers placed under stage construction will deflect properly under dead load and that the desired bridge deck cross slope will result.

A. The minimum number of girders within a construction phase that will support live loading is 3. This requirement provides structural redundancy under live load as well as provides a more rigid structure that is less apt to twist under eccentric loading. This requirement may be waived (reduced to 2 girders) by the **DSD** for the replacement of an existing structure if traffic requirements preclude the use of 3 girders.

   Separate computations for deflections due to dead load and superimposed dead load should be made for each stage of construction. In addition, the slab and temporary overhangs should be analyzed for the barrier and live load condition that will occur during each stage. Details should be added to the plans with a note stating that the slab and slab overhang for each stage has been designed for the loading conditions shown in the details.

B. If at all possible, use a third (closure) pour approximately 2.5 feet wide within the middle portion of a bay between stages. Placing the closure pour in this positive moment area of the deck between girders will assist in keeping the longitudinal joints tight throughout the life of the structure. The closure pour will help to isolate the main second stage deck slab during the curing process from undesirable vibrations caused by traffic on the first stage deck. In addition, the closure pour permits a smooth transition between the top surfaces of the main deck pours should there be any vertical misalignment between stages due to differential deflection between groups of stringers. If the closure pour cannot be made wide enough to accommodate the transverse bar splice, and if deflections are expected to be small, consideration should be given to the use of mechanical couplers on the transverse reinforcement. If specified, the cost of furnishing and placing the mechanical couplers should be included in the engineer's estimate for the reinforcing steel item. The practice of bending up transverse reinforcement in restricted stage construction situations, then rebending them down shall not be allowed. It is difficult to realign the bars properly, and the coating is damaged. Similarly, the practice of welding transverse reinforcement should be avoided, due to the cost of welding and repairing the resulting damage to bar coatings.

C. Transverse intermediate diaphragms and cross frames in the bay between stages shall not be installed until the second stage deck slab has been in place for at least 72 hours, or they may be installed by connecting at one end only. If a closure pour is used, those diaphragms in the bay below the closure pour shall be installed (or connected at both ends) before the closure pour is placed. Diaphragm fit-up misalignments due to differential girder deflection between stages have been a typical problem of stage construction. For this reason, the details shall require field drilling of the connection holes in either the diaphragm or connection plate, or both, at one end of the diaphragm to avoid this problem.

D. Finally, top struts shall be included in the configuration of diaphragms in both bays adjacent to the closure pour if cross frame type diaphragms are used. These top struts assist the diaphragm in resisting rotation of the interim fascia girders.

3.4.2 - GUIDELINES FOR STAGE CONSTRUCTION OF DECK SLABS ON PRESTRESSED CONCRETE BEAMS

The following guidelines will help to ensure that prestressed beams placed under stage construction will result in the desired bridge deck thickness, cross slope and vertical alignment of transverse tendon holes due to proper beam deflection and long term camber growth of Stage II beams.

A. Separate computations for deflections and stresses due to dead load and superimposed dead load should be made for each stage of construction.

B. Typically all prestressed beams for a structure are cast within a few days of each other. For stage construction, the Stage II beams are left in storage while the Stage I beams are installed and the remaining Stage I construction is completed. Due to creep and the differential loading history between the Stage I and Stage II beams, the Stage II beams will have more upward camber than the Stage I beams, at the time of Stage II beam installation. This results in a thinner Stage II deck and possible misalignment of transverse tendon holes. If the anticipated differential camber will exceed ½”:

   a. Maintain a minimum 6 inches thick Stage II deck by either; designing and detailing a thicker Stage I deck; or installing the Stage II beams at a lower elevation.

   b. Alter the vertical placement of the transverse tendon holes for either Stage I or Stage II beams to maintain their differential alignment to within ½”.

For estimating the projected camber growth (Time Dependent), use 50% of the transfer camber (without creep correction) for this value.

Example: Camber at transfer (w/o creep) = 12 inches.

Anticipated camber growth = .5 x 12 inches = <u>6 inches.</u>

C. The same number of transverse tendons shall be used for the construction of each stage as required for the final condition.

D. The transverse tendons shall not be spliced, but shall be continuous across the entire width of adjacent beams for each stage. This may result in larger diaphragms to accommodate multiple transverse tendons at each diaphragm for Stage I beams. The beams shall be designed for this additional load.

