New York State

DEPARTMENT OF TRANSPORTATION

BRIDGE MANUAL

(US CUSTOMARY EDITION)

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Bridge Manual

New York State Department of Transportation

Office of Structures

4th Edition
(1st US Customary Edition)

April 2006

Key for Revisions:

January 2008; same revisions as Addendum #1 to the metric edition and conversion to US Customary units

April 2010; Addendum #1 (USC)

May 2011±; Addendum #2 (USC)
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# Aesthetics

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## Appendix 23A

Glossary
Section 1
Introduction

1.1 Purpose

This Bridge Manual has been prepared to provide policies, guidance and procedures for bridge project development and design for the New York State Department of Transportation. This manual provides guidance for decisions in the bridge project process, documents or references policies and standards that need to be considered, and provides a commentary discussing good bridge engineering practice.

One of the primary goals of this manual is to provide assistance to designers to ensure that “quality” bridges are constructed. “Quality” bridges are durable, economical, aesthetically pleasing, and environmentally sound.

Although this manual provides guidance on design procedure, many subjects presented only highlight criteria and practice. A complete analysis and design to produce a safe, economical and maintainable structure is the responsibility of the designer.

1.2 Applicability

This manual applies to all bridges constructed under contracts with the New York State Department of Transportation. Designers are required to consult the manual for policies, guidance, details and interpretation of the design specifications. In addition, its use is encouraged for all bridges in New York State.

Highway and pedestrian bridge design are governed by the design specifications contained in the most recent issuance of the **NYSDOT LRFD Bridge Design Specifications** or the **New York State Department of Transportation Standard Specifications for Highway Bridges–2002**. This manual does not replace the provisions of these specifications. It is intended to supplement the design specifications in areas that are not addressed or fully covered. Additional information on the design of facilities for pedestrians, bicycles, and persons with disabilities may be found in Chapters 17 and 18 of the **Highway Design Manual**.

Major long span bridges are special cases for bridge design. They typically need special design criteria which go beyond the provisions of the NYSDOT LRFD Bridge Design Specifications. The NYSDOT LRFD Bridge Design Specifications do not have an explicit span limitation, however, the commentary states that spans in excess of 600 feet were not considered in its development.
Major long span bridges should have specific bridge design criteria developed once the bridge type has been selected and before final design begins. If during preliminary development it is determined that the NYSDOT LRFD Bridge Design Specifications do not cover all aspects of the structure design, appropriate supplemental design criteria should be developed by researching design criteria for similar structures in the US and Canada.

1.3 Policy

NYSDOT has officially adopted the AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications for use in New York State. The AASHTO LRFD Bridge Design Specifications and the “LRFD Blue Pages” constitute the NYSDOT LRFD Bridge Design Specifications. The adoption of these specifications continues a process in which NYSDOT has been transitioning from the NYSDOT Standard Specifications for Highway Bridges–2002 to full adoption of the LRFD specifications. The NYSDOT Standard Specifications for Highway Bridges–2002 consists of the 17th edition of the AASHTO Standard Specifications for Highway Bridges together with the New York State “Blue Pages.” The NYSDOT LRFD Bridge Design Specification is mandatory for the design of all new and replacement bridges by NYSDOT and Consultant designers. The FHWA mandated a full implementation date on October 1, 2007 for all State-initiated Federal-aid funded projects. For locally administered Federal-Aid projects see Chapter 9 of the NYSDOT Procedures for Locally Administered Federal-Aid Projects Manual. The existing NYSDOT Standard Specifications for Highway Bridges–2002 are now archived and used when necessary for the repair and rehabilitation of structures. The design specifications that may be used for rehabilitation and repair projects include the LRFD Specifications, the Standard Specifications or the specifications used in the original design.

Load Ratings – Currently, NYSDOT overload permitting and bridge posting policies require that new and replacement bridges be load rated using the Load Factor Design (LFD) or Allowable Stress Design (ASD) methods. For this reason, load ratings will continue to be computed by the LFD or ASD method. The load ratings for all new or replacement bridges will also be computed by the Load and Resistance Factor Rating (LRFR) method. Load rating for both methods shall be shown on the Contract Plans. LRFR ratings shall be shown at the inventory and operating levels as rating factors of the AASHTO HL-93 load. Once overload permitting and bridge posting policies are revised to accommodate LRFR, load ratings using LFD and ASD methods will be discontinued.

Buried Structures – Buried structures include box culverts, three-sided frames, and pipes. Any buried structure designs begun in October 2010 or later shall be designed by LRFD. For designs begun before October 2010 designers may continue to use either the NYSDOT Standard Specifications for Highway Bridges–2002 or the LRFD specifications for the design of buried structures.
1.4 Referenced Standards, Manuals and Documents

The following references contain material that is relevant to bridge project development and design. They contain provisions that pertain to a particular type of bridge or part of the bridge project process. Instead of reproducing them in full in this manual, they are incorporated by reference. Bridge designers need to consider their provisions where applicable.

The NYSDOT references can be found at https://www.nysdot.gov/publications.

The Bridge Detail (BD) Sheets referenced below contain standard details and, occasionally, instructions to designers on material that is to be incorporated into the Contract Plans.

- American Railway Engineering & Maintenance of Way Association Manual for Railway Engineering (AREMA)
- NYSDOT Bridge Deck Evaluation Manual
- NYSDOT Bridge Detail (BD) Sheets
- NYSDOT Bridge Inspection Manual
- NYSDOT Bridge Inventory Manual
- NYSDOT Bridge Safety Assurance Vulnerability Manuals
- NYSDOT CADD Standards and Procedure Manual
- NYSDOT Structures Division Cell Library
- NYSDOT Project Development Manual
- NYSDOT Environmental Procedures Manual/The Environmental Manual
- NYSDOT Highway Design Manual
- NYSDOT Manual of Uniform Traffic Control Devices
- NYSDOT Prestressed Concrete Construction Manual (PCCM)
- NYSDOT Standard Specifications for Construction and Materials
- NYSDOT LRFD Bridge Design Specifications
- NYSDOT Standard Specifications for Highway Bridges (Blue Book)
- NYSDOT Steel Construction Manual (SCM)
- NYSDOT Procedures for Locally Administered Federal Aid Projects
- NYSDOT Survey Manual
- FHWA Seismic Retrofitting Manual for Highway Bridges
- AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities
- AASHTO LRFD Movable Highway Bridge Design Specifications
- AASHTO Maintenance and Management of Roadways and Bridges Manual
- AASHTO Guide Specification for Fatigue Evaluation of Existing Steel Bridges
- AASHTO Roadside Design Guide
- AASHTO Guide for the Development of Bicycle Facilities
- AASHTO Guide Specification and Commentary for Vessel Collision of Highway Bridges
- AASHTO Manual for Assessing Safety Hardware
**Bridge Deck Repair**

That type of work that is intended to return the structural deck of an existing bridge to a condition of suitable ride quality and/or safe wheel load capacity. The deck may be composed of concrete, steel or other material, and the type of construction may include monolithic decks as well as separate wearing surfaces over a slab. The restorative work may include overlay or separate wearing surfaces (with or without a waterproof membrane) over the whole deck area of the bridge or over substantial areas. For purposes of this policy, a complete bridge deck replacement should be classified as a bridge rehabilitation. Under this policy, bridge deck repair done in conjunction with other superstructure or substructure restoration work also should be classified as a bridge rehabilitation. A bridge deck repair project may include some incidental structure repair work that is related to the deck repair work (e.g., header or backwall repair).

**Clear Roadway Width of Bridge**

The clear distance between inside faces of bridge railing, or the clear distance between faces of curbs, whichever is less. The typical Department 5-inch wide brush curb (introduced at the bridge only) shall not be considered to reduce the rail-to-rail dimension.

**Design Speed**

A speed used to determine the physical features of a highway. It may or may not be equal to the statewide limit or to the posted speed limit at the bridge site. The design speed is determined according to Chapter 2 of the *Highway Design Manual*.

**Federal-Aid Project**

A bridge or highway project that is to be funded, either entirely or partially, with Federal-aid funds.

**Highway Project**

A construction project whose primary objective is to construct a new highway, or to reconstruct, or to restore and preserve, an existing highway. The project may include bridge work of any type that is incidental to the primary objective.

**Narrow Bridge**

A bridge carrying two-way traffic, but less than 18 ft in clear width between railing or curbs, or a one-way ramp less than 12 ft. wide.

**National Highway System (NHS)**

A network of major roads that were designated by the Federal Highway Administration in consultation with the individual states and signed into law in November 1995.²

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² A list of designated NHS Highways is contained in the “National Highway System Route Listing” and is maintained by the Highway Data Services Bureau of the Office of Technical Services.
### New Bridge
A bridge constructed to serve a new or relocated highway that is not intended to serve as a substitute for an existing bridge being removed as part of the same project. It shall be considered a new bridge when a bridge is constructed to ultimately become a substitute for an existing bridge which will be removed in a subsequent project.

### One Lane Bridge
A particular type of narrow bridge, carrying two-way traffic but less than 16 ft. in clear width between railing or curbs.

### Pedestrian/Bicycle Bridge
A structure provided specifically for the travel of bicyclists and pedestrians, frequently as part of a shared use path facility.

### Planned Improvements
Improvements to the roadway width projected within a 20-year planning horizon. They do not necessarily need to be programmed. These are, however, documented plans the Department or local municipality hopes to accomplish when funding becomes available and when it fits into the Region's or local agency's capital program. Whether or not there are planned improvements shall be addressed in the scoping documentation used to establish the project design criteria. Refer to the *Project Development Manual* for requirements on addressing planned improvements in project scoping and development.

### Roadway
That portion of a highway, including all through traffic lanes, auxiliary lanes, and shoulders, suitable for vehicular use. Also referred to as "surfacing" or "pavement."

### Shoulder
That portion of the roadway, graded but not necessarily paved or surfaced, for accommodation of stopped vehicles, for emergency use and for lateral support of subcourses and surface courses. For purposes of this policy, the shoulder shall refer to the usable shoulder (see Appendix 2A for illustrations of shoulders). For applying this policy, the existing approach shoulders should be measured no closer than 100 ft. from the ends of existing bridges. If the approach shoulder width varies, a determination must be made of what the most typical shoulder width is for that section of highway. Be aware that providing the typical width may cause the project limits to be extended slightly to widen the varying shoulder.

### Sidewalks
Space provided on a structure exclusively for the use of pedestrian travel, generally separated from the roadway by a raised curb. See Chapter 18 of the *Highway Design Manual*.

### Surfaced Shoulder
A roadway shoulder that is paved, or stabilized and maintained with a bituminous or other similar surface treatment.

### Traveled Way
That portion of the roadway exclusive of shoulders, designed for the movement of vehicles.
2.3.3 Miscellaneous Bridge Width Considerations

**Curbs:** For curbed highways and streets, the full curb-to-curb width and the curbing should generally be carried across the bridge. The full shoulder dimension or curb offset dimension will be measured to the face of curb. If a concrete barrier is used, a separate stone curb is not used on the bridge and the offset dimension is taken to the inside edge of the barrier.

On structures that introduce a curb where one is not present on the highway approach, a minor curb encroachment is allowed into the shoulder for structures with steel railing systems. Railing systems will be allowed a 5 inch encroachment, with the full shoulder dimension being measured to the face of railing.

On structures with sidewalks, the minimum sidewalk width does not include the width of the curb. The standard dimension from face of rail or barrier to face of curb is 5'-7". This dimension assumes the minimum 5 ft. sidewalk width and includes all curbs up to 7 inches in width on the highway approach. The dimension from face of rail or barrier to face of curb may be reduced or increased to match a curb width varying from the assumed 7 inch curb. For example if there is a 5 inch stone curb on the approach the dimension from face of rail or barrier to face of curb may be reduced to 5'-5". The face of curb on the bridge and the highway approach should line up.

It is no longer recommended that encroachments be allowed on concrete barriers in determining the curb to curb width of the bridge.

**Stage Construction:** In order to maintain minimum traffic lane widths during construction, it is sometimes necessary to build a wider structure than required for the permanent condition. Depending upon the magnitude of the widening, wider permanent shoulder or sidewalk widths may result. The railing/barrier line should normally be placed at the fascia with a transition to the highway section taking place on the approach.

For projects that must accommodate truck traffic during staging, the minimum recommended temporary travel lane width is 11 ft. Where low volumes of passenger vehicles traveling at low speeds are anticipated, temporary travel lanes as narrow as 9 ft. may be considered although a 10 foot travel lane would be recommended. The use of temporary structures for the maintenance of pedestrian traffic should be considered prior to making a new structure much wider than necessary.

**Twin Structures:** Many major highways have medians that vary in width from some minimal dimension to distances in excess of 100 ft. When building new, widening existing, or rehabilitating existing structures, the joining of the structures between these opposing alignments should be considered. Two factors are used as evaluation criteria:

1. If the distance between the median edges of the two opposing travel lanes is less than 24 ft., the median should be closed. However, once the total bridge width exceeds 100 ft., the use of a longitudinal open joint at the center line of the median is recommended.

2. If the work zone traffic control scheme is best addressed by the closure of a median larger than the previous identified 24 ft. dimension, then the median should be closed and the use of a longitudinal joint considered.
Curved Alignments: There are four possible configurations to consider when a curved highway alignment is to be carried on a bridge (See Figure 2.1). The relationship of the beam, fascia line and railing or parapet would fall into one of the following cases:

Case I
- Straight beams
- Straight fascia line
- Straight railing/fascia line

Case II
- Straight beams
- Straight fascia line
- Curved railing/parapet line

Case III
- Straight beams - variable overhang
- Curved fascia line
- Curved railing/parapet line

Case IV
- Curved beams
- Curved concentric fascia line
- Curved concentric railing/parapet line

Steel girders will usually follow Case III or Case IV depending on the radius of curvature.

Prestressed concrete slab and box unit structures will normally be built in accordance with Case I or II. Case I will allow the anchorage for the railing/barrier to be located at a fixed location. Case II will require varying the anchorage location.

Prestressed concrete I-beams or Bulb-tee units would be fabricated straight and could follow Case I, II, or III, with Case III the preferred option. When Case III is selected, consideration must be given to the width of the top flange and the width of the concrete deck slab overhang.

For bridges with sidewalks, the curb should follow the curved alignment and the railing/barrier should follow the fascia line. Provisions must be made on the approach to properly transition the railing/barrier line on the structure to the typical highway railing system.

In circumstances where a sharply curved roadway is carried by a straight bridge the railing/barrier should follow the curve of the roadway to avoid confusion to the motorist.

When using a straight fascia and a curved railing/barrier, consideration should be given to the deck area that would be exposed behind the back of the railing/barrier. If this area gets too large it can become a safety concern.
### Lateral Distance from Centerline of Outside Track to 1 on 2 Embankment*

<table>
<thead>
<tr>
<th>Railroad Section</th>
<th>With Off-Track Maintenance Roadway</th>
<th>Without Off-Track Maintenance Roadway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill</td>
<td>28 ft.</td>
<td>20 ft.</td>
</tr>
<tr>
<td>Cut</td>
<td>30 ft.</td>
<td>22 ft.</td>
</tr>
<tr>
<td>Cut–Heavy Snow Area**</td>
<td>33 ft.</td>
<td>25 ft.</td>
</tr>
</tbody>
</table>

* When the outer track is on a horizontal curve, increase these dimensions one inch for every degree of curvature to a maximum of 1'-6".

** Heavy Snow Area - All portions of state except NYC area and Long Island.

#### Table 2-3
**Lateral Offset from Centerline of Tracks**

Piers located within 25 ft. of the centerline of a track shall be of heavy construction or be protected by a concrete crash wall in accordance with current American Railway Engineering and Maintenance of Way Association (AREMA) specifications.

**Railroad Bridges**–A typical single track, thru-girder bridge is shown in Figure 2.9. The dimensions shown in Figure 2.9 are only for reference. Prior to final design, the railroad involved must provide an approved section. A general clearance diagram for railroad bridges is shown in Figure 2.5.

### 2.5.4 Miscellaneous Corridors

At times, besides being required to cross a major feature such as a roadway or river, the new bridge must accommodate secondary corridors. These corridors can range from a defined paved bikeway/walkway to a level area of natural ground which would allow passage under the bridge of such things as cattle and wildlife. This requirement should be identified in the design report as well as on the Bridge Data Sheet - Part 1.

A minimum corridor width and a desired headroom should be indicated if it becomes a control feature. Unpaved access roadways for fire, emergency or maintenance equipment also fall into this category.
2.6 Live Loading Requirements

2.6.1 New and Replacement Bridges

New and replacement bridges shall be designed to carry not less than the AASHTO HL-93 live load and the NYSDOT Design Permit Vehicle.
2.6.2 Bridge Rehabilitation

Existing highway bridges should be rehabilitated to carry the HS 20 live load, unless economically unjustified.

Bridges whose superstructures are completely replaced while retaining all or part of the substructure will be designed in accordance with *NYSDOT LRFD Bridge Design Specifications*. Existing substructures to remain shall not be upgraded solely to accommodate the higher live loads or LRFD Specifications.

Where the HS 20 loading cannot be economically justified, bridges should be rehabilitated to support an H 20 live load. In some cases, locally owned bridges or State-owned bridges carrying local roads may be rehabilitated to a lesser loading provided that heavy loads are anticipated to be rare. The minimum acceptable loading for a rehabilitated structure is H 15. Rehabilitation of any structure to a live loading less than HS 20 must be expressly approved by the Regional Director.

2.6.3 Temporary Bridges

Temporary structures carrying vehicular traffic shall generally be designed for an HS 20 live load. While an HS 20 design live load is sufficient for all current legal loads, it is recognized that in a few situations, the design live load for temporary structures should be increased to an HS 25 design live load. This should be considered for only the following types of projects:

- Interstate or equivalent highways with very high Average Daily Truck Traffic (ADTT). Very high ADTT can generally be taken to be over 10,000.
- Interstate or equivalent highways where it is anticipated that the temporary structures will be in service longer than one year.
- Other locations that may have unique situations in regard to very heavy industrial truck traffic, anticipated very heavy permit vehicles or access to railroad yards and port facilities.

It is also recognized that some locations may not require a HS 20 design live load for temporary structures. This would most often be the case for structures on parkways or in rural areas. However, locations in rural areas should be treated with caution since many low volume roads frequently carry heavy vehicles such as logging trucks, milk tankers and heavy farm machinery. Structures on parkways that will be in use over a winter season should also be treated with caution because snow removal equipment may approximate HS 20 loading.

All uses of temporary structures with design live load less than HS 20 need to receive approval from the Regional Structures Engineer. In certain circumstances, temporary structures designed for a live load less than HS 20 will require posting. In no case will approval be granted for a design live load less than H 15. In no case shall a temporary bridge on an NHS designated route be designed for less than HS 20.

Place Standard Note #7 from Section 17.3 on the plans for all projects containing temporary structures.
2.6.4 Pedestrian Bridges

All pedestrian bridges will be designed in accordance with NYSDOT LRFD Bridge Design Specifications and the AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges, December 2009. The owner may waive the fracture critical member requirements for design of tubular members. See Section 8.18 for additional guidance.

2.6.5 Railroad Bridges

All structures carrying railroads will be designed for Cooper E-80 loading (U.S. Units), unless noted otherwise.

2.7 Alignment, Profile and Superelevation

2.7.1 Horizontal Alignment

The alignment of a bridge can be controlled by a highway realignment project or be set by the standards that are to be used for a bridge only replacement project. Three factors normally dictate the chosen alignment: class of highway, design speed and traffic volume. The requirements of each individual project should be reviewed prior to establishing the necessary horizontal and vertical control standards. If possible, the highway designer should avoid placing spiral alignments and compound curve alignments on structures. Conventional highway treatments such as spiral alignments, reverse curves and superelevation banking transitions, when used on a bridge, can complicate the design, increase cost and make construction difficult.

Severely skewed alignments can cause uplift, seismic design and maintenance problems, and may result in a structure that is considerably longer than the existing structure.

2.7.2 Profile

When selecting project standards, such as maximum grades and stopping sight distances, the highway designer should avoid placing a sag curve at the bridge location. If this is not possible, the bridge designer should avoid placing the beam itself on a sag and fabricating it with negative camber. The placement of a level (0%) grade on the bridge should be avoided. If possible, steel beams shall use haunches for sag correction with the top and bottom flanges remaining parallel on a vertical tangent. (See Section 8.9.1, for further discussion on sag cambers for steel bridges.)

Prestressed units shall not be subjected to negative camber. The only corrective measure which can be used for adjacent units is to vary the thickness of the wearing surface. If this procedure cannot accommodate the geometry of the curve in a reasonable manner, the use of the adjacent slab or box units is not recommended. Prestressed I-beam or spread box/slab units can use varying haunches to accommodate some sag vertical curvature.
Section 3
Planning New and Replacement Bridge Types

3.1 Scoping

There are always certain questions that must be answered when a bridge project is identified. These same basic questions arise regardless of whether the project is being evaluated as part of a highway upgrade program or as a more urgent need such as a structure load posting or closure. The time involved in going through this process may be lengthy or, due to the urgency of the situation, it may be expedited. All projects identified by the New York State Department of Transportation are first addressed through a process known as "Scoping."

Scoping is defined as a process that establishes a genuine consensus about the nature of a proposed project and what is to be accomplished. The products of this process are:

- Project Objectives
- Design Criteria
- Feasible Alternates
- Reasonable Cost Estimate(s)

To develop these products, the designer will ask many questions whose answers will help define the products. Some of these questions include:

- What is necessary to satisfy projected needs?
- Is the roadway alignment a problem? (e.g., accident history, nonstandard features)
- Is an adequate roadway section provided?
- What is the condition of the bridge?
- Could it be a highway improvement project only or should bridge work be included?
- Does the bridge provide an adequate opening for the feature it crosses (i.e., waterway, roadway, or railroad)?
- Can the existing bridge be widened? Should it be widened based on its condition?
- Can part or all of the bridge be retained? If so, for how many years?
- What input is the community providing (e.g., historical, maintenance of traffic, utilities, and aesthetic treatments)?
- What preliminary cost estimates are available?
- When can the work be scheduled?
The answers to these questions will define the appropriate highway and bridge work. This process will also establish the project objectives that will result in one of three decisions:

- Short-Term Repair
- Long-Term Rehabilitation
- Replacement

### 3.2 Preliminary Engineering

During the preliminary engineering process, any structure(s) within the limits of the project must be assessed with regard to:

- The load carrying capacity of the existing structure(s).
- The expected remaining life of the structure(s).
- The geometric features of the existing structure(s) and its approaches as well as structural features such as railing, bearings, fatigue-prone details, etc.

Sometimes it is not clear whether the bridge should be rehabilitated or replaced. Additional input is needed to make this decision. See Section 19 for more information on the rehabilitation versus replacement decision. Cost comparisons of the remaining possible solutions, as well as a constructability evaluation, are needed. This preliminary engineering process becomes more project specific, and more detailed answers to the following questions are now sought:

- What services must be maintained and what services can be interrupted (e.g., utilities, emergency, fire and ambulance, school bus routes, etc.)?
- How can traffic be maintained during construction?
- How will a new bridge differ from the old? Should it be longer or shorter? Should it be wider or narrower?
- What procedures are different between a rehabilitation project and a replacement project?
- Does the site require any special construction considerations?
- How much will it cost and how long will it take to complete each of the various options?
- Should prefabricated bridge elements and systems be used to speed construction, save costs or improve work zone safety?

These refined evaluations will result in more project-specific findings. A final recommendation should then be made. When the recommendation is a bridge replacement, a Final Design Report will present the findings, Design Approval will be sought and a "Site Data Package" will be prepared for the specific bridge site. Bridge rehabilitation projects will follow a similar process. Section 19 of this manual also provides guidance for evaluating a rehabilitation option.
Further information on scoping and preliminary engineering is contained in the *Project Development Manual*.