E. All shear keys between Stage II beams as well as the shear key between Stage I and Stage II beams should be filled prior to Stage II transverse tendon installation.

F. If at all possible, use a third (closure) pour between the main pours. The closure pour should be approximately 2.5 feet wide and centered over a beam's edge. This will help to isolate the main second stage deck slab during the curing process from undesirable vibrations caused by traffic on the first stage deck. In addition, the closure pour permits a smooth transition between the top surfaces of the main deck pours should they be misaligned due to improper deflection or camber of one or both groups of beams.

G. Wait a minimum of 72 hours following completion of the first stage deck pour before beginning the second stage pour. Wait a minimum of 72 hours following completion of the second stage deck pour before beginning the closure pours.

3.5 - SHOULDER TREATMENT

Thruway Mainline, ramp, and overhead bridges shall incorporate either a straight run-off with four rail bridge rail; or two rail bridge rail with curbing, four rail bridge rail with sidewalk, concrete parapet with sidewalk, or concrete barrier to contain and direct drainage off the structure (at the ends of the bridge or at scuppers). Curbs shall only be used for the two rail bridge rail application or when sidewalks are required. Refer to Subsection 3.1.4.1 – Thruway Rail/Barrier and Overhang Design Policy for guidance on the appropriate rail/barrier system to use.

3.6 - BRIDGE DECK DRAINAGE

Structures that have curbs, sidewalks, or barrier preventing drainage off the side of the deck shall be analyzed to ensure that ponding of water, which could create traffic safety problems (such as hydroplaning), does not occur. The following design criteria shall be used on all structures (overheads and mainlines) which do not use curbless details.

A. The puddle width shall be restricted to the shoulder.

B. Maximum puddle depth shall not exceed 2 inches.

C. The design is to be based on the rainfall intensity of the most severe storm. See Table 3.6 on next page for rainfall intensity data.

See Appendix C for typical drainage and scupper details. The designer is encouraged to review the **FHWA HEC** 21 - Design of Bridge Deck Drainage, dated May 1993 @: http://www.fhwa.dot.gov/bridge/hec21.pdf

Rainfall Intensity Data for Bridges within the Thruway Corridor

	Intensity (in/hr)	Intensity (in/hr)	
Location	**5min storm/ 2 year event**	**5min storm/ 10 year event**	**Thruway Limits for Location Use**
NYC (Manhattan)	4.998	6.418	0.00 to MP 16, including I-95
Peekskill	4.786	6.224	MP 16 to MP 60, including I-84
Poughkeepsie	4.66	6.097	MP 60 to 100
Catskill	4.577	5.992	MP 100 to MP 140, including Berkshire Spur
Albany	4.393	5.724	MP 140 to MP 170
Canajoharie	4.16	5.402	MP 170 to MP 210
Utica	4.091	5.303	MP 210 to MP 250
Syracuse	4.162	5.386	MP 250 to MP 330
Rochester	4.145	5.376	MP 330 to MP 410
Buffalo	4.219	5.469	MP 410 to MP 440, including Niagara Section
Silver Creek	4.275	5.562	MP 440 to MP 470
Jamestown	4.39	5.724	MP 470 to MP 496 (Pennsylvania Line)

Rainfall Intensity values taken from NYSDOT Scupper Program User Manual dated June 1999.

TABLE 3.6

Notes:
1) Due to Thruway policy of placing barrier on all mainline structures, the 5 min/10 year event shall be used on all mainline bridges.
2) For all overheads that use curbless details, the 5min/2 year rainfall intensity shall be used.
3) For all overheads that use barrier or curb, are less than 330 feet in length and have a vertical curve located in the general vicinity of middle of the bridge, the 5min/2yr rainfall intensity shall be used.
4) All other overheads that use barrier or curb which do not meet the criteria of note 3, shall use the 5min/10 year rainfall intensity event.

3.7 - BRIDGE DECK ACCESS HOLES

Deck access holes are 1 foot diameter holes through the deck in the vicinity of the fascia. On mainline twin structures, where the distance between interior fascias is small (1 to 3 inches), these holes provide access for welding leads, air hoses, electrical lines and paint hoses for future maintenance. Mainline structures are typically very wide and so access from the outside fascias to the interior can be very difficult if possible at all. On rehabilitation and replacement projects the designer should consult with the Division Bridge Engineer to determine if and where deck access holes should be located. Refer to Appendix C for details of deck access holes on page C6-7.