### 3.3 Site Data

Once the project objectives are established, work begins on the final design and preparation of the *Plans*, *Specifications* and *Estimate* package. The PS&E package consists of two parts, the highway portion and the bridge portion. Information needed to establish parameters for the final design is provided to the bridge designer by the Region. The Region prepares and assembles this "Site Data" package or oversees its preparation by a consultant. The Regional Structures Engineer is responsible for verifying accuracy and completeness of the data.

The site data package consists of two parts:
- Bridge Data Sheet - Part 1 - Must be completed for all structures.
- Bridge Data Sheet - Part 2 - Waterway supplement, which must be completed for most structures over a waterway. (See Section 3.4.1)

These forms also require various supporting documentation (see Appendices 3A and 3B). An electronic version of the appendices is available on the Office of Structures web site.

Electronic files are required. Hard copies of the site data package are optional. For designs to be progressed in the Office of Structures, the package will be reviewed by the Bridge Program and Project Development Group. For structures crossing water, the package will also be reviewed by the Hydraulic Engineering Unit. For consultant and Regional (in-house) bridge design projects, the Office of Structures Design Quality Assurance Bureau will be responsible for the review. For this type of project, see Appendix 3D for the required portion of the site data to be submitted.

With completion of these reviews and resolution of major comments, final design begins.

### 3.4 Hydraulics

#### 3.4.1 Hydraulic Design

Projects involving waterway crossings will generally require a hydraulic analysis unless it is clear that, because of the bridge’s height, length, substructure configuration and construction method, there will be no significant effect on hydraulics. Consult the Office of Structures Hydraulic Engineering Unit for guidance on whether or not a hydraulic analysis is required. If an analysis is required, the necessary supporting documentation is outlined in Appendix 3B, Bridge Data Sheet-Part 2, Waterway Supplement. For definitions of ordinary high water, ordinary water and low water, see Section 17, Note 48.

Any work, permanent or temporary, that involves placement of constrictions or obstacles to flow within a channel or floodway (e.g., cofferdams, water diversion structures, causeways, etc.) will require the concurrence of the Office of Structures Hydraulic Engineering Unit or the Regional...
Hydraulics Engineer. Such obstructions have the potential to increase water surface elevations in violation of Federal flood insurance and control regulations, or to create dangerous scour potential. Since evaluation of these possibilities may at times require significant hydraulic analysis, any such proposed work should be brought to the attention of the Office of Structures Hydraulic Engineering Unit or the Regional Hydraulics Engineer as early as possible.

### 3.4.2 Hydraulic Table

For all projects where the hydraulic opening for the feature crossed is the controlling factor, a Hydraulic Table is required on the plans. The following table shall be shown:

| HYDRAULIC DATA |
|-----------------|-----------------|------------------|
| **Drainage Area** = | (sq. miles) | Basic Flood Design Flood |
| **Recurrency Interval** (yrs) | 100 | 50 |
| **Peak discharge** (ft³/s) | | |
| **High Water Elevation @ Pt. of Max. Backwater** | **Existing** | **Proposed** |
| **Avg. Velocity Thru Structure @ Design Flood** = | ft/s | |
| **Scour Analysis:** | Minimum Channel El. ft. |
| Q<sub>100</sub> Scour Depth (ft) | | |
| Q<sub>100</sub> Scour Elev. (ft) | | |
| Q<sub>500</sub> Scour Depth (ft) | | |
| Q<sub>500</sub> Scour Elev. (ft) | | |
| **Begin Abutment** | | |
| **Pier** | | |
| **End Abutment** | | |

*Scour depth is measured from minimum channel elevation.*

| Table 3-1 Hydraulic Data Table |

For projects requiring the use of a temporary bridge to cross the waterway, the following notes should be completed and placed directly under the Hydraulic Table. Note 2 is to be used only when a hydraulic analysis permits.

1. The proposed temporary structure shall provide a minimum clear opening of _____ ft perpendicular to the flow with a minimum acceptable low beam elevation of _____.

### Table 3-1

<table>
<thead>
<tr>
<th>Drainage Area = (sq. miles)</th>
<th>Basic Flood</th>
<th>Design Flood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrency Interval (yrs)</td>
<td>100</td>
<td>50</td>
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<tr>
<td>Peak discharge (ft³/s)</td>
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<tr>
<td>High Water Elevation @ Pt. of Max. Backwater</td>
<td><strong>Existing</strong></td>
<td><strong>Proposed</strong></td>
</tr>
<tr>
<td>Avg. Velocity Thru Structure @ Design Flood</td>
<td>ft/s</td>
<td></td>
</tr>
</tbody>
</table>

Scour depth is measured from minimum channel elevation.
A minimum clear waterway area of _____ ft² is required below the minimum low beam elevation.

2. As an alternate to the minimum clear opening specified above, the Contractor may elect to use a single circular pipe of _____ diameter or a series of multiple pipes having a minimum diameter of ____. A minimum effective flow area of _____ ft² is required below elevation ______.

The following note shall be placed directly under the Hydraulic Data Table for Three- and Four-Sided Structures:

The proposed structure shall have a minimum hydraulic area of _____ ft² below the design high water elevation of ______ at the upstream fascia of the structure. This area shall be measured perpendicular to the flow. The minimum clear span shall be ______ ft² perpendicular to flow; a clear span exceeding this by more than 10% shall require the concurrence of the Regional Hydraulics Engineer or the Office of Structures Hydraulic Engineering Unit.

3.4.3 Slope Protection Criteria

All erodible or disturbed banks in a project that are subject to hydraulic flows shall be protected by stone fill to an elevation 1 foot above design high water. Medium stone fill will be used when the average velocity through a structure is 10 ft/sec or less at design flow. Heavy stone fill will be used when the average velocity through a structure is from 10 ft/sec to 12 ft/sec at the design flow, or as directed by the Office of Structures Hydraulic Engineering Unit or the Regional Hydraulics Engineer.

For banks subject to wake or wave action, bank protection shall be carried to a height equal to 3 feet above the maximum navigable elevation.

All slopes not protected with stone fill and which cannot be seeded, e.g. under a structure, shall be protected with select granular fill slope protection, concrete block paving or grouted stone. Slope protection under a structure should be carried a minimum of 3 feet outside the fascia line. Select granular fill slope protection shall be placed to a thickness of 8 inches. Light stone fill shall be placed to a thickness of 1 foot and can be provided in lieu of granular fill when heavier protection is desired.

See the latest BD sheets for stone fill placement and key-way details.

3.4.4 Scour Monitoring Devices

Scour monitoring devices are sometimes installed on existing piers and abutments. They are not normally used on new construction. Scour monitoring devices can be considered for use in the following circumstances.

1. Bridges with a known history of scour and no scour retrofits.
2. Bridges over streams on erodible materials, mainly with silt sands and gravel (or stone fill on top of erodible material).

3. Bridges where there is no easy access to measure the stream bed during floods.

4. Bridges over streams with high velocities that make it impossible to measure the depth of scour holes by probing, or because the velocity prohibits the measuring device from staying vertical in the scour hole during a flood.

5. Bridges over streams with high debris loads because the debris would prohibit probing for the depth of scour with either weights on a line or with a pole; however, some of the devices may be easily damaged by debris or ice.

6. For a critical bridge on the flood watch program. (Other things being similar, structures carrying high traffic volumes should be given preference.)

**Background**

Scour monitoring devices have been in existence for many years and their reliability has improved. Properly installed and maintained, they have provided critical information during flooding that alerted bridge owners to close a bridge during critical stages.

Scour monitoring devices measure the scour at one point in the stream bed. If scour happens outside the device’s measuring area of influence the monitoring device probably will not give a true reading of the maximum scour when it occurs.

Most scour monitoring devices have several limitations, especially when they are trying to measure the extent of a scour hole during a flood and in riverine situations. During a flood it is possible to get inaccurate readings (both high and low) that may not reflect actual conditions because of air bubbles due to velocity and debris, but in general if the device indicates a problem, it should be considered accurate.

Monitoring devices should not be a substitute for scour retrofits such as stone fill. No monitoring device is foolproof, and any device may fail during floods. Monitoring devices should be used in addition to, not in place of, sending people to the location to determine the extent of scour. Monitoring devices do not guarantee the safety of the bridge during floods.

**Operation and Maintenance Procedures**

Any scour monitoring device should initially be checked once a week for at least two months to gain confidence in its operation, understand its limitations and be able to distinguish if a reading is true or affected by other environmental factors.

If a device is installed there should be operation and maintenance procedures developed with input from the manufacturer and instructions for record keeping. Directions for reading the device shall also be conveyed to the Regional flood watch teams.

**Types of Scour Monitoring Devices**

There are several devices available that are recommended for consideration: Brisco scour monitor, magnetic sliding collar scour monitor, sonar scour monitor, driven rod with piezoelectric
polymer film sensors, buried float-out devices, etc. NCHRP Report #396 discusses these devices and gives their pros and cons.

The following scour monitoring devices have been used with some success at installations throughout New York State: Brisco scour monitor; Magnetic sliding collar scour monitor; Sonar scour monitor. They are described below:

1. **Brisco Scour Monitor:**

   It can be used in most situations, (but usually not in sandy channels); it is fairly simple with no high-tech components. If the channel consists mainly of sand, the rod will vibrate in the stream bottom so it will require a bottom plate to avoid vibrating into the sand. Sand, suspended sediment and ice could also get between the rod and the enclosing pipe, binding the rod to the pipe and inhibiting movement as it descends into the scour hole (even though this does not happen very often). It may require reinforcement or protection in streams or rivers carrying heavy ice or debris to avoid denting the outer pipe. It will not show any backfilling of the stream bottom. In a salt water environment the sleeve and the rod should be galvanized to avoid corrosion and the device should be checked for barnacles.

2. **Magnetic Sliding Collar Scour Monitor (Described in NCHRP Report #397B):**

   It is a simple, reliable scour monitor preferred by the New York Office of the USGS. The cables carrying the signal can be attached to the back side of the pier columns to avoid damage from ice or debris. It may be hard to install in streams with large boulders or rocks where excavating and installing the guide pipe may become a construction problem. It will not show any backfilling of the stream bottom. The collar and guide pipe will not corrode in a salt water environment nor interfere with magnets since they are stainless steel. The guide pipe must be driven to below the extent of possible scour. In salt water environment, the device should be checked for barnacles.

3. **Sonar Scour Monitor (Described in NCHRP Report #397A):**

   This scour monitor can be used in deep water more effectively than shallow water because if it is not always submerged, air bubbles trapped around the transducer head, will alter the reading given by the device. Fast flowing water may also introduce air bubbles, suspended sediment, debris or water turbulence at the transducer head which may alter the readings. It can show backfilling of the stream bottom. The reading during actual scour may be inaccurate due to the conditions mentioned previously. The head of the device requires regular maintenance and should be checked for barnacles, algae, or other obstacles if they exist in the vicinity. Since the sensor device in a sonar scour monitor is relatively inexpensive it may be worthwhile to use more than one sensor to measure scour at a foundation as a back up in case the first device becomes inoperative.

Further information on scour monitoring devices and guidance for their use may be obtained from the Office of Structures Hydraulic Engineering Unit.
3.4.5 Stream Crossing Permit Requirements

In 2007 the Buffalo and New York City Districts of the US Army Corps of Engineers modified the Regional Conditions of the Nationwide Permits. The Regional Conditions require an open bottom or an embedded invert to create a natural streambed for short span structures over fish-bearing streams. See EI 10-028 for complete requirements.

3.5 Structure Selection Process

3.5.1 Establishing Span Lengths

The geometric design policy outlined in Section 2 of this manual must be considered as well as the Design Report, site data package and correspondence to establish bridge span lengths. Design criteria for the lower roadway must also be considered.

The profiles and sections of the features being crossed as well as the crossing feature create two mathematical reference planes. The relationship of these planes to each other can be established by a NYSDOT computer program known as VERTCL (Shoulder Break and VERTical CLEarance Program). Other 2D and 3D COGO or CADD routines can also be used to determine the location of the minimum critical vertical clearance point and the maximum available beam depth. The resulting available beam depth, when used in conjunction with other project geometry, allows for the evaluation of various span lengths and configurations.

The shoulder break program also provides the limits of the bridge opening. This is known as the shoulder break area (see Figure 3.1). The overall bridge length is smaller than the shoulder break length. See the users’ manual for examples of how to use this program.

Figure 3.1
Shoulder Break Area
3.5.2 Bridge Type Based on Span Lengths

3.5.2.1 Span Lengths Less than 40 ft

See section 3.4.5 for stream crossing requirements. The various types of units and materials available for this span range include:

**Structural Plate Pipes (aluminum and steel)**

These units are available in various shapes and sizes. They can be used for shallow fills (~2 ft minimum), as well as deep fills. Their uses include pedestrian, bike and animal underpasses, railroad tunnels, and vehicular tunnels. They have been used as liners for masonry and concrete arches as well as other pipes. Steel plates are rarely used for water crossings due to corrosion concerns.

Presently, the use of a bridge-size type of structure is limited to secondary roadways and low fill areas. Environmental and size constraints normally dictate whether to use steel or aluminum. For a discussion and details of this type of structure see the appropriate chapter of the latest NYSDOT LRFD Bridge Design Specifications and the latest manufacturer's catalogues. Steel and aluminum pipes are considered to be equal alternates.

**Precast or Cast-In-Place Reinforced Concrete Structures**

Reinforced concrete structures for culverts and short span bridges consist of four sided boxes, three sided frames and arch shapes. These structures are usually precast in segments and assembled in the field. The precast segments are usually designed by a professional engineer employed by the Contractor after the award of the contract. Four-sided boxes and prismatic three-sided frames are usually designed using the computer program ETCULVERT. Non-prismatic shaped and arch-shaped three sided structures are designed using other computer programs. For additional information on the structure types below, see Chapter 19 of the Highway Design Manual.

**Four Sided Boxes** have a maximum practical single-cell clear span of approximately 20 ft.

**Three-Sided Structures** have a maximum practical clear span of approximately 50 ft. These units are supported on strip footings founded on rock or piles. A precast or cast-in-place, full-invert slab/footing unit can also be used.

Both three-sided structures and precast arches can be used for many of the same situations identified for the larger pipes. In order to obtain the necessary headroom for some cases, the units may be raised by supporting them on a pedestal wall. The use of multi-cell adjacent units to convey a waterway is discouraged due to the potential for blockage by debris catching and accumulating in the intermediate piers.

Use of three-sided structures is discouraged in the following situations:
1. **Spans longer than 40 ft with low fill heights.** With low fill heights the use of arch shapes is not feasible and three-sided frames (flat top of slab) are inefficient. Use of conventional bridges with prestressed slab unit superstructures must be investigated.

2. Structures with stage construction, on a skew greater than 10° and with a span longer than 40 ft. Arch shapes are very difficult to use in a stage construction with skew and three-sided frames are inefficient. Use of conventional bridges with prestressed slab unit superstructures must be investigated.

**Deck Slabs or Deck/Girder Designs**

Prestressed slab units, stress-laminated timber decks and concrete or timber decks with steel or timber girders cover this entire span range. Conventional reinforced concrete slabs, however, are inefficient for spans greater than 24 ft due to their excessive depth and heavy reinforcement.

Composite deck systems utilizing concrete with built-up steel girders or rolled sections can also be considered for spans in this range.

**3.5.2.2 Spans Between 40 ft and 100 ft**

Three-sided units can be used to a maximum span of about 50 ft. Adjacent prestressed concrete slab units can be used to a maximum span of about 60 ft. Prestressed concrete box units, concrete I-beams, bulb-tee sections, etc., are used for the remaining portion of the span range. Bulb-tees are usually preferred over concrete I-beams. (For bridges with large cross slopes, the smaller top flange width of concrete I-beams may make them more attractive than the bulb-tee.) Deck/Girder systems using laminated timber beams have a maximum span of about 80 ft. Conventional composite design systems utilizing concrete decks and steel stringers can be used for the entire span range. At the lower end of the span range rolled beam sections would be used. Fabricated, welded plate girders would more likely be used at the upper end.

Special prefabricated bridge panels with concrete decks and steel beams can reach spans approaching 100 ft. They have the advantage of reduced field construction time.

**3.5.2.3 Span Lengths Between 100 ft and 200 ft**

Special modified prestressed concrete box beam units up to 4’-6” deep can span up to 120 ft. Prestressed concrete I-beams and bulb-tee beams ranging from 4’-7” to 6’-7” in depth can span up to approximately 150 ft. Bulb-tees are usually preferred over concrete I-beams. The designer should investigate the feasibility of transporting and erecting the beams, especially those with a span longer than 130 ft. Composite steel plate girder systems can easily and economically span this range. Single spans up to 220 ft have been used. Once the single span exceeds 165 ft, alternate multiple span arrangements should be considered. The cost of additional substructures must be compared to the greater superstructure cost.
When a wingwall length exceeds 25 ft., an alternate type of wingwall system should be investigated. Various types of sheeting or modular walls may prove to be more economical than a cast-in-place cantilever design.

Special details such as below ground cast-in-place or masonry block sills may be used to support architectural stone or brick facings. If form inserts are used to obtain an aesthetic appearance, the wall thickness must be increased by an amount equal to the relief of the insert.

Narrow roadway medians will generally require the alignment of a median pier to approximate the skew of the roadway. In wider medians, 60 ft or more, pier skews may be modified. In narrow medians where a pier will be subject to road spray, salt and snow build-up, a solid pier should be considered.

The use of small, isolated column piers is discouraged where the potential for impact by heavy trucks is possible. Where multicolumn piers are used, the potential for impact should be evaluated, and when deemed necessary, a crash-wall-type, partial-height plinth should be used. At railroad crossings, pier crash walls should be made parallel to the track and meet current AREMA specifications.

Substructure placement should also consider drainage requirements in the area around the substructure.

### 3.7 Work Zone Traffic Control

#### 3.7.1 General

Before finalizing the type and configuration of the new structure, one final consideration must be evaluated. The method for temporary traffic control may become the overriding consideration in the selection of the preferred alternative as well as affect the cost and scope of the work. The temporary traffic control method for a project is generally decided in Project Design Phases I → IV. It is presented in the Design Approval Document. In order of preference typical methods for temporary traffic control used by NYSDOT are:

- Off-Site Detour
- Stage Construction
- Temporary on-site detour bridge.
- New alignment such that the existing bridge/roadway can be used to maintain traffic. This can include a partial or complete alignment shift.

Occasionally, the chosen method for temporary traffic control presents difficulties that require the method be revised during final design. Cost, constructability, safety, anticipated traffic volume, traffic capacity, and community impact are important criteria to be evaluated when comparing competing temporary traffic control methods. For example, stage construction presents construction difficulties that could result in a less desirable finished product and costly work zone traffic control. Night construction may also be considered as an optional method. Dialogue with the highway designer should be maintained through all design phases.
3.7.2 Off-Site Detour

Off-site detours often impose a cost on users in terms of the additional time and mileage needed to circumvent the construction site. Depending on the additional travel time imposed on the user, these costs can be negligible or very significant. This decision can also affect businesses, school bus operations, emergency services, etc.

Local residents and officials may prefer an off-site detour if it includes payment for a necessary roadway upgrade of the detour route or if special measures to mitigate the effects to local users/services can be arranged. An example of this is an adjacent fire district agreeing to temporarily provide service to an area separated from its normal fire service provider by bridge construction. From a construction perspective, an off-site detour presents the best opportunity for the contractor to do work efficiently. An off-site detour will almost always mean a simpler, less expensive, faster construction process that will likely yield a more durable final product (as compared to stage construction).

3.7.3 Stage Construction

Stage construction is appropriate when a suitable off-site detour is not available, or when the traffic volume is so large that off-site detouring is not practical. To accommodate high traffic volumes, widened shoulder areas can be provided on the new structure to carry multiple lanes of traffic during staging operations. Stage construction can even be considered for existing bridges that have some form of nonredundant superstructure, e.g., thru girders, if additional supports or load carrying members can be added. Large profile changes between existing and proposed conditions can make staging difficult and require expensive sheeting schemes. The costs associated with stage construction are difficult to estimate in the early stages of a project. Until the actual staging details are developed, the cost of staging can only be indicated as an additional percentage of the estimated project cost.

The procedures and details proposed for staging should be thoroughly investigated to avoid orders-on-contract. Cost overruns associated with omissions or errors which should have been identified and addressed by additional site evaluations, record plans or subsurface investigation can be very costly.

Depending upon the complexity and extent of the stage construction, the additional cost can range from 10% to 30%.

Guidelines for Stage Construction Details

- The Region is responsible for determining minimum lane widths, shoulder widths and pedestrian access needs for each condition of staging. The Region should also identify any restrictions placed on any of the utilities.
- Show staging details for old and new pier(s) in each of the appropriate cross-sectional views.
• Use a dashed line pattern to identify limits of removal work in each stage. Limited removal work can also be identified as a crosshatched area, e.g., partial sidewalk removal.

• A dashed line should also be used to indicate temporary barrier and its location.

• Identify all temporary and permanent utilities in the appropriate stage.

• All transverse staging sections should include a true vertical and horizontal representation of the existing and new pier status at each stage. Any temporary supports or shoring details should also be included.

• All details should be drawn showing a true representation of the existing and proposed conditions with regard to their true elevation and horizontal relationship. When possible each preceding stage should be detailed below the previous. This downward projection should give a true representation of the location of the existing and proposed features with relationship to each other.

• Temporary cantilevered outrigger sidewalk details should be provided when the existing or proposed partial bridge section cannot accommodate both vehicle and pedestrian traffic within the dimensions proposed. This may be waived only if minimal pedestrian safety or mobility impacts will occur. Fencing may be used as the pedestrian fascia barrier in some cases.

• As a temporary condition (if alternate pedestrian routes and/or detours permit), all or a portion of the sidewalk area placement can be delayed as a means of providing room for vehicle lanes and shoulders. A temporary sidewalk width of at least 5 ft. is preferred. The absolute minimum sidewalk width is 3 ft. if a 5 ft-wide passing zone is provided every 200 ft. See the Highway Design Manual, Chapter 16 for further information.

• Temporary concrete barrier (each unit) shall be pinned to the concrete deck or stiffened with box beam if the design speed of the detour exceeds 45 mph. If the design speed of the detour is less, pinning of the barrier can be omitted if a minimum set back of 1 ft. from the edge of deck slab to edge of temporary concrete barrier can be maintained. Pinning of the barrier to the existing deck is acceptable provided the condition of the existing concrete is acceptable. Barriers should not be placed on large overhangs without checking the capacity of the deck slab. If possible, place the temporary barrier directly over a beam or on the deck slab between two beams. A temporary barrier stiffened with box beam is preferable to pinning because of its superior deflection performance.

• For further information on stage construction design, see Section 5.1.9.

3.7.4 On-Site Temporary Bridges

The on-site temporary bridge serves to keep the roadway facility operational during construction. The type of temporary structure to be used is greatly dependent upon site conditions. The alignment, profile, typical roadway section and the minimum span/opening will
be specified by the State. The type of temporary structure may be left to the Contractor's option, or the Department may direct that a specific type be used. It will also be the Department's decision as to whether the temporary structure should be leased or purchased.

Options to consider when a temporary bridge is proposed include:

- **The Traditional Manner:**
  A temporary detour structure is specified by the designer. The Contractor is made responsible for the design and plans of the temporary bridge and must submit them to the Department for review and approval. Upon the completion of the project and the return of traffic to the permanent roadway corridor, the structure's salvage is the Contractor's responsibility. All detour structure costs are eligible for federal participation except they are limited here to a “rental-type” reimbursement.

- **The Local Bridge Incentive Program:**
  A temporary detour structure is again specified by the designer, but additional consideration is given to the permanent disposition of the temporary detour structure. The required bridge design, specifications, plans and project development are tailored to both the temporary and permanent installation sites. All costs associated with this option are eligible for Federal participation. Even costs for removal of the existing local bridge at the site where the temporary structure is to be permanently placed are eligible. Additional guidelines can be obtained from FHWA.

- **Innovative Designs:**
  Innovative design procedures can be introduced by either the designer or the Contractor. An example would be a roll-in or sliding technique. In this version, the temporary substructure and the new superstructure are located on a temporary alignment, parallel to the permanent corridor. The temporary substructure must be designed to carry the new bridge superstructure as well as being capable of handling the horizontal and vertical jacking forces. The permanent superstructure is then used as the temporary detour, while the old bridge is removed and the new permanent substructures are built. Once the new substructures and approach work are completed, traffic must be completely shut down for a short period of time for the jacking operation(s). The new superstructure is then moved to its final location.

Right-of-way, archeological, historical preservation, environmental and utility issues all have to be addressed as they relate to the placement of a temporary bridge. One or more of these factors may severely affect the use of a temporary bridge to maintain traffic at the site.

### 3.7.5 Alternative Alignments

Using an alternative alignment is a temporary traffic control approach most often used when it is necessary to eliminate an undesirable feature associated with the existing alignment, for example, a sharp curve. Due to high traffic volumes and certain traffic movements, it may be the most efficient way to handle traffic. The alternative alignment may either be a full or partial shift of the roadway's horizontal alignment. This approach can involve the same issues as mentioned
for the on-site temporary bridge method; R.O.W., environmental, etc. In some cases the State may already own the R.O.W. adjacent to the existing bridge which will help reduce the cost. The cost and need for real estate acquisition can be a critical project concern. With an alternative alignment the project cost is also increased by the cost of roadway construction from the point of divergence to convergence with the existing alignment.

3.8 Alternate Designs

The process that has been outlined allows for an evaluation of options. By working through the process and applying site or design constraints, various alternatives are eliminated. This process of elimination and evaluation results in the most efficient and economical structure for most small and medium bridge projects.

For projects involving major structures (estimated cost $10 million or more) it may be more advantageous to determine the most cost efficient structure by competitive bidding. Alternate bridge types could be developed in the following manner:

- Value Engineering
- Conceptual Plans only
- Detailed Alternate Bridge Designs and Associated Plans

New York State includes a Value Engineering clause on all projects, whereby the Contractor may propose an alternate design for review and approval.

3.9 Hazardous Materials

The two hazardous materials most likely to be encountered in bridge replacement or rehabilitation projects are asbestos and lead-based paint. Asbestos has been used historically in several common bridge construction materials. Typical applications include bearing pads/sheet packing, joint filler, caulking, utility conduits, paint and other coatings. Removal/disturbance of asbestos-containing material is regulated under State and Federal Regulations. For guidance related to asbestos inspection and abatement design associated with bridge replacement or rehabilitation projects, refer to Chapter 1.C of the Environmental Procedures Manual.

The following items should be used to implement and maintain effective Health and Safety controls for lead removal as needed.

- Item 570.01, Lead Exposure Control Plan
- Item 570.02, Medical Testing
- Item 570.03, Personal-Exposure-Monitoring Sample Analysis
- Item 570.04, Decontamination Facilities
3.10 Environmental Considerations

3.10.1 Introduction

When designing a bridge, a designer is required to fit a solution to a problem. A proposed work strategy of rehabilitation or replacement must adequately address a deteriorated or inadequate bridge or a newly proposed crossing. Solutions to these problems must be developed while considering certain criteria and parameters. The criteria can be found in laws or specifications governing loads, stresses or operational requirements. Some parameters are defined by site conditions, soil properties, seismic classifications, hydraulic considerations, etc. Other parameters are defined by social, economic or environmental issues. A designer attempts to develop a solution that economically addresses the conditions that define the problem while accommodating applicable criteria and parameters.

The Governor’s Environmental Initiative of 1998 re-emphasized the importance of assuring a project’s consideration of environmental parameters. These parameters are meant to assure the maintenance of clean air and water and to advocate projects that “fit” in community settings, maintain historic significance, and accommodate recreational opportunities, where appropriate.

True support of the Governor’s initiative requires that the Department’s designers ascribe to the precepts of the initiative and integrate them into the project development and design processes. This must be done in a way that resulting products reflect the Department’s steadfast environmental ethic.

Every attempt should be made to identify environmental requirements and enhancements as early in the project development process as possible. This will allow an evaluation of the impacts they may have to project development, design and construction, the costs they impart to the project and the benefits that result in the final product. Obviously, decisions of scale, those that meaningfully impact project scope, cost or schedule, should be introduced in the scoping stage. “Details,” items that enhance appearance but do not have serious design, construction or cost implications, can be considered and introduced later in project development.

3.10.2 Types of Project Enhancements

There is a wide variety of enhancements available for bridge projects. For the purposes of this discussion, three classifications are identified as Structural, Aesthetic and Recreational.

1. Structural Enhancements

These are enhancements that affect the way a structure performs. The enhancement can be in the form of a structure type or layout which may not be optimum from an economic or a purely structural standpoint but is selected for superiority in combining sensitivity to community setting or historic ambiance and maintenance of acceptable operating standards. Examples are replacement trusses that bear extra fabrication and construction costs or haunched prestressed boxes that replicate “arch” construction but involve extra material and fabrication costs. These alternates may not be as structurally
3.11.2 Format

The Bridge Preliminary Plan generally consists of at least two sheets. The following details appear on each sheet.

Sheet 1

- Plan view of the finished structure with the general features of the existing bridge shown dotted
- Full elevation view of the new structure
- Hydraulic Summary Table/Detour Opening Note
- Appropriate Highway Curve Data Table
- Preliminary Approval Signature Box

Sheet 2

Any continuation of the plan and elevation view should be broken at a point of support (pier or abutment) and continued a small distance past the support. The center line of support shall be the location of the match line.

- Full Transverse Section of the New Structure (showing a pier type where appropriate)
- All necessary profiles with banking details
- A detailed banking diagram of the bridge deck if it is in transition
- Construction and Traffic Staging Details - Start with the existing structure and continue showing the typical traffic and new construction limits in each stage. A finished bridge section does not have to be shown if it has been provided elsewhere on a preliminary bridge plan sheet. These sections should follow a true projection sequence from the top to the bottom of the sheet.
- Typical Approach Section showing the approach slab, railing transition details, and wingwall or retaining wall treatment where appropriate.
- Special elevation views to show the treatment of wingwalls, slopes, etc. (as required).

Preliminary Plan Sheet Notes

This is a listing of general and specific design notes as well as questions or proposals to the Region for review and comment. The preliminary cost estimate of the structure and preliminary foundation information (if available) are included. These notes are prepared on standard 8½ x 11 paper and included with the preliminary plan. (See Appendix 3G.)

3.12 Structure Justification Report

Each new and replacement structure requires the preparation of a Structure Justification Report. This report will also list principal dimensions and features of the existing and replacement structure. A sample Structure Justification Report form is provided in Appendix 3H. The report should include a discussion of waterway opening and alignment, skew, span length, number of spans, existing features, available structure depth, utility locations, horizontal clearances, material choice, aesthetic features, railing and constructability.
The structure type options that were considered prior to selecting the final structure type and configuration should also be discussed. If the final choice was based on an economic comparison, the supporting estimates should be provided. All Structure Justification Reports must contain a determination and statement whether or not the structure is considered innovative or unusual. See Section 20.2.2 for criteria and information on innovative and unusual bridges.

3.13 Hydraulic Justification Report

Each new and replacement structure over water requires the preparation of a Hydraulic Justification Report (HJR). The report is prepared or approved by the Hydraulic Engineering Unit (or Regional Hydraulic Engineer) prior to Preliminary Plan approval by the Deputy Chief Engineer, Structures.

Major rehabilitations may require an HJR if the waterway area is being affected. Contact the Hydraulic Engineering Unit or Regional Hydraulic Engineer to determine if an HJR is necessary.

The report contains a brief description of the stream crossing and watershed, and any existing ice or debris issues. A description of the existing structure and any hydraulic or scour deficiencies is provided. The discussion of the proposed structure includes type, material, alignment, dimensions and whether a temporary detour structure will be provided. The hydraulic analysis is summarized and freeboard noted for both the Design flow ($Q_{90}$) and Basic flow ($Q_{100}$). Specific scour protection and hydraulic features are described.

When a hydraulic analysis is not required (i.e. bridge over gorge with abutments not near the waterway, or bridge over controlled section of NYS Barge Canal) the Hydraulic Engineering Unit prepares a statement summarizing the reasons an analysis is not needed, in lieu of the HJR.

3.14 Accelerated Bridge Construction

Some prefabricated bridge elements and systems may offer significant advantages over onsite cast-in-place construction. Advantages can include a reduction in field construction time, lower costs resulting due to off-site fabrication and standardized components, and improved safety because of reduced exposure time in the work zone. The controlled environment of off-site manufacturing helps ensure consistent quality of components for durability and long-term performance.

There are considerable rewards that can be attained with thorough planning, design and execution of accelerated bridge construction contracts. A detailed evaluation should be made to determine if a job should be accelerated. Consideration must be given to the applicability of the design, the contracting industry's abilities, project site conditions, costs and construction schedules. The Region and the Contractor must be committed to the accelerated schedule to ensure success. Shared responsibility, risk and control are needed for a successful project. Reduced schedules save money for all parties. When properly implemented, accelerated bridge construction can and should result in an inexpensive and durable bridge that meets schedule and budget requirements.

Additional information and guidance on selecting accelerated bridge construction for a project is available at www fhwa dot gov bridge prefab framework cfm.
Appendix 3D
Preliminary Plan Development
for New and Replacement Bridges

Introduction

The preparation of a Preliminary Structure Plan is the first step in preparing final bridge plans for inclusion in a project PS&E package.

The Preliminary Structure Plan presents in a clear and concise way, the intended bridge design for the project. The proposed structure should be compatible with the overall conditions of the site; that is, geometric, topographical, cultural, ecological, etc., and should be consistent with the cost, scope, and schedule established for the project.

The importance of the Preliminary Structure Plan should not be minimized. The plan provides interested parties both within and outside the Department with an opportunity to understand the project work. The clearer the preliminary plan, the clearer that understanding will be, and the more relevant review comments will be. A well developed Preliminary Structure Plan presents a structure that will be safe, economical, constructible, and consistent with the requirements of the project.

The following is a step-by-step procedure for developing a Preliminary Structure Plan. While specifics of the project may result in a slight reordering of the steps presented, all the steps should be included in the development.
STEPS IN THE PRELIMINARY PLAN PROCESS:
NEW OR REPLACEMENT STRUCTURES

1. Collect Support Data
   a. Design Approval Document (DAD) - Provides the latest project definition.
   b. Bridge Site Data - Region or Consultant assembles a Site Data Package (SDP) for each bridge in a project. The package provides the designer with the information required to select a structure for a specific site. It provides the hydraulics engineer with data needed to perform a hydraulic analysis and it defines any outside agency requirements (utilities, DEC, etc.). (See Appendices 3A and 3B for SDP requirements.)

      The Site Data Package shall be reviewed and approved by the Regional Structures Engineer.

      All Site Data necessary to perform a hydraulic analysis and evaluation will be submitted to the hydraulics engineer at the earliest possible date. Appropriate portions shall be submitted electronically. The hydraulics engineer can be the Office of Structures Hydraulic Engineering Unit, the Regional Hydraulics Engineer or a Consultant.

      If the Office of Structures is the bridge designer, then a complete Site Data Package for each structure should be submitted to the Director of the Structures Design Bureau. Appropriate portions should be submitted electronically. One copy should be sent to the Geotechnical Engineering Bureau.

      If the Region or a Consultant is the bridge designer, only those portions of the Site Data Package (excluding hydraulic requirements) that facilitate the technical progress review need to be submitted to the Office of Structures Design Quality Assurance Bureau. Refer to Item 3 of this appendix, "Perform In-Progress Technical Review," for required submissions. One copy of the SDP should be sent to the Geotechnical Engineering Bureau.

2. Develop the Structure Study Package
   a. Prepare Structure Study Plan

      This plan may also be referred to as an “advance preliminary,” “40% preliminary” or “size, type and location.” Its purpose is the same, however: to ensure that all issues or questions regarding the concept of the proposed structure are resolved at the earliest point practical in the design process. The size, type, and location/orientation of the structure are the major items investigated and selected at this point in the process. For a typical structure, a Structure Study Plan should include the following information:

      - Plan view (1:240) showing bridge centerline and features crossed
      - Substructure locations (existing and proposed)
Preliminary Plan Development

- Span lengths
- Elevation view (1:250) or larger
- Minimum clearances (horizontal & vertical)
- Full transverse sections of proposed bridge including proposed staging details (if applicable) and utility locations (if applicable)
- Existing contours
- Existing & proposed boring locations
- Profile of all roads and/or railroads, including banking diagrams*
- Horizontal alignment data
  *Included in Design Approval Document (if available)

b. Prepare Structure Justification Report (SJR)

This report documents why the particular structure size, type and location as presented in the Structure Study Plan was selected. It does not need to cover why replacement was selected over rehabilitation (or vice versa), since that decision has already been documented in the Design Approval Document. Typical topics to be discussed in the SJR include:

- Superstructure type, configuration, materials
- Substructure type, foundation constraints (if known)
- Hydraulic, M&PT, Railroad, ROW constraints, etc.

An SJR form which facilitates the report preparation is available for use by the designer (See Appendix 3H). The "Comments and Alternates" portion of the form should include, but not be limited to, a discussion of the following factors to the extent they affect the type of structure selected:

- M&PT requirements
- Utilities
- Design exceptions due to nonstandard features (e.g., sag curve and crest curve)
- Brief narrative of existing hydraulic conditions at the site (e.g., ice, debris)
- Subsurface soil conditions, type of foundation, and type of temporary sheet piling/lagging system (if required)
- Any special features (e.g., aesthetic treatments)
- Anticipated construction problems
- Construction cost estimates
- Structure alternates eliminated from selection
- Reasons for barrier/railing type selected
- Reasons for alternate selected
- A determination whether the structure is innovative or unusual.

c. Prepare a Preliminary Cost Estimate

The Office of Structures has developed a preliminary bridge estimating tool called the Preliminary Cost Estimate Worksheet. It uses a cost estimate methodology based on shoulder break area. The shoulder break methodology is advantageous for use early in a project when bridge
particulars, such as abutment heights and locations, are not known. This methodology provides reasonable compensation for positioning abutments anywhere within the shoulder break length. The approach also utilizes cost comparisons to similar bridges constructed in the recent past. Copies of the most recent Preliminary Cost Estimate Worksheet, in a spreadsheet format, may be obtained from the Office of Structures Bridge Program and Project Development Group, in electronic or hard copy form, or from the Department web site.

d. Establish Hydraulic Criteria

For bridge projects over water, the designated hydraulics engineer, the Office of Structures Hydraulic Engineering Unit, the Regional Hydraulics Engineer, or a design consultant will provide the designer with a hydraulic summary which includes a preliminary “Hydraulic Data Table.” The summary will document the review of the proposed structure regarding freeboard and scour requirements, and document other hydraulic requirements considered in the selection of the type and size of the structure. Hydraulic criteria for any temporary structure will also be required.

3. Perform In-Progress Technical Review

A progress review is performed at this time to ensure that the structural solution being developed is consistent with the scope of the project, is technically and economically appropriate, and responds to the site conditions, restrictions, etc., that have been identified.

This review of the structure study package (structure study plan/structure justification report/preliminary cost estimate/hydraulic criteria) should be conducted to gain a consensus among affected Regional Groups, the Office of Structures, and the Regional and Main Office Geotechnical Engineering Groups. It should include the consultant, if that consultant is performing work for the Department which is impacted by the bridge work in any way. This review should take place regardless of designer, since the review helps ensure that the structure being presented satisfactorily meets project requirements and provides an early evaluation of possible foundation problems and alternatives. The review also allows the Geotechnical Groups to determine if additional subsurface information is warranted (e.g., more or deeper soil borings, more rock cores or probes). The Geotechnical Engineering Group responsible for the structure foundation recommendation should also evaluate the appropriateness of the type of structure proposed and the proposed temporary/permanent sheet piling/lagging system. A preliminary foundation recommendation memorandum will be issued by the Geotechnical Engineering Group as part of their review.
For a complete review, the following items are required:

- Structure Study Plan
- Structure Justification Report
- Preliminary Cost Estimate
- Bridge Site Data
  - Soil Boring Logs
  - Bridge Data Sheets Part I (Items 1-26)
  - Part II (Items 1-29)*
- Preliminary Hydraulics Summary and Data Table*
- Design Approval Document
- As-Built Bridge Plans (for Replacement Bridges on similar alignment)
  *Required for hydraulic crossings only.

The Structure Study Plan Package should be submitted directly to all reviewers (i.e., the Office of Structures, Regional Structures Engineer, Main Office and Regional Geotechnical Engineering Bureaus and any impacted project consultant) for review.

In-Progress Technical Review comments for region designed projects shall be coordinated by the Office of Structures Design Quality Assurance Bureau.

In-Progress Technical Review comments for consultant designed projects shall be coordinated by the Region, the Consultant Manager or the Office of Structures Design Quality Assurance Bureau. The Region shall designate the coordinator of progress review comments.

In-Progress Technical Review comments for Office of Structures designed projects shall be coordinated by the Structures Design Bureau.

One month shall be provided for technical review after all review material is received.

4. Complete Preliminary Structure Package
a. Prepare Preliminary Structure Plan

The Preliminary Structure Plan is developed from the Structure Study Plan, considering comments generated from the In-Progress Technical Review. The Preliminary Structure Plan will present the project in more detail and include a an 8½ x 11 Preliminary Plan Note sheet, containing descriptive project information. The completed plan should present a full picture of the bridge project and work that is to be done. The Preliminary Structure Plan should include the following:

- Plan view including controlling clearances and dimensions
- Full transverse section of the proposed structure with elevation view of a proposed pier
- Sections of approach treatments
• Profiles of over and under features and banking diagrams
• Stream profile and sections (only if relocating the stream)
• Hydraulic Box including temporary structure note
• Staging details showing bridge sections including maintenance of traffic stages and new construction stages
• *Notes regarding design specifications
• *Proposed foundation treatment
• *Disposition of utilities
• *Special conditions that may apply
• *Updated preliminary cost estimate
  *included in preliminary notes

Appendix 3F contains a preliminary plan checklist and layout and Appendix 3G contains preliminary plan sheet notes that should be used as a Quality Control tool by the design group progressing this plan.

b. Revise Structure Justification Report

During completion of the Preliminary Structure Plan, the SJR should be revised (if necessary) to reflect any changes resulting from new information or review comments.

c. Revise Preliminary Cost Estimate

During the completion of the Preliminary Structure Plan, the preliminary cost estimate should be revised (if necessary) to reflect any changes resulting from new information or review comments.

d. Prepare Hydraulic Justification Report

The hydraulic engineer will provide the designer with a Hydraulic Justification Report, (HJR) to be appended to the SJR, prior to submitting the completed Preliminary Plan Package to the Deputy Chief Engineer (Structures) for approval.

e. Complete Preliminary Plan Checklist (See Appendix 3F).

5. Transmit for Final Review

The completed Preliminary Structure Package (revised Preliminary Structure Plan, Preliminary Plan notes, revised SJR, revised Preliminary Cost Estimate, and the HJR) shall be submitted for final review. Submissions and comment coordination shall be the same as in Item 3, In-Progress Technical Review of the Structure Study Package.

6. Resolutions of Final Review Comments and Approvals

The final comments are resolved and a revised Preliminary Structure Package is sent to the Deputy Chief Engineer (Structures) for approval.
The Preliminary Structure Package occasionally will be approved and transmitted to the Region with additional minor comments. These minor comments may include changes to notes or minor detail changes (e.g., wingwall skew angles). These minor comments should be incorporated into the Advance Detail Plans.

7. Distribution of Approved Preliminary Bridge Plan

   a. After approval, the following groups shall be notified by email indicating the location of files in Projectwise by the Office of Structures. Organizations without access to Projectwise shall receive pdf file(s):

      Region
      NYS Thruway Authority/Canal Division (when involved)
      FHWA – Consult Chapter 4 of the Project Development Manual.
      Concrete Unit, Office of Structures - For bridges utilizing precast concrete elements.
      Design Services Bureau - For projects involving railroads or when the Design Services Bureau is doing the highway design
      Consultant Management Bureau (when involved)
      Geotechnical Engineering Bureau
      Foundation & Construction Unit, Office of Structures
      Special Designs - When the following special designs are used files will be sent to known suppliers.
         • Prefabricated steel bridges
      Design Quality Assurance Bureau - For structures with unconventional sidewalk, bicycle facility or shared-use path details.

   b. After receipt of the Approved Plan, the Region makes the following distribution:

      DEC - (for projects involving water crossings).
      State Historic Preservation Officer (SHPO) - When involved.
      Utility Companies - When involved.
      Local Officials - When involved.

8. Revisions to an Approved Preliminary Structure Plan

Any changes made to the Preliminary Structure Plan after "Approval" by the Deputy Chief Engineer Structures (D.C.E.S.) shall be made only with concurrence of the D.C.E.S.
PRELIMINARY BRIDGE PLAN DEVELOPMENT FLOW CHART
NEW AND REPLACEMENT BRIDGE PROJECTS

This flow chart is the same, regardless of designer and/or hydraulic engineer
* The FDR may or may not be finalized prior to the ADP’s. At the ADP stage the
designer should at least have an interim report
In-House Preliminary Bridge Plan Preparation Sequence

- SDB Designer initiates contact with various units and organizations to assure awareness of the proposed project.
- SDB, in consultation with the Bridge Foundation Unit and GEB, attempts to verify the adequacy of the existing subsurface information or the need for additional borings.

Develop Structure Study Package (See NYSDOT Bridge Manual – Appendix 3D 2.a-d)

- Layout & Design by Design.

Site Data Received & Reviewed by SDB
- SDB Coordinates with; GEB, Bridge Foundation Unit, Hydraulics, Coast Guard, Railroad

Design Decision (Director/Asst Dir SDB)
- SDB assures completeness and conformance to Design Criteria represented in the project's Final Design Report. SDB identifies any physical or environmental characteristics that may influence the size, type or location of the proposed structure.
- SDB maintains communication with the Region to assure timely site data submissions.

In-Progress Technical Review
- Two Copies:
  - RDE - att: RSE.
  - GEB – cc: Bridge Foundation Unit;
  - Concrete Eng. Unit (Precast Only);
  - Hydraulic Engineering Unit (for bridges over water);
  - Highway & Railroad Design Section of the DSB if joint design with DSB;
  - Rail Agree. Section of DSB if RR project;
  - Consultant if joint Design with Cons.
- One Copy:
  - Director/Asst. Dir. SDB.

Incorporate comments and prepare Final Preliminary Plan Package (See NYSDOT Bridge Manual – Appendix 3D 4.a-d)

Submit for “approval”:
- Through: Asst. Dir. SDB → Dir. SDB
- To: D.C.E.S. for Approval

SDB Distributes
- SDB enters project into Preliminary Plan database and distributes
  - Two Copies:
    - RDE - att: RSE;
    - Rail Agreements Section of DSB, if RR Project
  - One Copy:
    - GEB – cc: Bridge Foundation Unit;
    - Highway & RR Design Section of DSB, if joint design with DSB;
    - Consultant Engineering firm, if joint design with Consultant

- SDB maintains a database that contains both basic and unusual project features, and allows “sorting” for future reference.

Abbreviations
- D.C.E.S. – Deputy Chief Engineer Structures
- GEB – Geotechnical Engineering Bureau
- DSB – Design Services Bureau
- RDE – Regional Design Engineer
- RSE – Regional Structures Engineer
- SDB – Structures Design

May 2011
ELEVATION (Scale 1" = 20’ or 1" = 40’, but may vary)

□ Scale Bar

□ Position immediately beneath the plan.

□ Indicate elevation of structure along fascia, looking parallel to highway. May be projected down if the scale is the same.

□ Indicate and identify appropriate existing ground line (show dashed where changing, solid where there is no change).

□ Indicate and identify datum elevation line.

□ Indicate and identify fixed and expansion bearings, if applicable.

□ Identify embankment slopes.

□ Indicate approximate existing and proposed footing locations and elevations. Show piles if required.

□ Indicate and identify any architectural treatment on abutment and walls.

□ Indicate and identify over road highway approach railing and bridge railing/barrier.

□ Indicate and identify existing and proposed pipes and utilities, where appropriate.

□ For structures over highways:

  a. Indicate section but not dimensions of under roadway. Identify as existing, proposed, and future.
  b. Indicate and identify § or H.C.L., station line, T.G.L. and point of rotation (P.O.R.) of under roadway.
  c. Identify cross slopes of under roadway.
  d. Identify minimum horizontal clearances and indicate guide rail, where required.
  e. Identify minimum vertical clearance over travel lane or usable shoulders.
  f. Indicate and identify type and thickness of slope protection.
  g. Indicate and identify "deflection berm" or safety slopes, if required, at piers and abutments.

□ For Structures over Streams:

  a. Indicate and identify the theoretical or actual bottom angle width or channel width at the controlling elevation.
  b. Indicate and identify slope protection.
  c. Identify Design High Water Elevation at § bridge or Maximum Navigable and Normal Pool elevations, where applicable.
  d. Indicate and identify minimum freeboard above Design High Water elevation, or vertical clearance over maximum navigable pool elevation.
  e. Indicate and identify navigation lights where applicable.
f. Indicate stone fill at piers where required, i.e., around the footing, inside the cofferdam, etc.
g. Provide navigation channel dimensions.
h. Show pier impact protection details and locations of rub rails or dock fenders, where appropriate.

For Structures over Railroads:

a. Indicate all pertinent track dimensions not shown in plan.
b. Indicate and identify min. vertical clearance over railroad clearance point.
c. If clearance from centerline of track to face of multi-columned pier is less than 25’ indicate a crash wall (unless railroad has waived this requirement).
d. Indicate minimum horizontal clearance dimensions from 6’ of track to nearest substructure on each side.

TYPICAL BRIDGE SECTION (Scale 1” = 10’ or 1” = 20’)

- Orient looking upstation.
- Indicate widths and identify lanes, shoulders, sidewalks, medians, tapers, auxiliary lanes and all other elements carried on the structure and show cross slopes.
- Indicate and identify ℄ or H.C.L., T.G.L., station line and P.O.R..
- Identify slab depth and description (9½” monolithic bridge slab), or type and thickness of wearing surface (6” on prestress concrete sections).
- Indicate and identify railing, barrier and curb type and height.
- Indicate and identify prestressed concrete beams, steel stringers or other types.
- Indicate that size and spacing of beams/girders are to be determined by designer.
- Indicate and identify utilities and conduits.
- Indicate configuration of pier.

STAGE CONSTRUCTION SECTION (Scale, as required)

- Existing and proposed sections for each stage
- Identify removal (dashed) and new construction
- Temporary (dashed) and permanent railing or barriers
- Temporary lane widths, sidewalks and shoulders/offsets
- Cross slopes may be omitted due to space constraints
- Concrete closure placement location and width
Appendix 3G
Preliminary Plan Sheet Notes

1. GENERAL NOTES:

2. DESIGN SPECIFICATIONS: NYSDOT LRFD BRIDGE DESIGN SPECIFICATIONS


4. DESIGN LOAD: AASHTO HL93 AND NYSDOT DESIGN PERMIT VEHICLE

5. FUNCTIONAL CLASSIFICATION:

6. DESIGN SPEED:

7. WORK ZONE DESIGN SPEED:

8. PROJECT TRAFFIC YEAR:

9. AADT:

10. TWO-WAY DESIGN HOUR VOLUME:

11. PERCENT OF TRUCK TRAFFIC:_____%

12. BOTTOM OF FOOTING ELEVATIONS — ABUTMENTS: PIERS:

or

13. TOP OF FOOTING ELEVATIONS - (FOR ROCK)

14. ESTIMATED COSTS TO BE INCLUDED IN BRIDGE ESTIMATE:

   BRIDGE @ $_____ PER SHOULDER BREAK SQUARE FEET

   REMOVAL OF EXISTING STRUCTURE $___________
   WORK ZONE TRAFFIC CONTROL (BRIDGE SHARE) $___________
   DETOUR STRUCTURE $___________
   SPECIAL APPROACH WORK $___________
   UTILITIES (BRIDGE SHARE) $___________
   MISCELLANEOUS $___________
   CHANNEL WORK (BRIDGE SHARE) $___________
   TOTAL BRIDGE SHARE $___________
DESIGNER NOTES

The following notes are to be used by the designer as appropriate.

15. ASBESTOS:
16. REGION INDICATES THERE IS NO ASBESTOS ON EXISTING BRIDGE.
17. THE PRESENCE OF ASBESTOS ON THE EXISTING HAS NOT YET BEEN DETERMINED.
18. REGION INDICATES THERE IS ASBESTOS ON EXISTING BRIDGE.
19. AVAILABLE BEAM DEPTH:
20. AVAILABLE BEAM DEPTH: ___ FT. - ___ IN. BASED ON 2 FT. MIN. FREEBOARD.
21. AVAILABLE BEAM DEPTH: ___ FT. - ___ IN. BASED ON ___ FT. - ___ IN. VERTICAL CLEARANCE.
22. PLEASE INVESTIGATE POSSIBILITY OF USING ___ FT. - ___ IN. BEAM TO PROVIDE 0 IN. OF FREEBOARD.
23. USE ___ FT. - ___ IN. PRESTRESSED CONCRETE BOX BEAMS.
24. USE ___ FT. - ___ IN. PRESTRESSED CONCRETE SLAB UNITS.
25. USE ___ FT. - ___ IN. x ___ FT. - ___ IN. GLULAM STRINGERS, WITH ___ FT. - ___ IN. GLULAM DECK WITH ___ FT. - ___ IN. MINIMUM ASPHALT WEARING SURFACE.
26. THE MINIMUM FREEBOARD CONSIDERED ACCEPTABLE AT THIS LOCATION IS XXX FT. THIS CAN BE ACHIEVED BY USING A ___ FT. - ___ IN. DEEP BEAM AND A 6 IN. WEARING SURFACE, OR 9½ IN. DECK WITH 2 IN. HAUNCH. AFTER FINAL DESIGN, THE FREEBOARD SHOWN IN ELEVATION A-A SHOULD BE REVISED TO REFLECT THAT ACTUAL ABSOLUTE MINIMUM FREEBOARD.
27. BASED ON MEETING AN EXISTING LOW BEAM ELEVATION OF ___ FT. - ___ IN., ___ FT. - ___ IN. IS THE AVAILABLE BEAM DEPTH. THIS PROVIDES A FREEBOARD OF ___ FT. - ___ IN.. THE ACTUAL FREEBOARD MUST BE CALCULATED BASED ON FINAL BEAM DEPTH.
28. If freeboard is 2 ft. or more – say 2 FT. MIN. ALLOWABLE FREEBOARD.
29. If 0 in. freeboard is provided, show in elevation as 0 IN. FREEBOARD.
30. Do not indicate a negative freeboard.
31. Under pressure flow, show location of water surface and label in elevation view.
# Appendix 3H
Structure Justification Report

## STRUCTURE JUSTIFICATION REPORT

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¹(See Appendix 3D.2.b for information about factors that should be considered.)

May 2011
STRUCTURE JUSTIFICATION REPORT
P.I.N:
B.I.N:
PAGE:

COMMENTS CONT’D:

Signature/Title:_____________________________
Date:______________________________________
Figure 5.4
Slab Placement Sequence - A
(For Decks Over 360 cubic yds.)

Figure 5.5
Slab Placement Sequence - B
(For Decks Over 360 cubic yds.)

Figure 5.6
Slab Placement Sequence - C
(For Decks over 360 cubic yds.)
5.1.9 Stage Construction Deck Slabs

5.1.9.1 General Considerations

Stage construction should be used only if absolutely necessary. It increases construction time, Work Zone Traffic Control costs, and overall construction cost. The resulting deck slab has the potential of having lower quality than if placed in one continuous placement. However, because site conditions often necessitate stage construction it is a common strategy employed when replacing existing bridge decks, superstructures and complete bridges. It allows structures to remain in service during all or most of the replacement process, thereby avoiding detours or expensive temporary bridges.

During the construction operation, a portion of the proposed bridge width is built as an independent bridge for a specific stage of that construction process. Thus, a "bridge" exists in service for some period of time that may have different performance characteristics than the finished full width structure. It is extremely important that the bridge resulting from each stage of construction be evaluated to ensure the serviceability required during that stage. It is also important that the bridge be analyzed for the various construction loads to which it will be subjected, including, but not limited to, erection operations and slab placement operations.

Attention to the design and service behavior of these partially complete structures will avoid construction problems, unanticipated costs and delays, and potential failures. It will also provide a better engineered structure during the various stages and eventually through the bridge’s entire service life.

A third placement (Closure Placement) between the stages should be used if possible. This will help to isolate the second stage deck slab during the curing process from undesirable vibrations caused by traffic on the first stage deck slab. In addition, the closure placement permits a smooth transition between the top surfaces of the deck placements should they be misaligned due to variation from the theoretical deflection of one or both groups of girders. The closure placement should be wide enough to accommodate the transverse bar splice. If it cannot be made wide enough, mechanical connectors shall be utilized on the transverse reinforcement. Consideration should also be given to increasing its width to keep the first and/or second stage overhang from becoming too large.

Notes from Section 17 will be placed on the plans where applicable. They also contain instructions concerning the installation of the diaphragms between the stages.

Eccentric construction stage loads (particularly on stage widths supported by 2 or 3 girders) can cause the superstructure to noticeably move laterally during the deck placement. When lateral movements are anticipated, additional permanent or temporary bracing to resist such movements should be considered. It may also be possible to brace against the adjacent existing structure (or previously completed adjacent stage). When bracing against an adjacent structure, the bracing must allow for freedom of vertical movement so the construction stage deck pour deflection will occur as predicted. Top struts shall be included in all cross frames located in temporary fascia bays of each stage of construction.
When penetrating sealers are applied to concrete they penetrate the surface, chemically bond to the concrete, and prevent water and chlorides from entering. Because the sealers bond below, not on, the surface, they cannot be abraded away easily. Good surface preparation prior to applying the sealer is essential to achieve the desired maximum penetration. Contaminants must be totally removed and the surface allowed to dry. When the surface is properly prepared, a five-year service life of the sealer can be achieved.

Penetrating sealer should be applied to all new and concrete overlaid bridge decks, to protect the surface from scaling due to early exposure to deicing chemicals. This is recommended because the majority of bridge deck and overlay placements occur late in the construction season thereby making them prone to early exposure to deicing chemicals, and because the concrete, regardless of age, will receive some benefit from the application of a sealer.

Parapets and barriers allow the use of curing compounds. Because curing compounds prevent penetration of sealers into concrete, sealers should not be used unless the membrane cured surfaces are allowed to cure and then are sandblasted.

Usage Guidelines

**New Bridge Decks**: To protect new, “green,” concrete from scaling, a penetrating type sealer (which does not contain an aqueous solvent/carrier) shall be applied to the top surface of all newly constructed bridge decks, bridge deck rehabilitations, sidewalks and concrete approach slabs, in accordance with Item 559.1896__18.

**Existing Bridge Decks**: Application of sealers to the top surface of existing bridge decks shall be in accordance with Item 559.1796__18. Place Note 99 of Section 17.3 on the plans.

Existing decks with good quality concrete and epoxy-coated reinforcing steel should generally not be considered for sealer application. Decks with such protection are usually only sealed as a remediation for construction, material, or other problems, such as hairline cracks or an open surface. The use of sealers in these situations should be decided on a case by case basis, in consultation with the Regional Materials Engineer. Sealers are not a viable alternative for protecting improperly air entrained concrete.

Sealers may be used on existing decks with uncoated steel reinforcing bars or less than 3 inches of cover to slow down any existing corrosion and postpone more costly repairs. Sealers do not stop corrosion, but the corrosion process is slowed by reducing intrusion of water and chlorides.

**5.1.11 Aggregate Requirements for Concrete Decks and Approach Slabs**

To provide adequate wet-weather friction, a concrete wearing surface must have sufficient macrotexture and microtexture. Macrotexture is provided by manipulating the concrete surface during or after construction (e.g., Astroturf drag and saw-cut grooving). Microtexture is the texture on the surface of the exposed aggregate particles.

As concrete decks and approach slabs are subjected to traffic loads the cement paste abrades away, reducing macrotexture. If wear becomes excessive before the slab reaches the end of its structural life, macrotexture can be improved through relatively inexpensive treatments such as saw-cut grooving.
Traffic also reduces the microtexture of the concrete surface by “polishing” the exposed aggregate surfaces. The hardness of the aggregate determines its resistance to polishing under traffic. Once compromised, microtexture cannot be restored through inexpensive treatments, and in most cases the only remedy is to overlay the surface. Therefore, it is essential that appropriate aggregate be used during initial construction of the slab. Since 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 traffic volume and site geometry. High traffic volume (AADT), braking traffic, or turning traffic will polish aggregate more quickly than straight rolling traffic. The *NYSDOT Standard Specifications for Construction and Materials* contains requirements for four types of friction aggregate; Types 1, 2, 3, and 9. Each type is intended for use under specific traffic and geometric conditions. The aggregate requirements are in addition to all surface texture requirements such as turf drag or saw-cut grooving. Increasing the macrotexture from these treatments does not compensate for using inappropriate aggregate.

If any portion of the bridge deck or approach slabs meets any one of the criteria listed below, use the Aggregate Type Selection table (Table 5-4) to determine the appropriate aggregate. If the bridge deck or approach slabs do not meet any of the criteria, use Type 9 aggregate. The designer shall specify only one type of aggregate for each bridge and its approach slabs by selecting the appropriate pay item.

- The deck or approach slabs are ≤ 500 ft. before a stop sign, traffic signal, or yield sign, as measured from the stop bar or yield sign.
- The deck or approach slabs are in a location where vehicles regularly queue regardless of distance from a traffic control device.
- The deck or approach slabs are ≤ 500 ft. from the point of curvature of a curve requiring reduced speed limit, chevrons, advisory speed, advisory curve or other warning signs or signals as defined in the *Manual of Uniform Traffic Control Devices (MUTCD)*.
- The deck or approach slab is ≤ 500 ft. before an exit ramp, as measured from the initiation of the taper for the deceleration lane.
- The deck or approach slab is ≤ 500 ft. after an entrance ramp, as measured from the terminus of the taper for the acceleration lane.
- The deck or approach slab is located on an entrance or exit ramp.
- Any location where the ratio of wet weather accidents to total accidents is greater than the state average for the same facility type.
In urban areas, if downspouts extend to the ground, and the potential exists for malicious damage, steel pipe may be used. Fiberglass downspout systems have more impact resistance than PVC systems.

Occasionally, downspouts have been encased in the substructure concrete. This practice should be avoided whenever possible, because it usually creates clean out problems and can also result in chloride damage to the concrete. If used, the installation shall include a 1 inch compressible protective covering between the pipe and the concrete to accommodate expansion of the pipe and shrinkage of the concrete.

Downspouts shall be placed at the least objectionable location by attempting to hide them from view behind columns. The surface below the outfall shall be protected by the use of a stone, concrete slab, or grouted block paving.

5.5 Deck Expansion Joints

5.5.1 Transverse Expansion Joints

Many deck joints and details have been used over the years, with varying results. The one constant result is that nearly all joint systems leaked after a short duration in service. Therefore, their use should be avoided whenever possible through the use of continuous spans, jointless abutments, and semi-integral or integral abutments.

Joint systems currently in use include armorless joints, armored joints and modular joints. See the current BD sheets for selection criteria for each joint system.

5.5.1.1 Armorless Joint Systems

Armorless joint systems are preferred for superstructure movement of 2½ inches or less. This range of movement has historically been handled by armored joint systems, which are no longer the preferred system (see Section 5.5.1.2). Armorless bridge joint systems are expected to alleviate many problems associated with armored joints and compression seals.

Armorless joint systems have been used by NYSDOT Bridge Maintenance for many years with excellent results. There are no skew limitations for armorless joint systems but skews over 45° require close attention to sizing criteria on the current BD sheets.

The elastomeric concrete used in armorless joint systems offers a durable header material that cures much faster than traditional concrete. This minimizes lane closure times, reduces Work Zone Traffic Control costs and shortens delays to the traveling public. Unlike traditional concrete, fresh elastomeric concrete bonds extremely well to previously placed fully cured material. It can be installed in segments, making it adaptable to stage construction as well as staged repairs or replacements. Elastomeric concrete headers shall not overhang the concrete slab.
The poured liquid sealant, closed-cell cross-linked foam seals or preformed seals of armorless joint systems are easily placed in their entirety or in segments. They require very little time to place and/or cure allowing restoration of traffic in a matter of hours.

When replacing only the existing armored joint and header for a minor rehabilitation and the opening between the deck and the backwall or deck slabs exceeds the maximum opening given in the BD sheets it may still be possible to use an armorless joint without doing additional deck work. If the maximum opening (set opening + design movement) does not exceed 5 inches an armorless joint can still be used.

### 5.5.1.2 Armored Joint Systems

Persistent maintenance problems with armored joints have been routinely encountered. During initial construction, proper consolidation of concrete under the horizontal leg of the armoring angle is difficult. The resulting voids lead to water collecting under the angle. When this water freezes it lifts up the armoring angle and increases the likelihood of snow plow impact.

An additional problem is corrosion of the steel angle. On the vertical face, corrosion creates a gap at the seal to angle interface which allows water to leak onto the superstructure and substructure elements below. On the horizontal face, corroding steel causes the concrete in contact with the angle to spall away, creating a larger gap for water to get under the angle. This causes leakage behind the angle in even when the seal remains watertight.

Repair of damaged armored joint systems is time consuming and difficult. Damaged compression seals cannot be repaired and must be replaced in their entirety. Typically the whole system needs replacing which requires removal and replacement of the concrete header and armoring angles. This requires jack-hammering, cutting out the steel angles, and placing new steel angles and concrete. The repaired section cannot be opened to traffic until the concrete has cured, requiring long term lane closures.

There are skew limitations for armored joint systems. See the current BD sheets for allowable skews and selection criteria.

### 5.5.1.3 Modular Joint Systems

Modular joint systems are used for larger movements. Single-cell modular joint systems may be used for up to 2 inches of superstructure movement. Multicell modular joint systems are used for superstructure movement over 2 inches. There are no skew limitations for modular joint systems but skews over 45° require close attention to sizing criteria on the current BD sheets.
Section 6
Bridge Railing

6.1 Introduction

The obvious function of bridge railing is to provide protection at the edges of structures for traffic and pedestrians. In performing this function, the railing must have the strength to withstand the vehicular impact and the geometry and details to safely redirect the vehicle without serious snagging or overturning. The decision of what type of railing to use is based on many factors including traffic volume, design speed, bridge geometry and the number of heavy trucks.

The development of any new railing and barrier systems must meet the requirements established in the AASHTO Manual for Assessing Safety Hardware (MASH) 2009. The MASH sets forth new crash test requirements and criteria for accepting railing systems. The current standard NYSDOT railing and barrier systems (as detailed in the Bridge Detail (BD) sheets) developed under NCHRP 350 are still approved and may continue to be manufactured and installed. Systems approved for use under NCHRP 350 criteria are not required to be retested using MASH criteria.

A good background reference that discusses bridge railing design issues is FHWA’s October 1998 manual, Improving Highway Safety at Bridges on Local Roads and Streets.

6.2 Types of Railing

The following is a list of the types of railing systems used by NYSDOT:

- **Traffic or Vehicular Railing** - A railing used for the purpose of providing a physical barrier to safely restrain vehicles on the bridge.
- **Pedestrian Railing** - a railing or a fencing system that provides a physical barrier for pedestrians crossing a bridge and of sufficient height to minimize the likelihood of a pedestrian falling over the system.
- **Bicycle Railing** - a railing or fencing system that provides a physical guide for bicyclists crossing a bridge and of sufficient height to minimize the potential for a bicyclist to fall over the system.
- **Combination Railing** - A bicycle or pedestrian railing system added to a traffic railing or concrete barrier system.
- **Vertical Faced Concrete Parapets** - a traffic barrier system of reinforced concrete, usually used adjacent to a sidewalk.
- **Permanent Concrete Traffic or Bridge Barrier** - a traffic barrier system of reinforced concrete having a traffic face which is a safety shape, single-slope, F-shape or Texas-type Barrier.
• **Transition** - a railing system which should provide a gradual change in stiffness from a flexible highway guide rail to a rigid bridge rail or concrete barrier or parapet.

### 6.3 Railing and Barrier Design for New and Replacement Bridges

#### 6.3.1 Service Levels

The first step in the selection of a railing/barrier system is to establish the proper design service level for the bridge. The service level is designated in terms of Testing Levels TL-1 thru TL-6 as defined in NCHRP 350 and AASHTO LRFD specifications. The previous system of service levels used performance Levels PL-1 thru PL-3. There is essential equivalency in the crash test requirements as follows:

<table>
<thead>
<tr>
<th>NCHRP 350</th>
<th>1989 AASHTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>TL-2</td>
<td>PL-1</td>
</tr>
<tr>
<td>TL-4</td>
<td>PL-2</td>
</tr>
<tr>
<td>TL-5</td>
<td>PL-3</td>
</tr>
</tbody>
</table>

The 1989 AASHTO Guide Specification contains warrants based on ADT, design speed, percentage truck traffic and horizontal and vertical geometry. Although there is an ongoing study to reevaluate these criteria, these warrants provide a rational basis for the railing/barrier selection.

The general descriptions of the service levels to be used are as follows:

**TL-2 (PL-1)**—Taken to be generally acceptable for most local and collector roads with favorable site conditions, work zones and where a small number of heavy vehicles are expected and posted speeds are reduced.

**TL-4 (PL-2)**—Taken to be generally acceptable for the majority of applications on high-speed highways, expressways and interstate highways with a mixture of trucks and heavy vehicles.

**TL-5 (PL-3)**—Taken to be generally acceptable for applications on high-speed, high-traffic volume and high ratio of heavy vehicles for expressways and interstate highways with unfavorable site conditions.

A recommendation of the service level will be made by the designer to the Deputy Chief Engineer Structures (D.C.E.S.) based on the general descriptions above and the NYSDOT LRFD Bridge Design Specifications unless a variance can be justified. The recommended service level will be shown on the preliminary structure plan tear sheet.
6.3.2 Railing/Barrier Design Alternatives

Once the appropriate service level has been established, some functional and geometric criteria need to be established. These criteria are discussed as follows:

**Under-crossing Feature** - Bridges over another highway or railroad must have either a concrete barrier or a curb. This is necessary to prevent roadway drainage from dropping onto the under feature. Bridges over waterways may use a curbless section if not on an interstate or other controlled access highway.

**Pedestrian Traffic (Sidewalk on Bridge)** - Bridges carrying a sidewalk must use a concrete parapet or four-rail railing at the fascia with a minimum height of 3’-6” above the sidewalk surface. It is presumed that bridges with a sidewalk do not carry bicycle traffic on the sidewalk. When a sidewalk is separated from vehicular traffic by a traffic railing, then a minimum 3’-6” high pedestrian railing or fencing must be used on the fascia.

**Pedestrian Traffic (No Sidewalk on Bridge)** - A railing or concrete barrier with a minimum height above the roadway of 3’-6” shall be used.

**Bicycle Traffic** - If a bridge bicycle railing is to be used, it shall be a railing or combination concrete barrier and railing with a minimum height of 3’-6” above the roadway surface.

The *Highway Design Manual* (Chapters 17 and 18) should be consulted for warrants to determine when bicycle or pedestrian railing should be provided.

Bridges that carry bicycles on a bikeway that is separate from vehicular traffic may use either of the bicycle/pedestrian railings shown on BD-RP2 or BD-RP3 on the fascia of the bridge. If a steel railing is used to separate the traffic from the bikeway then a rub rail(s) should be placed on the back side of the traffic railing to protect the bicyclists from the railing posts. Fencing can be used as an alternate to the standard details shown, but the posts and rails must be designed to withstand the loads specified in the *NYSDOT LRFD Bridge Design Specifications* for bicycle and pedestrian railing.

Table 6-1 shows the available railing and barrier options for the different design service levels. Current BD Sheets should be consulted for the details of the various systems.
<table>
<thead>
<tr>
<th>TL-2 (Less than 500 AADT)</th>
<th>TL-2 (Less than 1500 AADT)</th>
<th>TL-2 (Greater than 1500 AADT)</th>
<th>TL-4</th>
<th>TL-5 and Controlled Access Interstate</th>
<th>Controlled Access Non-Interstate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Thrie Beam (BD-RL1E)</td>
<td>1. Double Box Beam-Rail Curbless (BD-RL3E)</td>
<td>1. 2’-10” Safety Shape (BD-RC1E)</td>
<td>1. 3’-6” Single-Slope (BD-RC11E)</td>
<td>1. 3’-6” Single-Slope (BD-RC1E)</td>
<td></td>
</tr>
<tr>
<td>2. Double Box Beam-Rail Curbless (BD-RL3E)</td>
<td>2. Steel Three-Rail Curbless (BD-RS1E)</td>
<td>2. Steel Three-Rail Curbless (BD-RS1E)</td>
<td>2. 3’-6” F-Shape (BD-RC14E)</td>
<td>2. 3’-6” F-Shape (BD-RC15E)</td>
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<tr>
<td>5. Steel Five-Rail Curbless (BD-RS3E)</td>
<td>5. Steel Two-Rail with Brush Curb (BD-RS1E)</td>
<td>5. Steel Two-Rail with Brush Curb (BD-RS1E)</td>
<td>5. Steel Two-Rail with Brush Curb (BD-RS1E)</td>
<td>5. Steel Two-Rail with Brush Curb (BD-RS1E)</td>
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</tr>
<tr>
<td>7. Timber Rail (BD-RT1E)</td>
<td>7. 2’-10” Safety Shape (BD-RC1E)</td>
<td>7. 3’-6” F-Shape (BD-RC14E)</td>
<td>7. 3’-6” F-Shape (BD-RC14E)</td>
<td>7. 3’-6” F-Shape (BD-RC14E)</td>
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</tr>
<tr>
<td>8. 2’-10” Safety Shape (BD-RC1E)</td>
<td>8. 3’-6” Single-Slope (BD-RC11E)</td>
<td>8. 3’-6” Vertical Parapet (BD-RC2E)</td>
<td>8. 3’-6” Vertical Parapet (BD-RC2E)</td>
<td>8. 3’-6” Vertical Parapet (BD-RC2E)</td>
<td></td>
</tr>
<tr>
<td>9. 3’-6” Single-Slope (BD-RC11E)</td>
<td>9. 3’-6” F-Shape (BD-RC14E)</td>
<td>9. 3’-6” Texas-Type (BD-RC8E)</td>
<td>9. 3’-6” Texas-Type (BD-RC8E)</td>
<td>9. Timber Rail (BD-RT1E)</td>
<td></td>
</tr>
<tr>
<td>10. 3’-6” F-Shape (BD-RC14E)</td>
<td>10. 3’-6” Vertical Parapet (BD-RC2E)</td>
<td>10. Timber Rail (BD-RT1E)</td>
<td>10. Timber Rail (BD-RT1E)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. 3’-6” Vertical Parapet (BD-RC2E)</td>
<td>11. 3’-6” Texas-Type (BD-RC8E)</td>
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<tr>
<td>12. 3’-6” Texas-Type (BD-RC8E)</td>
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**Table 6-1**

Railing and Barrier Selection Table
6.3.3 Railing/Barrier Selection

6.3.3.1 Interstate and Controlled Access Highways

All new and replacement bridges and deck or superstructure replacements on interstate and other controlled access, high-speed highways shall use concrete bridge barrier (parkways without truck traffic and culvert structures are excluded). For interstate bridges, 3'-6" high F-Shape or single-slope barrier shall be used. For other fully or partially controlled access, high speed highways, designers should evaluate the required railing design service level according to Section 6.3.1 to determine if the service level is Test Level-4 and an 2'-10\” high concrete safety shape barrier can be used.

Exceptions to this guidance should be discussed and justified in the Design Approval Document and be approved by the D.C.E.S. Exceptions that will be considered are in the cases of a deck replacement when the existing superstructure is not adequate for the increased dead load associated with a concrete barrier or where a concrete barrier on the inside of curve would reduce sight distance to less than the allowable.

A number of recent accidents have involved tractor trailers penetrating steel bridge rail and causing severe damage and injury. There is a common misperception that steel bridge railing is designed to contain a heavy tractor trailer impact. In reality, the current standard two-rail and four-rail bridge railings are designed and tested to a Test Level-4, under NCHRP 350, to contain a 4400-lb pickup truck at 60 mph with a 25-degree angle of impact and an 18,000 lb single-unit van truck at 50 mph with a 15-degree angle of impact. The design standards for previous railing systems had significantly lower impact loads.

There are no known steel railing systems designed for an impact by an 80,000 lb tractor trailer (Test Level-5 level of service). It would be extremely difficult to design such a steel railing system because the impact force must be transferred to the deck at each post location. A concrete barrier is much more effective in that it distributes the force to the deck through the continuous deck/barrier interface.

6.3.3.2 Other Highways

The Railing and Barrier Selection Table (Table 6-1) lists the available choices for each design category. The first choice in most design categories is a concrete barrier or parapet. This preference is based on the concrete barrier’s strength, durability and low initial and maintenance costs compared to metal railing systems. Factors that may cause an alternative selection to be made are:

**Bridge Deck Drainage** - On bridges over waterways where concrete barriers would necessitate the use of scuppers, a curbless railing should be used. Generally, for most bridges it will not be necessary to use scuppers with concrete barriers. It is usually possible to carry the deck drainage off the ends of the structure without scuppers, unless the bridge becomes very long, wide or has a flat profile. The bridge deck hydraulics must be checked.
Aesthetics - In areas where the aesthetics of the railing/barrier is a prime concern, the Texas Type C411 concrete barrier is an option. However, the cost of this barrier is significantly higher than a standard barrier and its use is restricted to situations where a service level of TL-2 (PL-1) applies. A barrier with an outside face treatment using one of the many types of form liners should also be considered. Concrete cover and bridge width must be increased when form liners are used. Concrete barrier can be colored by staining the cured concrete for an aesthetic effect. Color added to the concrete mix is not recommended because of the variability of results. Exposed aggregate finishes should be avoided because of maintenance concerns.

A timber railing is also available for use in areas such as the Adirondack and Catskill Parks where a rustic appearance is desired. In certain situations it may be desirable to provide a view of scenic under features. An open railing system could be used in these situations.

Visibility - When intersections or driveways are close to the end of the bridge, an open railing system may be selected over a concrete barrier to increase visibility of oncoming traffic from the intersecting roadway. It should be pointed out that the visibility through the steel railings is limited and becomes even less with the addition of pedestrian fencing or permanent snow fence to the railing. This factor should only be a consideration in unusual circumstances.

Snow Accumulation - In areas with heavy snowfall, Regions sometimes consider using open railing on bridges over waterways to mitigate the effect of snow accumulation on the shoulders. The intent is to push snow through an open railing during snow plowing operations to reduce the need for maintenance forces to remove accumulated snow from the bridge shoulder. However, the ability to push snow through the relatively close spacing of the rails is limited at best. Bridges over highways and railroads will ordinarily carry a snow fence on the structure. Therefore, snow accumulation is usually not a factor in the railing/barrier decision on such bridges.

Geometric design policy for new and replacement bridges ordinarily results in a shoulder wide enough to permit snow storage. The factor of snow accumulation driving a decision to use open railing rather than a concrete barrier should occur only in unusual circumstances.

6.3.4 Weathering Steel Bridge Railing

Use of weathering steel for bridge railing to achieve a “rustic” appearance is no longer allowed because accelerated deterioration has been noted inside the railing tubes. In most cases, standard galvanized guide rail should be used. If a rustic appearance is required, timber bridge railing or painted galvanized steel may be used.
6.3.5 Transitions

Approved transitions from bridge railing and barrier to highway railing are shown in the BD – RC, RL, RS and RT series. If it is necessary to transition from corrugated beam highway rail to box beam highway rail (or vice versa), make the transition away from the bridge in accordance with the details shown on the Highway Standard Sheets. The purpose of bridge railing/barrier transitions is to provide a smooth transition from the rigid bridge rail to the flexible highway guide rail without forming a snagging pocket.

When driveways or other roadways are in close proximity to the end of the bridge and make the use of the full transition length impossible, the designer shall utilize as much of the transition as possible. The highway guide rail shall be terminated in accordance with the highway standard sheets where conditions permit.

6.3.6 Modifications

Modifications to any of the standard railing/barrier systems may be made only with the approval of the D.C.E.S. Any substantial modifications would generally require a crash test to qualify the system. This will also be determined by the D.C.E.S.

6.4 Precast Concrete Barrier

The Contractor has the option of constructing concrete barrier by one of three methods: cast-in-place, slip formed or precast. If the precast method is chosen, the Contractor must use one of the preapproved precast concrete barrier systems. The approved systems are listed on the Department’s Technical Services - Materials – Approved list. The approved systems are specific in their details, materials and method of attachment to the deck slab.

In certain circumstances the designer may wish to require the use of a precast concrete barrier system. In that event, the normal barrier pay item can be used, but a note on the plans should state that only the precast option is allowed. No details of the barrier reinforcement or anchorage should be shown on the plans. A note should be placed to state that the precast barrier must be one of the approved systems.

6.5 Pedestrian Fencing

On bridges over railroads or highways where there is a potential for vandalism from pedestrians, pedestrian fencing should be provided. The fencing is attached to the back side of steel railings, concrete barriers and parapets. It is located on the back side to minimize the potential danger from flying debris if a truck impacts the railing or barrier and leans into the pedestrian fencing. As an alternate, fencing may be mounted to the top of a barrier through a longer base plate or corbelled edge as long as the standard distance from the face of the barrier to the fencing is maintained. Details are shown on the BD Sheets.
Pedestrian fencing over railroads shall be carried a minimum of 20 ft. past the center line of any single track or from the centerline of the two most external tracks. If there is an off-track maintenance roadway adjacent to the tracks, the fencing should be extended a distance of 3 ft. past the edge of the maintenance roadway. If the required limits of pedestrian fencing over the railroad corridor beneath the structure are a significant portion of the overall structure length, the Region may decide to simply run the pedestrian fencing along the entire length of the structure.

Pedestrian fencing shall have a minimum height of 8 ft. as detailed on the current BD sheets and extend to a point 10 ft. beyond edge of the shoulder of the under roadway.

### 6.6 Permanent Snow Fencing

Structures with open railing that pass over a roadway should be equipped with snow fence in the area over the under roadway. The purpose is to retain and disperse the snow from snow plowing operations. Permanent snow fence should be chain link fence mounted to the back side of the railing. If used, the recommended height of snow fence is 4 ft. as detailed on the current BD sheets.

Bridges with concrete traffic barriers (2’-10” high) may need snow fence installed on the back of the barrier depending on local conditions. It is recommended that bridges over interstate highways have such fencing. Bridges with higher concrete barrier or parapet (3’-6”) ordinarily do not require snow fence. If used, permanent snow fence on concrete barrier should have a height of 2 ft. above the top of the barrier. Permanent snow fence should be installed on the back side of railing and barrier for the same reason discussed under Pedestrian Fencing. As an alternate, it can be mounted to the top with certain restrictions as discussed in Section 6.5.

Permanent snow fence should be used judiciously. It has the potential to create more problems than it solves (particularly on concrete barrier) and may be unattractive. When snow fence is used, it should extend to a point 10 ft. beyond the edge of the shoulder of the under roadway.
6.7 Railing/Parapet Design Dead Loads

The following uniform dead loads based on current BD sheets in lb/ft. can be assumed for design purposes:

- Two-Rail with brush curb (2'-1" wide) 210
- Four-Rail curbless 85
- Safety Shape Concrete Barrier 465
- Vertical Concrete Parapet 445
- Texas-Type Barrier 430
- Single-Slope Concrete Barrier 600
- F-Shape Concrete Barrier 585
- Timber Rail 75
- Single-Slope Median Barrier 715
- Single-Slope Median Wide Barrier 890
- Permanent Concrete Median Barrier (Type A) 410
- Permanent Concrete Median Barrier (Type B) 515
- Permanent Concrete Median Barrier (Type C) 610

<table>
<thead>
<tr>
<th>Table 6-2</th>
<th>Railing/Barrier Design Dead Loads (lb/ft)</th>
</tr>
</thead>
</table>

6.8 Guidelines for Railing Treatments on Rehabilitation Projects

6.8.1 Background

A majority of the bridge railings currently on NYSDOT structures have not been crash tested in accordance with NCHRP 350 criteria. As of October 1, 1998, these existing railings are considered nonconforming features and FHWA requires that they be considered when progressing a rehabilitation project on the structure.

6.8.2 Purpose

These guidelines identify a course of action that will allow the designer to address, in a uniform and consistent manner, the variety of situations encountered in rehabilitation project development and design. These rehabilitation guidelines will:

1. Identify the warrants to be considered in selecting a bridge railing treatment.
2. Categorize situations based on general work strategy.
3. Propose actions for the various categories.

4. Define project decision responsibilities and authorities.

Railing treatments on rehabilitation projects is a complex subject with many project specific considerations. Although these guidelines have been adopted, it is realized that they cannot cover every situation and engineering judgment will be required in their interpretation. A flow chart outlining these guidelines is shown in Appendix 6B.

6.8.3 Warrants

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 designer’s decision is based:

A. **Existing Bridge Railing** - age, original design criteria, materials, anchorage, snagging characteristics, vaulting causing features, discontinuities, transitions, fascia characteristics, maintenance concerns and other contributing factors.

B. **Required Design Service Level** - Federal and State standards for Design Service Levels as shown in Section 6.3.1.

C. **Roadway System** - NHS, non-NHS, 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 amount of damage to the bridge railing.

F. **Historic/Aesthetic Considerations** - community input, SHPO input, Regional 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. Approved transition details are shown on the Bridge Detail sheets which coincide with the appropriate bridge railing.
Section Eight
Structural Steel

8.1 Design

8.1.1 Design Methods

Structural steel has long been used as a bridge material in New York State. It continues to be commonly used and is the usual choice for spans over 115 feet. Structural steel design should be in accordance with the *NYSDOT LRFD Bridge Design Specifications* for all new and replacement bridges. The *NYSDOT Standard Specifications for Highway Bridges* may be used for rehabilitation of existing bridges.

Load and Resistance Factor Design (LRFD) is the required design method for all new steel structures designed in New York State. It introduces limit states as a design philosophy and uses structural reliability methods to achieve a more uniform level of safety. Factor of Safety is replaced with a new statistically based measure of safety called the Reliability Index “$\beta$”. LRFD requires a Design Reliability $\beta=3.5$, which provides for a notional failure probability of 1 in 10,000.

The LRFD code defines four design limit state categories:

- Strength Limit States - ensure strength and stability, both local and global.
- Service Limit States - impose limits on stress and deformation.
- Fatigue and Fracture Limit States - limit the liveload stress range under regular service conditions.
- Extreme Event Limit States - ensure the structural survival of a bridge during a major event such as a vessel collision, flood, earthquake, etc.

Within each category there are multiple limit states. Steel bridges shall be designed using Strength 1 (for moment and shear), Service 2 (overload, liveload deflection, bolted connections) and fatigue. A Strength 2 limit check of new girders utilizing the NYSDOT Design Permit Vehicle is also required.

LRFD introduces new live load criteria which will provide heavier loads on shorter spans and lighter loads on longer spans than are provided in the LFD specification.

**Service Load Design**, also known as **Allowable Stress Design (ASD)**, is the older and generally more conservative design method for medium to long bridge spans (over 100 ft). ASD achieves its factor of safety by limiting the stresses on the member to some percentage of the maximum stresses that the member could take before yielding. Since the dead load and live load stresses are considered at the same time, there is no provision for the certainty of the dead loads or the uncertainty of the live loads. As span lengths increase and dead loads become a much higher percentage of the total load, ASD becomes overly conservative and uneconomical.
Strength Design, also known as Load Factor Design (LFD), achieves its factor of safety by applying multipliers, or load factors, to the design loads. These multipliers increase the load effects, or stresses, applied to the member above those induced from the design loads alone. Since the dead loads are known, the load factor applied to them is relatively small. By comparison, live loads are highly variable and, therefore, the applied load factor is relatively large. The factored stresses are then compared to the yield stress, or ultimate capacity, of the loaded member.

The benefit of handling dead loads and live loads separately is that it provides a uniform factor of safety for live load in bridges of any span length. As span length increases and dead load becomes a larger part of the total load, LFD becomes increasingly more economical than ASD because of the smaller load factor applied to the dead load.

LFD must always be checked for deflection and serviceability criteria. Designers are cautioned that at very long span lengths, typically in excess of 400 ft., LFD may not provide adequate reserve strength capacity in the bridge.

8.1.2 Analysis Methods

Straight girders should ordinarily be analyzed by the line element method. Only in very unusual circumstances should it be necessary to analyze a straight girder bridge by a grid, three-dimensional or finite-element analysis. The marginally increased refinement in the analysis offered by these techniques does not usually justify their substantially increased design effort. This conclusion is justified in large part by the fact that design loadings are only an approximation of actual traffic loads.

However, in some instances these more exact methods are justified. They are required for bridges with girders that have enough curvature to meet the requirements for curved girder analysis as defined by AASHTO. Some straight girder bridges that have extremely large skews (in excess of 45°), unfavorable continuous span arrangements, or faying girders (secondary girders framed to main girders for unusual geometric situations) may be candidates for a more exact analysis.

8.1.3 Design Considerations

The LRFD specification increases the role and responsibility of the designer to anticipate construction related issues and be aware that stresses during erection or construction are sometimes the controlling conditions of design. Examples of conditions that need to be checked are the erection of the girder and the placement of the concrete deck, both of which occur when there is a long unbraced compression flange. The designer should refer to Article 6.10.3 of the NYSDOT LRFD Bridge Design Specifications for requirements for stability checks.
8.9 Camber

Design cambers include: structural steel dead load, concrete dead load, superimposed dead load, vertical curve, and total of the above. The dead load from a future wearing surface shall be included in the determination of camber. When cambers vary between girders due to differing concrete slab loads, concrete placement sequence, or stage construction issues, they shall be shown separately in the table.

A camber table and camber diagram shall be shown on the plans. See the current structural steel Bridge Detail (BD) Sheets for details.

If a steel member is designed with no camber, a note shall be placed on the plans instructing the fabricator to place the mill camber up.

8.9.1 Sag Camber

By definition, a girder is said to have sag (or negative) camber if any portion of the curve formed by the top of web in the completed structure falls below a working line constructed through the top of web points at the girder ends.

Note that all intermediate support points are ignored when applying the above definition. The designer's attention is directed to the fact that sag camber can be introduced into a girder from superstructure geometry other than from a sag vertical curve. These other conditions include any superstructure (straight or curved) in which a superelevation transition length occurs within the span, or a horizontally curved superstructure supported on straight girders.

Girders with sag cambers are to be avoided because their unstable appearance is aesthetically objectionable. An exception to this policy may be made when the under feature of the structure is a waterway. This exception recognizes a reduced concern for aesthetics.

Designers may find that approved geometrics for a bridge project have not considered the Office of Structures' policy regarding sag cambers. If this condition exists, the Designer shall use the following guidelines to minimize the effect or eliminate, when possible, designing a sag cambered superstructure.

1. Investigate the possibility of revising the geometrics (i.e., modifying or relocating the sag vertical curve and/or modifying or relocating the superelevation transition off the superstructure). In those cases where a deeper haunch is required, the 8” reinforced haunch should be used in conjunction with a sag camber.

2. If a revision of the geometrics is not possible, a variable haunch shall be introduced to eliminate the need for the sag camber. The depth of haunch for this purpose shall be limited to a nominal 8”.
8.10 Moment, Shear and Design Load Tables

A table showing moment, shear, and design loads shall be provided on the plans. See the current structural steel BD sheets for details. Moments and shears shall be given at the same intervals as the camber table. Moments and shears for AASHTO HL 93 and the NYSDOT Design Permit Vehicle need to be shown separately.

8.11 Splices

8.11.1 Girder Splices

Girder details for all LRFD projects with spans of more than 140 feet or where a splice is otherwise required shall be prepared with field splice locations and splice design details shown on the plans. Details and location access constraints control the erection procedure. However, designers must always assure themselves that girders can be field spliced following the criteria shown in this section.

In the design of long stringers and girders, simple or continuous, straight or curved, consideration should be given to the need for field splices. Bolted field splices are preferred over welded field splices, because of substantial savings in time and money. Fill plates are not allowed.

Except for those cases where it is obvious that no field splice will be required (span lengths less than 130 ft. for straight or large radius curved members), the flanges should have sufficient excess area at points where splicing is anticipated to permit a bolted splice to be made.

Splice locations are generally selected near points of dead load contraflexure and where there is sufficient flange area to permit hole drilling while still maintaining the required net area.

DESIGN

General Practice

For simple spans or continuous spans where the total girder is less than 140 ft. in length, the girder may be assumed to be erected as a single segment and no splice design will be necessary.

For simple spans greater than 140 ft. in length, the preferred location for the splice, based on load considerations only, is at the one-third point.

For continuous spans greater than 140 ft. in length, the preferred location for the splice, based on load considerations only, is near the dead load contraflexure point. Note that on longer structures the points of dead load contraflexure can be greater than 140 ft. apart, in which case the preferred locations would be where the size of the splice and number of bolts is minimized.
Additional constraints on splice location include the following:

- The minimum distance from a flange plate transition groove weld to the nearest flange splice bolt hole or lateral gusset plate bolt hole is 12 inches.
- The centerline of field splice shall be located >5 feet from a flange plate transition groove weld.
- The minimum distance from a lateral gusset plate to the end of a flange splice plate is 6 inches.
- The minimum distance from a stiffener or connection plate to the end of a flange splice plate is 12 inches.
- The minimum distance from a stiffener or connection plate to a groove welded splice in either the flange or web is 6 inches.

As is current practice, the compression flange must be designed considering the steel dead load acting on the unbraced length (before diaphragms are attached). Refer to Section 8.4.2.5 for requirements for stability of the structural steel during transportation and erection.

It is preferable to group the design of the splices at any splice location by designing all splices using the heaviest section or greatest moment rather than vary the splice designs across the structure. This avoids confusion and possible construction problems, and should provide the most economical solution. In addition, it is preferable to have one design for all splice locations rather than having a different design at each splice point.

**Vertical Clearance**

When locating the splice, the designer shall consider the effect of the splice on vertical clearance. Vertical clearance at the splice location will be reduced by the bottom flange splice plate, washer, nut and free end of bolt (see AISC table titled “Entering and Tightening Clearances”). If the splice affects minimum or critical vertical clearance, the designer shall show the revised minimum or critical vertical clearance on the plans. Vertical clearance issues may control the location of splices.

**Erection**

Erected and spliced segments must be statically stable. Depending on the span arrangement, this may require the use of falsework or splicing of the girder on the ground. Note that when a girder is spliced on the ground the unbraced compression flange length may increase. The girder must be stable during all phases of erection and construction.

Structures which are difficult to erect (e.g., tub girders, long simple spans) should show a suggested method of steel erection in the Contract Plans. This is required because the Contractor is responsible only for additional stresses caused by their erection scheme, and the Contractor may assume the simplest erection method possible if none is shown on the plans.
Falsework

A generalized falsework schematic should be shown on the plans when it is required for stability of the compression flange or stability of the structure. When falsework is required, the designer must get approvals from the appropriate agencies. The Rail Unit, Real Estate or Highway Design (for Temporary Traffic Control) may typically need to be contacted. Railroads will not allow falsework within the track zone and also may not allow any splices above the tracks. Maintenance and Protection of Traffic issues may also control the location or use of falsework. Design of the falsework is the responsibility of the Contractor, subject to the approval of the D.C.E.S.

Shipping

The maximum shipping length is 140 ft. based on permitting and geometric limitations. The maximum girder depth is typically 14.0 ft., although depths up to 16 ft. may be used in special circumstances with the approval of the Metals Engineering Unit. The issue of special hauling permits is typically handled by the fabricator and is controlled by weight of the girder segment and the configuration of the truck and trailer used. The maximum shipping weight of a segment is 100 tons.

Cranes

For typical structures, the designer may assume the maximum single crane pick is 100 tons. Nearly all structures constructed for the Department are erected by a single crane of this type. For structures which require larger or multiple cranes to erect, contact the Metals Engineering Unit for assistance. When splicing needs to be done before erection it should be noted on the plans so the Contractor is aware of the possible need for a larger (or multiple) crane(s) at bidding.

Additional Items

A High-Performance-Steel simple span may be long enough to require the use of two field splices.

Falsework up to 16 ft. in height may be assumed to cost $5,000 per location for typical 40 to 50 feet wide structures. It is preferable to avoid the cost of these temporary structures and strengthen the compression flanges if the cost is similar.

Fracture-Critical Members shall have splice plates constructed from Fracture-Critical material.

Design Calculations

Bolted designs shall use ASTM A325 bolts only. Bolts should be designed as per the NYSDOT LRFD Bridge Design Specifications and the NYSDOT Steel Construction Manual (SCM). Bolts must be designed both for strength and for slip-critical loading using Class A surface conditions unless otherwise approved by the D.C.E.S. Bolt lengths shall be such that threads are excluded from the shear planes in the connection. Designers should reference NYSDOT SCM-Section 2 on bolting and splices (including fill plates, as appropriate). Use 7/8 inch bolts for typical girder splices. Unusual structures may require a larger bolt size.
Weathering steel is recommended for trusses because of its superior toughness. See Section 8.2.3 for painting guidelines. Galvanized steel may also be an option for trusses.

8.14.2 Truss Design Guidelines

Geometry:

Truss and member proportions should follow the guidelines provided in the NYSDOT LRFD Bridge Design Specifications or the NYSDOT Standard Specifications for Highway Bridges.

Sections:

Designers should keep variations in member shapes and sizes to a minimum. To achieve this objective, it is often desirable to establish a constant out-to-out dimension for all chord members. Based on past experience, it is frequently more cost effective to use fabricated members than rolled sections because of their tighter tolerances. Rolled sections may vary for “tilt” and “in-out” by more than \( \frac{3}{16} \) in. and sometimes require further work to bring them into the necessary tolerances.

Designers should use closed box sections for bottom chords whenever possible. Although closed box sections are more expensive to fabricate, they eliminate the long term maintenance and durability concerns associated with H-shaped sections. H-shape sections tend to trap debris and moisture.

Framing:

The floor system framing of trusses should be designed as simply supported although it is recognized that some negative end moments can and probably will develop. This should be considered when designing fatigue resistant details.

Stringers should be framed from floorbeam to floorbeam. Stringers that run continuously over the tops of floorbeams have led to uplift and fatigue problems. Additionally, consideration should be given to framing stringers below the plane of the floorbeam top flange to eliminate the cope at the top of the stringer.

Internal Diaphragms:

Designers shall include internal diaphragms within fabricated closed box chord sections. These diaphragms are to be located at panel points, and elsewhere where required by design.

Camber:

Because the steel fabrication industry prefers assembling trusses in a fully cambered position, (i.e.: member lengths adjusted for deadload and vertical curve cambers), designers are advised to evaluate the secondary force effects which will arise when the truss is fabricated in this fashion. It should be noted however, that these secondary force effects are generally minor when the truss proportions follow the guidelines provided in the NYSDOT LRFD Bridge Design Specifications or the NYSDOT Standard Specifications for Highway Bridges.
Gusset Plates

Design guidance for gusset plates can be found in Structure Design Advisory 08-001 (LRFD) and load rating guidance can be found in Technical Advisory 09-001 (LFD).

8.14.3 Truss Detailing Guidelines

Floor beam to truss connections should be blocked and never coped.

Details should be used that allow accessibility to make field bolted connections. Hand holes in the bottoms of closed box sections will be needed for erection purposes. These holes shall be protected with screening to prevent roosting birds from entering.

Details that allow accessibility for cleaning and high pressure washing are desirable.

Fill plates in bolted connections are sometimes necessary. Fillers greater than or equal to ¼” thick shall be designed in accordance with Section 6.13.6.1.5 of the NYSDOT LRFD Bridge Design Specifications.

Use Category “C” or better welded fatigue details on all fracture critical members.

Internal diaphragms on closed box sections should be detailed as being fillet welded to three sides, and tight fit to the fourth.

Designers shall include the following information on the contract plans, to facilitate the quality assurance review of the steel fabrication drawings:

- Table of Fracture Critical Members
- Table of LRFD Member Forces: DC1, DC2, DW, LL + Impact (AASHTO HL-93 and NYSDOT Permit Vehicle)
- Truss Camber Diagram: Provide the lengths members must be lengthened or shortened to compensate for dead load and vertical camber. Dimensions provided should include total unfactored deadload (DC1 + DC2 + DW) and vertical curve camber.
- Truss Working Lines Diagram: Provide member lengths (with horizontal components adjusted for grades greater than 3%), and offsets to datum for grade.

8.15 Miscellaneous Details

8.15.1 Bolsters

Bolsters are steel supports placed beneath the girder and above the bearing. They are typically used at piers when two spans have different depths. In new construction it is almost always preferable to step the concrete of the cap beam or pedestal instead of using bolsters. For aesthetic reasons it may be appropriate to investigate alternative designs that would not have adjacent spans with different girder depths. (See Section 23.)
• No intermediate diaphragms are required for spans up to 65 ft. Midspan diaphragms are required for spans greater than 65 ft., and up to 100 ft. Spans greater than 100 ft. require diaphragms at the third points.
• For superstructures with cross slope greater than 4%, AASHTO I-beams should be considered. These shapes have narrower top flanges, which will eliminate the need for large haunches.

9.4 Segmental Precast Box Girders

Segmental precast box girder superstructures may be viable and economical alternates for the following type of structures:

9.4.1 Long Multi-Span Bridges

Segmental precast box girders are well suited for long multi-span bridges on straight or slightly curved alignments in locations where Temporary Traffic Control issues and/or environmental concerns require that field work be minimized. Repeated use of an erection set up for the box girder segments is the main advantage. The Span-by-Span method of erection is generally used for these bridges.

9.4.2 Long Span Bridge on High Curvatures

Segmental precast box girders are well suited to accommodate high curvatures on long spans due to their high torsional stability. The balanced cantilever method of erection is generally used for these bridges.

9.4.3 Aesthetics

When long open spans with clean visual lines are desired, segmental precast box girder superstructures are a good solution. Haunching of the segmental girders to improve the visual impact and structural efficiency is possible with this type of superstructure.

9.4.4 Durability

The expected durability of segmental box girder bridges is relatively high. Segmental precast box girder bridges utilize post-tensioning in both the longitudinal and transverse directions to be free of tensile cracks. This results in an expected substantial increase in the durability of the overall structure. However, there are areas of vulnerability unique to this type of bridge.

1. Since the deck slab is an integral part of the box girder system, the complete replacement of the bridge deck is nearly impossible. To reduce this risk, the structure should be designed so there is no tensile stress at the top surface of the segment under service load conditions both including and excluding time dependent effects.
2. Deck run-off should not be allowed to flow over the grouted block-outs for tendon anchorages. When end anchorages are located in vulnerable areas, such as beneath a deck expansion joint, additional protective measures shall be provided. Post-tensioning ducts within the deck shall be polyethylene. Fabrication and erection of these structures shall be as per the *Prestressed Concrete Construction Manual* (PCCM).

### 9.5 Bearings for Prestressed Concrete Structures

All new prestressed concrete superstructure designs, with the exception of those using integral abutments, require elastomeric bearings of sufficient thickness to ensure that the bottom of the prestressed unit will be above the bridge seat a minimum of ⅝" for box beams and ½" for slab units. Cement mortar pads shall not be placed under the bearings.

For rehabilitation projects that require mortar pad replacement, the designer should choose one of the following alternatives:

- Replace the existing elastomeric bearings and mortar pads with thicker elastomeric bearings.
- Replace the mortar pad with a galvanized steel plate of equivalent thickness.
- Step the bridge seat or pedestal to an elevation sufficient to provide the necessary clearance (This option will normally require the use of Class DP Concrete, as specified in Section 582 of the *NYSDOT Standard Specifications for Construction and Materials*).

When choosing an appropriate alternative, the designer should strive for the most cost effective solution.

Bearings must be placed perpendicular to the centerline of the unit. The bearing width, at a minimum, must be ½ the width of the unit measured perpendicular to the centerline of the unit.

When the height difference across the width of the bearing due to camber and grade is in excess of the limitations set in the design specifications, then a tapered bearing (for adjacent box or slab units) or a constant thickness bearing with a tapered sole plate (for Bulb Tees and AASHTO I-beams) matching the required slope must be used.

### 9.6 Concrete Strength

High-Performance Concrete shall be the standard concrete for prestressed bridge elements. The minimum concrete strength $f'_{c}$ for prestressed concrete bridge beams shall be 10 ksi. The concrete strength at transfer $f'_{a}$ can be taken as 0.7$f'_{c}$ unless the designer determines a higher transfer strength is necessary.

### 9.7 Prestressing Strand Type

Only 270ksi Low-Relaxation Prestressing Steel Strand shall be used. The standard diameter used by NYSDOT is 0.6 inch. Other diameters are available, but may only be used with
approval of the D.C.E.S. Strength requirements and areas for the strand are available in ASTM A416.

9.8 Strand Pattern for Pretensioned Elements

9.8.1 Precast Box and Slab Units

A 2” x 2” center to center grid pattern shall be used for the prestressing strands in prestressed concrete beams. Strands shall not be placed within 2” of the centerline of the beam to provide room for the anchor dowel holes at the end of the beam. Strands shall not be placed such that they will conflict with the transverse tendons or tendon recesses. For additional information, see the appropriate BD sheet.

Prestressing strands shall be distributed evenly across a row to achieve uniform pretensioning in the end zones. Clustering of strands in the bottom corners of beams should be avoided as the uneven stresses can cause distortions to the beam. This is especially critical in longer beams with large skews.

9.8.2 Precast I-Girders

Prestressing strands are arranged in a 2” x 2” grid pattern as shown on the appropriate BD sheet. Prestressing strands shall be distributed evenly across a row to achieve uniform pretensioning in the end zones.

9.9 Tensile Stresses Due to Pretensioning

If higher than allowable tensile stresses are encountered during the design of prestressed members (usually at the top surface of the beam ends) the following design modifications are suggested in the order of preference:

1. Rearrange the strand pattern, including addition of strands near the surface exhibiting excessive tension. In general, four fully tensioned strands is a reasonable maximum number of strands to be placed near the tension surface for slab units. For box units, six is a reasonable maximum. For Bulb Tees and AASHTO I-Beams, 20% of the total number of strands (not including draped strands) is a reasonable maximum. In all cases, engineering judgment is required.

2. Drape strands for I-Girders (Bulb Tees and AASHTO I-beams).
   
   Note: Where draped strands are used, the total hold down force of all draped strands shall not exceed 75% of the total beam weight.
   
   Note: Prestressing strands in slab units or box units shall not be draped.

3. Debond some prestressing strands at the end of the unit to avoid excessive end stresses. Typically, this is accomplished in the fabrication plant by wrapping strand with a plastic sheath to prevent the bond from developing between the concrete and the prestressing strand.
When debonding of prestressing strands is required, design shall be in accordance with the NYSDOT LRFD Bridge Design Specifications with the following criteria:

a. The maximum allowable number of debonded prestressing strands is 25% of the total number of strands.
b. No more than 40% of the number of prestressing strands in any one row may be debonded.
c. The debonding pattern shall be symmetrical about the beam centerline.
d. The spacing of debonded strands shall be a minimum of 4”.
e. The outermost prestressing strands in a row shall not be debonded.
f. The debonded length(s) shall be clearly detailed on the contract plans. A maximum of four prestressing strands are permitted to be debonded for a given length. A minimum difference of 2’-0” is required between debonding lengths.
g. Do not debond prestressing strands in units 1’-3” or less in depth.

4. Provide a reasonable amount of bonded reinforcement as per the provisions of the design specifications.

9.10 Prestress Losses

Loss of prestress is the difference between the initial tensile stress in prestressing tendons at the time the strands were seated in their anchorages, and the effective prestress at a particular time at the considered location.

Losses that apply to both pretensioned and post-tensioned elements are Concrete Shrinkage, Elastic Shortening, Concrete Creep, and Steel Relaxation. Losses that apply only to post-tensioned elements are Anchorage Set and Friction (for drape and wobble). Computation of the losses shall be as per the applicable provisions of the design specifications.

**Concrete Shrinkage** - Shrinkage, after hardening of concrete, is the decrease with time of concrete volume. The decrease is due to changes in the moisture content of the concrete and physical-chemical changes, which occur without stresses attributable to actions external to the concrete. Shrinkage is conveniently expressed as a dimensionless strain under steady conditions of relative humidity and temperature.

**Elastic Shortening** - The concrete beam shortens at transfer when the prestressed strands are released and the force in them is transferred to the concrete. This elastic shortening is immediate and results in a reduction in the strain of the prestressing steel and therefore a prestress loss. The loss from elastic shortening should be included in both initial and total loss computations.

**Concrete Creep** - The time dependent increase of strain in hardened concrete subjected to sustained stress is defined as concrete creep.

**Steel Relaxation** - Steel relaxation is very similar to concrete creep. With steel relaxation the length of the strand is held constant under stress and there is a time dependent loss in stress.
The minimum distance from the center of a pile to the nearest footing edge should be 1'-6". The minimum distance from the edge of a pile to the nearest footing edge shall be 9". The minimum distance from the center of a pile to the nearest edge of the capbeam shall be 1'-6". The minimum distance from the edge of a pile to the nearest edge of the capbeam shall be 1'-0".

The tops of C.I.P. piles shall be embedded 6" into the footing. The tops of all other piles shall be embedded 1'-0" into the footing. Additional embedment requirements apply to integral abutments (see Section 11.6.1.6).

When a pier is composed of steel H-piles extending above the ground surface and embedded directly into a concrete capbeam, the piles shall be embedded a minimum of 2'-0" into the capbeam. The same embedment applies to C.I.P. piles unless the pile reinforcement projects into the cap. In this case, the embedment shall be 1'-0".

The front row of piles (at the toe) of all abutment and wall footings shall be battered. The outside rows of piles of all pier footings shall be battered. Minimum batter is 6 on 1; however, analysis may indicate that a greater batter is required. The maximum batter shall be 3 on 1. If a critical clearance problem exists (e.g., underground utilities), it may be possible to place some piles vertical that would ordinarily be battered. In this case, the Office of Structures' Foundations and Construction Unit should be consulted. Horizontal forces must be resisted through a combination of the horizontal component of a battered pile and the lateral resistance of the soil to the pile. Lateral resistance of piles is specified in the Foundation Section of the latest *NYSDOT LRFD Bridge Design Specifications* unless modified in the FDR.

11.1.4.3 Numbering and Tabulation of Piles

All piles used in a structure shall be numbered on the plans. The pile numbering shall begin with the number one (1) and proceed continuously through all piles in that substructure unit. The pile numbers shall restart with the number one (1) for each different substructure unit encountered.

In order to record the actual driven length, a table shall be placed on the plans for each different substructure unit. The table shall include a column titled “PILE NO.” and a column titled “LENGTH BELOW CUT-OFF.” The length below cut-off of each pile shall be filled in by the E.I.C.

11.1.4.4 Pile Splices

Steel H-piles shall be spliced using complete penetration groove welds or mechanical splices. Mechanical splices cannot be used on piles subject to uplift loads. The shells of C.I.P. piles shall be spliced by welding. If stated in the FDR, C.I.P. piles may be spliced mechanically, although mechanical splices still require a seal weld. Mechanical splices are not permitted on C.I.P. piles in integral abutments because they may be subject to bending.
When the estimated length of pile exceeds 30 ft., the designer's estimate shall allow for at least one-half the total number of piles to be spliced. This is a contingency to cover the situation where the actual length of driven pile exceeds the estimated length by more than 10 ft.

Details of pile splices and reinforced tips are shown on the current BD sheets. These details shall be included in the contract plans.

11.1.5 Drilled Shafts

Drilled shafts are typically used as an alternative to piles. They are capable of carrying very large loads. Drilled shafts are usually advanced with a steel casing, although a slurry solution is sometimes used to keep the excavation open. The FDR may require that the shaft be socketed a minimum distance into bedrock to develop the necessary skin friction to support the applied loads. When the shaft is excavated, reinforcement is placed and the shaft is filled with concrete.

11.1.6 Pilasters

Pilasters are typically square concrete columns that are used when rock is located too near the surface to drive piles. They are capable of handling very large loads. Pilasters are usually constructed in an open excavation down to bedrock and may be socketed into bedrock a minimum distance.

11.1.7 Design Footing Pressures and Pile Capacities

Notes that specify either the maximum foundation pressure for spread footings or the maximum allowable pile load and ultimate pile capacity for pile foundations shall be shown on the contract plans. The wording and format of these notes are given in the FDR. For spread footings on rock, the actual design bearing pressure shown on the plans should be rounded to the nearest one-half ton/ft².

11.1.8 Footing Depth

The depth to which footings are carried below the ground surface is usually determined by three factors: frost depth, scour action, and foundation type.

Frost heaves in soil can cause displacement of the footing and damage to the structure. Spread footings founded on soil shall have their bottom of footing a minimum of 4 ft. below finished ground to assure that the bottom of the footing is below the maximum frost penetration. Spread footings on rock are not susceptible to frost heaves and, therefore, do not require the minimum 4 ft. depth. Spread footings on soil are not ordinarily used near water because of their vulnerability to scour action. If they are used near water, however, their bottom of footing needs to be well below any potential scour depth and special protective measures may be needed.
11.5.1.6 Gravity Retaining Wall

Gravity retaining walls are large masses of concrete or masonry that have nominal to no structural reinforcement in the back face of the stem. This type of retaining wall depends on its own large self weight to provide the lateral support and resist overturning forces. A large plan area at the base provides bearing on the soil or it may be pile supported. This type of retaining wall is usually no longer used for new bridges by NYSDOT.

11.5.1.7 Semigravity Retaining Wall

A semigravity retaining wall resembles a gravity retaining wall except the stem is somewhat thinner and vertical structural reinforcement is provided in the back face of the stem. The foundation uses either spread or pile supported footings. This type of retaining wall is no longer used for new bridges by NYSDOT.

11.5.1.8 Internally Stabilized Fill Type Retaining Walls

Mechanically Stabilized Earth System (M.S.E.S.) retaining walls consist of interlocking concrete shapes that create a wall face. Each of the concrete shapes has a soil anchoring system that mechanically reinforces the retained embankment and uses the weight of the fill as the stabilizing force to hold the panels in place. The efficient height range of walls of this type is 10 ft.-65 ft.

Geosynthetic Reinforced Soil Structures (G.R.S.S.) are similar to M.S.E.S walls, in that layers of geotextile membrane are covered with soil. In place of the interlocking concrete shapes in M.S.E.S. walls, the exposed face of the embankment is formed by folding the lower layer of reinforcing geo-grid over the top of the layer of fill that covers it. Subsequent layers of geo-grid and soil are placed and compacted until the desired height of the embankment is reached. The efficient height range of walls of this type is 5 ft.-35 ft. See Section 11.6.1.4 for more information on M.S.E.S. systems.

Mechanically Stabilized Wall Systems are a combination of M.S.E.S. and G.R.S.S. In this case, layers of geotextile membrane are covered with soil and anchored between prefabricated modular blocks that make up the exposed face of the embankment. Subsequent layers of block and reinforcing geo-grid are placed and compacted until the desired height of the embankment is reached. The efficient height range of walls of this type is 5 ft.-35 ft.

11.5.1.9 Cantilevered Sheet Pile Retaining Wall

Cantilevered sheet pile walls consist of a series of interlocking structural shapes that are set into the ground to a sufficient depth to mobilize enough passive earth pressure to withstand the active pressure from the retained soil. The structural shapes are most commonly made of steel and driven into the ground. Concrete shapes have also been used and jetted in place. Cantilevered sheet pile retaining walls are commonly used by NYSDOT for both temporary and permanent conditions. The efficient height range of walls of this type is 5 ft.-15 ft.
11.5.1.10 Tied Back Sheet Pile Retaining Wall

Tied back sheet pile walls consist of a series of interlocking structural steel shapes that are driven into the ground to a sufficient depth so as to mobilize enough passive earth pressure to withstand the active pressure from the retained soil at the bottom, and utilize a tie-back or anchored bulkhead system to support the top of the sheet piling. This type of retaining wall is commonly used by NYSDOT for both temporary and permanent conditions. The efficient height range of walls of this type is 15 ft.-65 ft.

11.5.1.11 Soldier Pile and Lagging Retaining Wall

This retaining wall consists of two main structural parts, the piles and the lagging. The piles are driven into the ground or set into augured holes at regular spacings and to a sufficient depth so as to mobilize enough passive earth pressure to withstand the lateral load from the retained fill. That lateral backfill load is transferred to the piles through the lagging which spans horizontally between the piles and behaves like a simple beam between two supports. The piles are commonly steel H-piles and the lagging could be heavy wood timbers or precast concrete panels. This type of retaining wall is commonly used by NYSDOT for both temporary and permanent conditions. The efficient height range of walls of this type is 5 ft.-15 ft.

11.5.1.12 Tied Back Soldier Pile and Lagging Retaining Wall

Similar to a normal soldier pile and lagging wall with the addition of a tie back system. The piles are driven into the ground or set into augured holes at regular spacings and to a sufficient depth so as to mobilize enough passive earth pressure to withstand the lateral load from the retained fill at the base of the excavation. The tie back system supports the top of the retaining wall. This type of retaining wall is commonly used by NYSDOT for both temporary and permanent conditions. The efficient height range of walls of this type is 15 ft.-65 ft.

11.5.2 Proportioning of Cantilevered Retaining Walls

Since the cantilevered retaining wall is by far the most common type of retaining wall used, it is important to achieve as much efficiency in its design as possible. In general, the width (B) of the footing should range from 0.40 to 0.60 times the height (H) of the wall above the top of the footing. The B/H ratio is closer to 0.40 when the bearing soil is firm or when the footing is on piles. The B/H ratio increases as the quality of the bearing soil and coefficient of friction decreases, and the slope of the fill and any other surcharge behind the wall increases. The distance from the centerline of the wall stem to the front edge of the footing (D) should be approximately 0.30 to 0.50 times the width of the footing. The footing thickness (T) is generally between 0.10 and 0.15 times the height of the stem but should always meet the minimum footing thickness requirement for the type of foundation selected. The stem thickness (t) should be at least 0.10 times the height for an economically reinforced section.
to keep the bridge seat free of soil. Although no longer commonly used, spill through abutments may be encountered on rehabilitation projects.

11.6.1.4 Mechanically Stabilized Earth Systems (M.S.E.S.) Abutments

M.S.E.S. abutments consist of a mechanically stabilized earth wall embankment supporting a short or stub abutment on top of the retained soil. Further information on M.S.E Systems is contained in Section 11.5.1.8. M.S.E Systems are to be installed and paid for according to the provisions of the Fill Type Retaining Wall items. M.S.E. Systems are the only kind of Fill Type Retaining Wall currently approved to support an abutment as shown in the BD sheets. Concerns about the response of this system to a seismic event have been satisfied by additional experience and AASHTO design specifications. Designers may consider the use of this system where site conditions are appropriate.

Guidelines for Use:

This type of abutment system is most efficient when the height of the wall supporting the bridge abutment is 15 ft. or greater. When the use of this system includes wingwalls and/or retaining walls the average height of the entire system should be 10 ft. or greater.

- The project site should be predominately a fill area. If extensive excavation is required, this type of system would be inappropriate.
- Utilities of any nature shall not be placed within or underneath the reinforced zone.
- If the project site involves a railroad, the railroad must approve the use of this type of system. A copy of the railroad’s acceptance letter of this type of construction should accompany the Structure Justification Report submitted to the Office of Structures.
- In waterway areas where the anticipated depth of scour falls below the concrete leveling pad, the use of this type system within the affected waterway area will not be approved. If the concrete leveling pad is founded on sound rock or the M.S.E.S can be located a substantial distance from the affected area of scour, the use of this system could be considered.
- Additional guidance for the use of M.S.E.S. can be found in Article 11.10 of the NYSDOT LRFD Bridge Design Specifications.
- When considering the use of M.S.E.S. for abutment support, the designer should consider the height of the M.S.E.S as well as the sensitivity of the proposed structure to differential settlement or differential movement. The designer should be aware that M.S.E.S. fills are not rigid structures, and are designed to deflect slightly vertically and laterally under load. Movement of the wall may be due to the soils beneath the wall, and/or the compacted backfill. The risk of settlement and differential movement typically increases with height. Due to the potential of larger vertical and lateral movements with taller walls, it is not desirable to place abutments behind M.S.E.S. walls when the M.S.E.S. wall height exceeds 25 – 30 feet.
- The bottom of footing shall be as shown on BD-EE13E. It cannot be placed 4 feet below grade because of interference with the wall straps. This is acceptable because the gradation of the backfill will not allow development of frost heaves.
Design Guidelines:

In addition to design requirements outlined in Article 11.10 of the NYSDOT LRFD Bridge Design Specifications, the following criteria have been adopted by NYSDOT.

- As a preliminary starting point for determining the span length, the centerline of bearings should be assumed as 7’-6” behind the front face of the M.S.E.S.
- A minimum distance of 2 ft. shall be provided between the back of the M.S.E.S. panels and the front face of the abutment footing.
- The top of the M.S.E.S. panel in front of the abutment footing shall be set 1 ft. above the berm elevation.
- A minimum vertical clearance of 4 ft. shall be provided between the bottom of the superstructure and the berm in front of the abutment footing.

Review and Approval:

The M.S.E.S. should be considered as an option for all bridge substructures and developed as a part of the Structure Study Plan. Use of this system should be compared with other abutment types to determine which option best meets project objectives, i.e., structure cost, functionality, construction time, aesthetics and other project specific parameters. The selected option shall then be progressed in the Structure Justification Report through the normal review and approval procedure as described in Section 3.

11.6.1.5 Gravity Abutments

Gravity abutments are large masses of concrete or masonry that have nominal to no design steel in the back face of the stem. This type of abutment uses its own large self weight to provide lateral support and resist overturning forces. A large plan area at the base provides bearing on the soil. This type of abutment is no longer usually used for new bridges by NYSDOT, but they may be encountered on rehabilitation projects.

11.6.1.6 Integral Abutments

In an integral abutment structure, a rigid connection is made between the primary support members of the superstructure and a pile supported substructure by encapsulating the support members into the abutment concrete. Unlike cantilevered abutments, integral abutments do not require a joint in the bridge deck or conventional bearings. An integral abutment does not have a footing, as the abutment is supported on a single row of piles extending out of the abutment stem. The piles are allowed to rotate and horizontally deflect as the abutment stem moves due to thermal expansion of the superstructure.

Integral abutment bridges offer many advantages over conventional cantilevered abutments. Joints at bridge abutments are prone to leak, allowing water containing road salts to drain onto the underlying superstructure beams, bearings, abutment backwalls and bridge seats. By doing away with these joints, future maintenance associated with joint leakage is eliminated, thereby greatly reducing the life cycle cost of the structure. Integral abutments also cost less to construct. Having no footing, no bearings, fewer piles, and relatively simple concrete forming requirements makes integral abutments a cost effective alternative to conventional abutments.
Another advantage of integral abutments is that they can be constructed in a much shorter time as compared to conventional abutments.

Integral abutments should always be considered as the first choice of abutment because of their lower construction cost and superior long-term performance.

Details of integral abutments for each type of superstructure can be found in the current BD sheets.

**Design Methodology**

There are two design methods for integral abutments: the “approximate method” and the “refined method”.

In the approximate design method, the superstructure support members are assumed to be simply supported at the abutment end for design purposes. For the design of the piles, the vertical reaction from the superstructure and the dead load of the abutment is assumed to be uniformly distributed to each pile. Also, bending stresses in the piles are ignored.

Horizontal reinforcement in the abutment stem of steel superstructure bridges is designed by considering the stem to be continuous between piles. The horizontal reinforcement in the front face of the stem is designed to withstand the positive moments between the beams due to full passive soil pressure. The horizontal reinforcement in the rear face is designed to withstand the negative moments at the beams caused by full passive soil pressure. Horizontal reinforcement in the abutment stem for prestressed concrete adjacent box beam superstructure bridges is usually nominal steel based on the prestressed beams fully supporting the abutment stem along its entire horizontal length. Vertical steel in the abutment stem is usually controlled by shear considerations. If the ratio of the abutment stem depth to spacing between the pile supports is 1:1 or greater, then deep beam considerations should be included in the design.

In order to use the approximate design method for integral abutments, each of the following criteria must be met:

- The expansion length used to calculate the movement at an integral abutment shall be less than 165 ft. (The expansion length of an integral abutment structure shall be measured as half the distance between abutments for both single span structures, and continuous structures with expansion piers.)

- The skew shall not be more than 45°.

- The reveal or dimension from the bottom of girder to the top of stone fill or finished grade shall not be less than 1 foot or more than 4 feet.

- For curved steel girder bridges, the horizontal geometry must be such that the NYSDOT LRFD Bridge Design Specifications, § 4.6.1.2, allows the girders to be designed as straight girders.

If any one of the above criteria is not met, then the refined design method must be used. Before using the refined method to design an integral abutment, the designer must obtain the approval
of the Deputy Chief Engineer (Structures). This should be done with submittal of the Structure Study Package for a Technical Quality Review (see Appendix 3D).

In the refined design method, the effects due to skew, curvature, thermal expansion of the superstructure, reveal, and grade are considered. It may be necessary to analyze the superstructure and abutment as a rigid frame system by using either a three dimensional finite element model or a two dimensional frame model. Piles are designed for both vertical loads and for bending. The interaction between the piles and the surrounding soil is considered. For abutments with a large reveal, it may not be possible to design the horizontal reinforcement in the front and rear face of the abutment stem for full passive pressure. The soil pressure resulting from the actual superstructure thermal movement may have to be used. For additional guidance on designing integral abutments using the refined method contact the Office of Structures.

**Approach Treatments**

Integral abutment bridges with:

- A length 100 ft. or less require no provision for expansion at the ends of approach slabs unless the highway pavement is rigid concrete.
- A length more than 100 ft. shall provide for expansion at the end of each approach slab. The span arrangement and interior bearing selection should be such that approximately equal movement will occur at each abutment.

**Pile Requirements**

Integral abutments have special foundation requirements. All integral abutments shall be supported on a single row of piles. C.I.P. or steel H-piles may be used for structures with lengths of 165 ft. or less. Only steel H-piles shall be used for structures with lengths more than 165 ft. When steel H-piles are used, the web of the piles shall be perpendicular to the centerline of the beams regardless of the skew, so that bending takes place about the weak axis of the pile. Orienting the piling for weak-axis bending offers the least resistance to thermal movement but increases the potential for flange buckling. For total bridge length of 245 ft. or greater, the designer shall investigate orienting the piles for strong-axis bending when the total lateral displacement causes buckling of the pile flanges.

The Office of Structures’ Foundation and Construction Unit, in coordination with the Office of Technical Services’ Geotechnical Engineering Bureau, will select a pile type for integral abutments on a case by case basis. If C.I.P. piles are used, pile casing requirements will be provided in the Foundation Design Report.

To accommodate expansion for bridge lengths of 100 ft. or more, each pile shall be inserted in a pre-excavated hole that extends 8 ft. below the bottom of the abutment. After driving the piles, the pre-excavated holes shall be filled with cushion sand. The cost of excavation, steel casings, and cushion sand shall be included in the unit price bid for the pile item. For bridges less than 100 ft., no special pre-excavation provisions are required for expansion purposes.

All piles placed in pre-excavated holes shall be driven to a minimum penetration of 20 ft. This will provide for scour protection and assure sufficient lateral support for the pile, particularly
when the top 8 ft. is excavated and backfilled with sand. If no pre-excavating for the piles is required, penetrations as low as 10 ft. can be used.

A pile bent configuration is to be used for the integral abutment detail. For steel and spread concrete girder bridges, a minimum of one pile per girder shall be used.

**Wingwalls**

Unlike other abutments, the wingwalls for integral abutments have special requirements. In-line wingwalls cantilevered from the abutment are the preferred arrangement. Flared walls cantilevered from the abutment may be considered by the designer on a case by case basis. The use of flared wingwalls should generally only be considered at stream crossings where the alignment and velocity of the stream would make in-line walls subject to scour. Piles shall never be placed under flared wingwalls that are integral with the abutment stem. Generally, the controlling design parameter is the horizontal bending in the wingwall at the fascia stringer caused by the large passive pressure behind the wingwalls. In-line or flared wingwalls connected to the abutment stem with lengths in excess of 13 ft. should be avoided.

Because of high bending moments due to passive soil pressure, it may be necessary to support long wingwalls (13 ft. measured along the wall) on their own foundation, which is independent of the integral abutment system. In this case, a flexible joint must be provided between the wingwalls and the backwall. The joint between the abutment and the wingwalls shall be parallel to the centerline of the roadway to accommodate the longitudinal movement of the bridge. A joint that is not parallel to the direction of movement will likely lead to binding between the abutment stem and wingwall. Separate wingwalls may be designed as conventional walls with a footing or a stem with a single row of alternately battered piles. The choice will be governed by the site and loading conditions, but walls using a single row of piles should generally be limited to a height of 13 ft.

U-wingwalls cantilevered from the abutment stem shall be allowed only if in-line or flared walls cannot be used because of right-of-way or wetlands encroachment. The U-wingwalls shall not measure more than 6'-6" from the rear face of the abutment stem. No piles shall be placed under the U-wingwalls. This would inhibit the abutment's ability to translate and would cause internal stresses. The distance between the approach slab and the rear face of the U-wingwall should be a minimum of 4 ft. If the approach slab must extend to the U-wingwall, it shall be separated from the U-wingwall by a 2" joint filled with at least two sheets of Premoulded Resilient Joint Filler, Material Subsection 705-07.

**Utilities**

Rigid utility conduits, such as gas, water and sewer, are discouraged for use with integral abutments. If they are used, expansion joints in the conduits must be provided at each abutment. Sleeves through the abutment should provide at least 2" clearance all around the conduit. Flexible conduits for electrical or telephone utilities that are properly equipped with an expansion sleeve through the integral abutment are acceptable.

**Stage Construction**

When stage construction is used with integral abutments, the use of a closure placement between stages in the abutments shall be considered. The use of a closure placement can
reduce the mismatch of the top of slab between stages caused by deflection from the superstructure. A closure placement in the abutment stem shall be required when the dead load deflection from the deck slab placement is calculated to be 3 inches or greater.

11.6.1.7 Semi-Integral Abutments

Description and Design Methodology

Semi-integral abutments use conventionally designed abutments where superstructure girders are supported by bearings and pedestals on a bridge seat. The girders extend over the bridge seat and are embedded in a backwall that hangs behind, but is not connected to, the abutment stem.

Full integral abutments have been used successfully by NYSDOT since the late 1970s. Their performance in terms of durability and first cost has been clearly superior to conventional abutments. This has mainly been due to the elimination of the deck expansion joint and the simple concrete forming required. Unfortunately, site condition criteria sometimes prevent their use. This is usually caused by rock being too close to the ground surface preventing the driving of piles or the necessity of using high abutments because of geometric constraints.

When site conditions have prevented the use of integral abutments, jointless decks at abutments have often been used. Jointless decks at abutments are conventionally designed but the deck slab extends and slides over the backwall. While jointless decks at abutments have performed better than conventional abutments with deck joints, there have been some problems with transverse deck cracking near the abutment backwall. Jointless decks at abutments are also limited to a maximum expansion length of 200 ft. Semi-integral abutments should be considered for use where site conditions prevent the construction of full integral abutments.

Semi-integral abutments are designed as conventional abutments with the following exceptions:

- Backwalls must be designed for full passive soil pressure.
- Wingwalls must be independent from the backwall to allow movement. Clearance details are shown on the applicable BD sheets.
- Adequate clearance to handle expected movements must be provided between the suspended backwall and the abutment stem.
- Provision for expansion at the ends of approach slabs should be provided in accordance with the details on the applicable BD sheet.
- The top reinforcement in the decks slab at the end of the span should be designed for the negative moment produced from the reaction of half the approach slab dead load and a live load reaction placed on the backwall. The dead load of the backwall should not be included because the backwall is constructed in a separate placement before the deck and will not contribute to tensile stress in the deck slab.

Stage Construction

When stage construction is used with semi-integral abutments, the use of a closure placement between stages in the backwall shall be considered. The use of a closure placement can reduce the mismatch of the top of slab between stages caused by deflection from the superstructure. A
closure placement in the backwall shall be required when dead load deflection from the deck slab placement is calculated to be 3 inches or greater.

Selection Criteria and Details

- Maximum skew = 30°.
- Maximum expansion length = 230 ft. (distance to nearest fixed bearing).
- No restriction on abutment height.
- No restriction on maximum grade.
- No restriction on footing type (spread or pile foundation).
- Utility restrictions are the same as integral abutments. See § 11.6.1.6 of the Bridge Manual.
- Single-span bridges should have one of the abutment bearings fixed. Multiple-span, continuous bridges can have both abutments with expansion bearings as long as there is a fixed bearing at a pier.
- Curved girder structures are allowed if the curved girders are designed as straight as provided in NYSDOT LRFD Bridge Design Specifications, § 4.6.1.2.
- Backfill procedures are the same as for Integral Abutments.
- The hanging backwall may have its bottom surface cast on the ground or formed at the option of the Contractor.
- Polyethylene curing covers need not be placed under the hanging backwall.

11.6.2 Abutment and Wall Details

11.6.2.1 Stem Thickness

The stem thickness of cantilevered high abutments is almost always governed by the size of the bridge seat required for clearance between the superstructure and the backwall, the bearings and the backwall, and seismic criteria. For bridges with a pier, seismic criteria may dictate the support length at the ends of beams. The minimum support length (N) in the longitudinal direction should be measured perpendicular to the centerline of bearing. The minimum support length (N) in the transverse direction should be measured perpendicular to the centerline of the beam. The minimum support length shall meet the requirements of NYSDOT LRFD Bridge Design Specifications § 4.7.4.4. The minimum bridge seat width is 3 ft. for steel, bulb tee and AASHTO I-beam superstructures and 2 ft. for adjacent concrete beam superstructures.
The stem thickness of integral and semi-integral abutments shall be as shown in the current BD-ID series. The centerline of the piles and the centerline of bearings of the beams shall always line up.

### 11.6.2.2 Pedestal Dimensions

The minimum height of the shortest pedestal is 6” when used with elastomeric bearings. If multi-rotational bearings are used, then the minimum height shall be 8”. The extra 2” is added for tolerance to allow the use of a taller multi-rotational bearing than the one used in the design and still provide a minimum pedestal height of 6”. If the difference in height between fascia pedestals is more than 6” then a sloping bridge seat should be used with both fascia pedestals being set at the minimum height. Pedestals more than 1’-6” high should usually be avoided for aesthetic reasons. Pedestals greater than this height should be investigated for their strength acting as a column.

The minimum distance from the center of the bearing anchor bolt to any exposed vertical face of the pedestal shall be 8”. In addition, the minimum distance from the edge of the masonry plate to any vertical face of the pedestal shall be 3” unless otherwise accounted for in the design. Masonry plate corners may be cropped to satisfy this requirement. The front face of all pedestals shall be flush with the front face of the abutment.

### 11.6.2.3 Drainage

The fill material behind all walls shall be effectively drained and weepholes shall be placed at a maximum spacing of 25 ft. In counterfort walls, there shall be at least one weephole for each pocket formed by the counterforts. Weepholes shall be located so that their invert is 6” above finished grade or low water in the case of stream bridges. Integral abutments generally do not require weepholes because of their minimal exposed height above finished ground.
11.7 Bridge Piers

For the purposes of this section, the term “pier” is defined as an intermediate support for a bridge superstructure, between the abutments, extending from below the ground surface to the bottom of the superstructure.

Piers may be required because of long spans, beam depth restrictions, or both. The pier may be a support point along a continuous superstructure, or it may be at the end of one simple span and the beginning of another. In either case, the pier must be designed to safely handle the dead, live, seismic and other loads introduced from the superstructure while at the same time handling any loads acting on the pier from flood water, ice flow, wind, and vehicular or ship impact. Suggested proportions of bridge piers can be found in Section 23.

11.7.1 Pier Types

Solid piers consist of a solid mass of reinforced concrete, without overhangs, that is usually rectangular in plan. Solid piers are used primarily for river or stream crossings, low-clearance bridges, bridges over divided highways with narrow medians, and where short columns on wide bridges would have high stress due to shrinkage. Solid piers can also be used to meet crash protection requirements adjacent to railroads. This type of pier is currently used by NYSDOT for new bridges.
11.7.1.2 Hammerhead Pier

With increasing pier height and narrow superstructures, the hammerhead pier becomes more economical by reducing the required amounts of material and forming. Hammerhead piers consist of a single large column with a capbeam overhanging on either side. Both the column and cantilevered ends of the capbeam support the superstructure beams. When located in a waterway, pier protection may be required. The overhangs of hammerhead piers may need to be investigated for the bracket and corbel effect as described in Section 15.10. This type of pier is currently used by NYSDOT for new bridges.

11.7.1.3 Multi-Column Pier

When piers need to be tall and wide, a multiple-column pier is usually the best choice. This pier type consists of two or more columns that can be either rectangular or circular. The columns are usually connected by a capbeam that supports the superstructure at points between the columns. For some highly skewed bridges with large beam spacing, it may be necessary to place individual columns under each bearing and to connect the top of the columns with a simple tie strut. When there are only two columns with overhangs, this pier is called a \( \pi \) (pi) pier. The overhangs may need to be investigated for bracket and corbel effects as described in Section 15.10. These types of piers are currently used in NYSDOT for new bridges.

A feature of most multi-column piers is the presence of the capbeam. This capbeam is subject to many design considerations that are not applicable to any other type of pier. The width of the capbeam is governed by the necessary width to support the bridge bearings with sufficient cover for the anchor bolts and the required support length for the beams. When the simply supported end of a beam rests on a pier, seismic criteria dictates the support length required. Support length (N) in the longitudinal direction should be measured perpendicular to the centerline of bearings. Support length (N) in the transverse direction should be measured perpendicular to the centerline of the beam. See Section 11.6.2.1. Round columns require that the capbeam be at least 2\(^{"}\) wider than the columns on all sides.

For seismic response reasons, high concrete columns (slenderness >60) in multi-column piers shall have reinforced concrete struts between the columns in the middle half of the column height.

11.7.1.4 Pile Bents

Pile bents are the simplest and least expensive piers to construct. This pier consists of driven piles with a concrete cap beam cast over the top of the piles to support the superstructure. This type of pier is inexpensive because there are no footings or columns to form or cast. Pile bents are not frequently used by NYSDOT due to concerns about aesthetics, corrosion of the exposed steel piles or steel pile casings, and the closely spaced piles trapping debris during a flood and reducing the available hydraulic opening.
### 11.7.2 Pier Protection

Bridges in navigable waterways that are subjected to heavy commercial traffic may require additional protection according to *AASHTO Guide Specification and Commentary for Vessel Collision Design of Highway Bridges*. Additional information can be found in Section 2 of this manual.

For stream bridges, a recommendation shall be obtained from the Office of Structures’ Hydraulic Design Unit regarding the need for and type of ice breaker for pier noses. If required, the ice breaker shall consist of a steel angle or other device secured to the concrete by a suitable anchor system. For solid piers, this breaker may be attached to the pier stem. For hammerhead piers and multi-column piers, a plinth may be required to provide sufficient strength against the anticipated ice flows. A plinth is a solid mass of concrete that surrounds the pier to an elevation 2 ft. above the 100-year flood or flood of record, whichever is higher. In a navigable stream, the plinth should be carried to 3 ft. above design high water or maximum navigable pool elevation, whichever is higher.

For piers between opposing directions of traffic, appropriate care must be taken to ensure that minimum horizontal clearances and highway traffic barrier requirements are satisfied. For more information, refer to the *Highway Design Manual* and Standard Sheets.

For multi-column or hammerhead piers adjacent to railroad tracks, the need for crash walls must be investigated based on the proximity of the pier to the tracks in accordance with current AREMA Specifications. Additional information can be found in Section 2 of this manual.


12.1.4 Multi-Rotational Bearings (Type M.R.)

Multi-rotational bearings are generally used in high load situations, or where the thermal movements are excessive for elastomeric bearings. Multi-rotational bearings consist of a confined elastomeric element (Pot design) or an unconfined polyether urethane disc (Disc design) to accommodate rotation, and a sliding element to accommodate movement. The expansion bearings of this type may be guided, allowing movement in one direction, or non-guided, allowing movement in any direction.

At locations where large movements are expected or where large sole plates are required, consideration shall be given to using four bearing stiffeners to better distribute the load rather than two located at the centerline of bearing. If four stiffeners are used, they shall be spaced apart at least the width of the stiffener. When using guided expansion bearings on very wide structures or curved structures, it may be necessary to increase the standard clearance between the guide bars and the bearing body to accommodate the transverse movement due to thermal expansion.

The coefficient of friction used for the design of the bearings shall be 5%, whereas the maximum coefficient of friction specified to the manufacturer is 3%. Multi-rotational bearings require more regular maintenance to ensure their performance than elastomeric bearings. This bearing type is currently being used on new bridges.

When shims are required on multi-rotational bearings with a capacity greater than 500 kips, the minimum shim plate thickness shall be $\frac{3}{16}$ inch in lieu of the normal $\frac{1}{8}$ inch.

12.2 General Design Considerations

12.2.1 Design Method

The provisions of the NYSDOT LRFD Bridge Design Specifications shall be used for the design of bridge bearings. The design thermal movement for the design of bearings shall be calculated using Procedure B for bridges with a concrete deck that have concrete or steel girders and using Procedure A for all other bridge types (see NYSDOT LRFD Bridge Design Specification Section 3.12). Note: the design thermal movement has to be factored by 1.2. Elastomeric bearings shall be designed using Method A (see NYSDOT LRFD Bridge Design Specification Section 14.7.6). Multi-rotational bearings shall be designed by the fabricator. Design examples of various bearing types can be found in the Office of Structures Mathcad Library.

12.2.2 Live Load on Bearings

Impact shall not be included in the live load when designing elastomeric bearings. Impact shall be included in the live load when designing multi-rotational bearings.

12.2.3 Minimum Loads on Bearings

Elastomeric bearings used with steel superstructures have a minimum pressure requirement due to dead load plus superimposed dead load of 200 psi to ensure the rubber element does
not “walk” out of position. Elastomeric bearings used with prestressed box beams or slab units do not have a minimum load requirement due to the presence of the anchor dowel. The minimum load on multi-rotational bearings due to dead load plus superimposed dead load is 20% of the capacity of the bearing to ensure proper operation of the bearing.

12.2.4 Uplift

Bridges with severe skews, curved girders, or unbalanced continuous spans may experience uplift of one or more of the beams. The preferred method of resisting uplift is to design a concrete counterweight over the bearings to weigh down the beam end and provide the minimum load for the bearing. If it is not possible to design a counterweight heavy enough to hold the beam end down, other possible solutions include changing the continuous spans to simple spans, making the uplift end of the beam the fixed end and providing uplift restraints that allow rotation in any direction, or changing the span or skew arrangement to eliminate the conditions creating the uplift. Care must be taken in designing uplift restraints that allow longitudinal movement. Anchor rods embedded in the pedestal passing through slotted holes in the girder usually do not work well due to a tendency for the anchor rods to bind. For specific design requirements for uplift, see the NYSDOT LRFD Bridge Design Specifications.

12.2.5 Bearings for Curved Girders

When setting bearings for curved girders, the assumed direction of expansion between points of support is a straight line chord between the fixed bearing and each expansion bearing along the continuous curved girder. However, the actual direction of expansion is in two planes. Bearings need to be designed to accommodate these movements.

Multi-rotational bearings are recommended for curved girders on skewed supports because they are better able to resist torsional forces in the superstructure.

12.3 Bearing Selection Criteria

Elastomeric bearings are preferred for most structures. Multi-rotational bearings are used when large loads and movements cannot be efficiently accommodated by elastomeric bearings. Only one type and size of bearing shall be used for each line of bearings.

When the required design load or movement exceeds the limits of the standard elastomeric bearings given below, the elastomeric bearings shall be specially designed or multi-rotational bearings shall be used.

Round elastomeric bearings should be considered for situations where there are sizable vertical loads or large skews where the use of rectangular bearings would necessitate a very wide bridge seat or pier cap.

For single span, non-integral structures the fixed bearing should be set at the low end of the bridge (the lowest bridge seat). This will reduce some of the stresses on the bearing as the structure will only expand uphill. Multi-span structures are more complex as fixed bearing placement will depend upon the number of spans and the shape of the profile. The first choice
should be to place a fixed bearing near the center of the bridge. However, whenever possible, consideration should be given to forcing the majority of the expansion movement uphill.

12.4 Painting of Bearings

The steel parts of all bearings, including weathering steel, shall be painted due to concern for the bearing steel being in contact with water for long periods of time and the resulting durability concerns with uncoated weathering steel. Painting of the bearing steel is covered under the NYSDOT Standard Specifications for Construction and Materials and the cost is included in the bearing items.

12.5 Standard Bearing Designs

Standard bearing design tables assume a total induced rotation of 0.007 radians (dead load rotation of 0.000 radians, live load rotation of 0.005 radians, and a rotation of 0.002 radians to account for installation uncertainties). The designer is responsible for determining specific required rotations and sizing the bearings accordingly.

The following are descriptions for the titles in the elastomeric bearing design tables. Bearings sizes in **bold italics** are preferred sizes, and should be used whenever possible.

<table>
<thead>
<tr>
<th>Length</th>
<th>Measured along the girder centerline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>Measured perpendicular to the girder centerline</td>
</tr>
<tr>
<td>Max. Load</td>
<td>Maximum allowable compressive load</td>
</tr>
<tr>
<td>Min. Load</td>
<td>Minimum load to ensure adequate bearing performance</td>
</tr>
<tr>
<td>N</td>
<td>Number of elastomer layers</td>
</tr>
<tr>
<td>( n_i )</td>
<td>Number of internal elastomer layers</td>
</tr>
<tr>
<td>Max. Move.</td>
<td>Maximum Movement: Maximum allowable bearing movement</td>
</tr>
<tr>
<td>( h_{rt} )</td>
<td>Total elastomer height (( n \times ) height of 1 layer)</td>
</tr>
<tr>
<td>Shape Factor</td>
<td>As defined by NYSDOT LRFD Section 14.7.5.1</td>
</tr>
<tr>
<td>Comp. Area*</td>
<td>Compressive Area: Plan area of the steel laminate reinforcement</td>
</tr>
<tr>
<td>Shear Area*</td>
<td>Plan area of the elastomer layer</td>
</tr>
</tbody>
</table>

* Included reduction for 2” diameter hole

Table 12-1
Bearing Nomenclature
### STANDARD TYPE E.L. ELASTOMERIC BEARINGS

<table>
<thead>
<tr>
<th>Length (in)</th>
<th>Width (in)</th>
<th>Max. Load (kips)</th>
<th>( n_i )</th>
<th>( h_{ri} ) (in)</th>
<th>Max. Move. (in)</th>
<th>Shape Factor*</th>
<th>Comp. Area* (in²)</th>
<th>Shear Area* (in²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>34</td>
<td>90</td>
<td>1</td>
<td>1</td>
<td>½</td>
<td>4.66</td>
<td>190.92</td>
<td>200.86</td>
</tr>
<tr>
<td>8</td>
<td>34</td>
<td>150</td>
<td>2</td>
<td>1 ½</td>
<td>¾</td>
<td>5.96</td>
<td>258.42</td>
<td>268.86</td>
</tr>
<tr>
<td>10</td>
<td>34</td>
<td>225</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>7.15</td>
<td>325.92</td>
<td>336.86</td>
</tr>
</tbody>
</table>

* Area of a 2” diameter hole for a pin was subtracted.

### Table 12-2
Bearing Design – Standard Type E.L Elastomeric

### STANDARD TYPE E.B. ELASTOMERIC BEARINGS

<table>
<thead>
<tr>
<th>Len. (in)</th>
<th>Wid. (in)</th>
<th>Max Load (kips)</th>
<th>Min Load (kips)</th>
<th>N</th>
<th>( h_{ri} ) (in)</th>
<th>Max Mov. (in)</th>
<th>S Fact (Exp)</th>
<th>S Fact (Fix)**</th>
<th>Comp Area (in²) (Exp)</th>
<th>Comp Area (in²) (Fix)**</th>
<th>Shear Area (in²) (Exp)</th>
<th>Shear Area (in²) (Fix)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>18</td>
<td>110</td>
<td>35</td>
<td>3</td>
<td>1 ½</td>
<td>¼</td>
<td>6.43</td>
<td>6.43</td>
<td>173.06</td>
<td>170.99</td>
<td>180</td>
<td>178.23</td>
</tr>
<tr>
<td>10</td>
<td>18</td>
<td>110</td>
<td>35</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>6.43</td>
<td>6.43</td>
<td>173.06</td>
<td>170.99</td>
<td>180</td>
<td>178.23</td>
</tr>
<tr>
<td>10</td>
<td>18</td>
<td>110</td>
<td>35</td>
<td>5</td>
<td>2 ½</td>
<td>1 ¾</td>
<td>6.43</td>
<td>6.43</td>
<td>173.06</td>
<td>170.99</td>
<td>180</td>
<td>178.23</td>
</tr>
<tr>
<td>14</td>
<td>18</td>
<td>190</td>
<td>50</td>
<td>5</td>
<td>2 ½</td>
<td>1 ½</td>
<td>7.88</td>
<td>7.88</td>
<td>244.06</td>
<td>241.99</td>
<td>252</td>
<td>250.23</td>
</tr>
<tr>
<td>14</td>
<td>18</td>
<td>190</td>
<td>50</td>
<td>6</td>
<td>3</td>
<td>1 ½</td>
<td>7.88</td>
<td>7.88</td>
<td>244.06</td>
<td>241.99</td>
<td>252</td>
<td>250.23</td>
</tr>
<tr>
<td>14</td>
<td>18</td>
<td>190</td>
<td>50</td>
<td>7</td>
<td>3 ½</td>
<td>1 ¾</td>
<td>7.88</td>
<td>7.88</td>
<td>244.06</td>
<td>241.99</td>
<td>252</td>
<td>250.23</td>
</tr>
<tr>
<td>14</td>
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<td>50</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>7.88</td>
<td>7.88</td>
<td>244.06</td>
<td>241.99</td>
<td>252</td>
<td>250.23</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>280</td>
<td>62</td>
<td>7</td>
<td>3 ½</td>
<td>1 ½</td>
<td>9.00</td>
<td>9.00</td>
<td>315.06</td>
<td>312.99</td>
<td>324</td>
<td>322.23</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>280</td>
<td>62</td>
<td>8</td>
<td>4</td>
<td>1 ¾</td>
<td>9.00</td>
<td>9.00</td>
<td>315.06</td>
<td>312.99</td>
<td>324</td>
<td>322.23</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>280</td>
<td>62</td>
<td>9</td>
<td>4 ½</td>
<td>2</td>
<td>9.00</td>
<td>9.00</td>
<td>315.06</td>
<td>312.99</td>
<td>324</td>
<td>322.23</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>280</td>
<td>62</td>
<td>10</td>
<td>5</td>
<td>2 ¼</td>
<td>9.00</td>
<td>9.00</td>
<td>315.06</td>
<td>312.99</td>
<td>324</td>
<td>322.23</td>
</tr>
</tbody>
</table>

** A 1 ½” diameter pin is assumed. The pin hole is not subtracted from the Shape Factor calculation because it is tightly fit. It is accounted for in the compression and shear area.

### Table 12-3
Bearing Design – Standard Type E.B. Elastomeric
Section 13
Approach Details

13.1 Approach Slabs

13.1.1 Purpose

Approach slabs provide a smooth transition between the bridge deck and the highway approach. The approach slab helps to reduce the "bump" that can be created when the approach fill settles at the end of the structure.

New York State DOT requires approach slabs to be used on all State-owned bridges except for buried structures. On local bridges the owner is given the option of requesting approach slabs. This resulted from a request by many local authorities to reduce the cost of new bridge projects. Local bridges usually have low volumes of high speed truck traffic, therefore, the need for approach slabs is reduced. Unless specifically requested otherwise, approach slabs are not required on local bridge projects unless the type of structure used demands them, such as integral or jointless.

13.1.2 Length Determination

Approach slab length is determined by taking 1.5 times the height of the abutment, measured from the bottom of footing to top of pavement, and dividing it by the cosine of the skew angle of the abutment. This length is taken along the station line and then rounded to the next higher foot. The maximum approach slab length is limited to 25 ft., while the minimum length is 10 ft. See Section 13.1.4 for length determination with skews greater than 30°.

13.1.3 Width Determination

The width of approach slabs used with conventional abutments and joint systems shall be from the edge of travel lane to edge of travel lane plus 1 ft. on each side. However, if the bridge is on a superelevated roadway where the crown line is at the edge of the travel lane, the approach slab should not extend the 1 ft. beyond the crown line. When the highway approach has curbs, the approach slab shall be placed from curb to curb.

For conventional abutments with U-wingwalls, the distance between the approach slab and the rear face of the U-wingwall should be a minimum of 4 feet to provide sufficient space for placement and compaction of shoulder material. If the 4 foot minimum can not be provided carry the approach slab to the rear face of the U-wingwall. A 1” gap filled with two sheets of an appropriate bond breaker shall be placed between the approach slab and the face of the U-wingwall to allow the approach slab to move vertically. Past experience shows that a single sheet of bond breaker material is insufficient.
On integral and jointless abutments the approach slab shall typically be full width from face of railing to face of railing when the approaches are straight and flared or in-line wingwalls, are shown. Curved approaches should be dealt with on a case by case basis. Approach slabs shall extend under any sidewalk on integral and jointless abutments. See current approach slab BD sheets for corner details.

U-wingwalls are undesirable on integral abutments and at the expansion end of jointless abutments. If they are used, the minimum gap between the approach slab and the U-wingwall shall be 2” and filled with at least two sheets of Premoulded Resilient Joint Filler, Material Subsection 705-07. Past experience has shown that binding has occurred with smaller gaps damaging both the wall and slab. See Section 5.2 for additional criteria for jointless decks and Section 11.6.1.6 for additional criteria for integral abutments.

13.1.4 Skewed Approach Slabs

For conventional abutments with skews of 30° or less, the end of the approach slab shall be parallel to the skew. For skews greater than 30°, the end of the approach slab should be squared off, and the length of the approach slab is measured along the shorter side at the edge of travel lane.

In cases of wide bridges with large skews, the length of the long edge of the approach becomes excessive. In these cases the end of the approach slab shall be parallel to the skew.

For integral and jointless abutments the end of the slab shall be parallel to the skew for all skew angles.

On curved structures the end of the approach slabs are typically placed radially. To simplify construction, the sides of the approach slabs should be on a chord, rather than on the curve.

If the strict interpretation of the above criteria creates excessively wide or long approach slabs, consideration shall be given to alternative details.

13.1.5 End of Approach Slab Details

When an approach slab meets a concrete approach pavement, a pressure relief joint/sleeper slab is required. When an approach slab with a conventional jointed abutment meets a flexible highway approach pavement, a pressure relief joint/sleeper slab is not required.

For span length requirements of integral abutments, abutments with jointless details and details of sleeper slabs see the BD-SA sheets.

Pressure relief joint and sleeper slab lengths are in addition to the approach slab length calculated in Section 13.1.2.
14.2.7.3 Superstructures

Rarely will the extensive effort needed to accurately model the superstructure in 3D be justified. As solid models are used more and the modeling process becomes easier, it is likely that more of the structure will be modeled in 3D.

Occasionally, approximate superstructure models are needed for the purpose of developing visualizations. The task evaluating the aesthetics of a proposed structure usually occurs early on in the design process. In this case, it is appropriate to approximate dimensions of the bridge geometry that have not yet been designed. These inexact models have limited use and should not be placed in the Bridge Design File.

14.2.7.4 Earthwork

For new and replacement bridge projects proposed earthwork should be modeled in 3D. Having a complete set of earthwork models is particularly useful in the design of complicated earthwork such as staged construction of replacement bridges. By generating detailed cross sections at any location within a project a designer can have a better understanding of what he or she is proposing. This is done using Microstation to generate sections through the earthwork and substructure solids and InRoads to drape the existing, proposed and excavation ground lines from the surface models. This results in an accurate representation of the proposed work revealing any conflicts or constructability concerns.

Because most earthwork items have their own level, earthwork models can be easily managed from a few model spaces. A designer might choose to put all excavation models in one model space and all backfill models in another. The exception to this would be stage construction. In this case, excavation and backfill model spaces should be created for each stage. This will allow earthwork elements to be displayed independently on their proper levels.

14.2.7.4.1 Surface Models

The designer will determine how a given element of earthwork is modeled; as a surface, a solid or 3D shape. This will depend on what is being modeled and what the model will be used for. In general, elements whose volume is measured against the existing ground, such as embankments and excavations, should be surface modeled. Other elements such as select backfills, slope protection, drainage and wall systems (sheeting, GRSS, T-Wall, MSES) should be modeled as solids or 3D shapes.

Surface models are created by drawing 3D lines, also known as features, in a model space of the Bridge Design File. Earthwork models are products of the bridge design effort and therefore should always be located in the Bridge Design File. The 3D lines can be manually placed or drawn using an InRoads tool such as Generate Sloped Surface. Each point on a feature line represents a single ground elevation at that coordinate location. These features can be imported into an InRoads surface and then triangulated. The triangulated surfaces can then be used to drape surface data into cross sections generated by Microstation. Triangulated surfaces are also used for estimating excavation and embankment volumes. Excavation and embankment feature models are often combined into a few model spaces in the Bridge Design File, but each triangulated surface should be in their own DTM file, appropriately named and kept in Projectwise.
Surfaces are usually constructed from three kinds of features; source features, transverse features and catch point features. Typically source features are bottom-of-excavation or shoulder break lines. Source features are the starting point for generating transverse features that represent slope lines. Both source features and transverse features should have their point-type set to breakline. Catch point features represent the intercepts of the transverse features and the original ground surface. Catch point features are typically the embankment toe or top-of-slope and should have their point-type set to exterior. Setting the point-type to exterior will prevent InRoads from triangulating beyond the extent of the data. Placing these three kinds of features on different levels allows their view to be controlled when they are referenced into drawing files.

From a workflow perspective, it is helpful to think of the feature model, 3D lines drawn in the Microstation model space, as the core data and creation of the triangulated surface a downstream process. In the event that a surface needs updating, the feature model should be changed and then the triangulated surface recreated by importing the new feature model into InRoads. This will insure that earthwork elements displayed in drawings are the same as those used for design and estimating.

### 14.2.7.4.2 Excavations

An excavation surface is created using the proposed substructure and the existing or original ground surface. When rock is anticipated in an excavation the designer should work with the Geotechnical Engineering Bureau to create an assumed rock surface in the area of the substructure. The assumed rock DTM file should be appropriately named and kept in Projectwise. The excavation surface is then created using the proposed substructure, the assumed rock surface and the existing or original ground surface.

In some cases the proposed excavations will overlap. For example, an excavation for removal of an existing substructure overlaps the excavation for an adjacent proposed substructure. In this case, assuming the excavations are to be made simultaneously, the two excavations should be drawn separately and then combined into a single feature model. Whenever estimating an excavation that includes an existing substructure, the volume of the substructure removal must be subtracted out. This is necessary because the existing ground surface always includes the existing substructures and removal of existing structures is not paid for under the excavation item.

### 14.2.7.4.3 Solid and 3D Shape Models

Earthwork modeled as solids and 3D shapes should be simple volumes or areas that represent the proposed work, not the detailed geometry of the actual installations. For example, sheeting could be modeled as a vertical slab with a thickness of a few inches. The front face would locate the sheeting wall. There would be little or no benefit in modeling the actual geometry of the individual sheet pile sections.
14.3 Detailing Standards

14.3.1 Bridge Detail (BD) Sheets

Bridge Detail (BD) Sheets are provided to assist in bridge plan standardization. These sheets serve as a guide in the preparation of the contract plans and may be accessed in CADD format through Projectwise or in PDF format through the DOT website.

14.3.2 Title Blocks

Care should be taken to ensure consistency in the TITLE BLOCKS of all sheets within a set of plans, including multiple bridge projects. Most Title Block information is filled out using the Plans – Plan Sheet Border and/or Plans – Detail Sheet Border interfaces in Projectwise. For an overview of document attributes, see Section 2.6 in Appendix 14 of the *Project Development Manual*. For a complete list of standard Projectwise interfaces, see Section 2.7 in Appendix 14 of the *Project Development Manual*.

The bridge label featured in the LOWER TITLE BLOCK should be shown like this (format may be varied because of space constraints):

```
FEATURE CARRIED
OVER
FEATURE CROSSED
```

14.3.3 Scales and Scale Bars

Refer to Section 20.9 in Chapter 20 of the *Highway Design Manual* for a discussion of scales. Scale bars shall be provided for larger scale drawings that are site oriented such as the General Plan and Elevation, General Subsurface Profile and earthwork and embankment plans. Scale bars shall not be shown on roadway profiles.

All details that are drawn proportionally shall be fully dimensioned and shall not display a numeric scale or scale bar. Any drawings intentionally drawn not to scale shall be labeled “NOT TO SCALE” and shall be fully dimensioned. Note #12 shall be included on the General Notes sheet.
The following are suggested scales (based on B-sized sheets, 11”x17”) to be used by detailers in the preparation of contract plans:

<table>
<thead>
<tr>
<th>Section</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary Plan</td>
<td>1” = 40'</td>
</tr>
<tr>
<td>Abutments</td>
<td></td>
</tr>
<tr>
<td>Plan and Elevation</td>
<td>1/4” = 1'-0”</td>
</tr>
<tr>
<td>Reinforcement</td>
<td>1/4” = 1'-0”</td>
</tr>
<tr>
<td>Piers</td>
<td></td>
</tr>
<tr>
<td>Plan and Elevation</td>
<td>1/4” = 1'-0”</td>
</tr>
<tr>
<td>Reinforcement</td>
<td>1/4” = 1'-0”</td>
</tr>
<tr>
<td>Transverse Section</td>
<td>1/4” = 1'-0”</td>
</tr>
<tr>
<td>Railings</td>
<td>1/2” = 1'-0”</td>
</tr>
<tr>
<td>Bearings</td>
<td>1/2” = 1'-0”</td>
</tr>
<tr>
<td>Superstructure Slab</td>
<td>1” = 10’, 1” = 20’</td>
</tr>
<tr>
<td>Prestressed Concrete</td>
<td>1/8” = 1’–0”, 1/4” = 1'-0”</td>
</tr>
<tr>
<td>Excavation</td>
<td></td>
</tr>
<tr>
<td>Plans</td>
<td>1” = 10’, 1” = 20’</td>
</tr>
<tr>
<td>Sections</td>
<td>1/8” = 1’–0”, 1” = 10’</td>
</tr>
<tr>
<td>Approach Slabs</td>
<td>1/8” = 1’–0”</td>
</tr>
<tr>
<td>Steel Framing Plan</td>
<td>1” = 10’, 1” = 20’</td>
</tr>
<tr>
<td>Girder Elevations</td>
<td>Not to scale</td>
</tr>
<tr>
<td>Joints</td>
<td>Not to scale</td>
</tr>
</tbody>
</table>

Table 14-1
Suggested Sheet Scales

14.3.4 Dimension and Table Value Rounding

The following is presented as a guideline to rounding dimensions and table values on the contract plans:

<table>
<thead>
<tr>
<th>Category</th>
<th>Rounding Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>Nearest 1/4 in</td>
</tr>
<tr>
<td>Steel</td>
<td>Nearest 1/16 in</td>
</tr>
<tr>
<td>Reinforcement Length – Bent Bars</td>
<td>Nearest 1/4 in</td>
</tr>
<tr>
<td>Reinforcement Length – Straight Bars</td>
<td>Nearest 1 in</td>
</tr>
<tr>
<td>Stations</td>
<td>Nearest 0.01 ft</td>
</tr>
<tr>
<td>Elevations</td>
<td>Nearest 0.01 ft</td>
</tr>
<tr>
<td>Camber Table</td>
<td>Nearest 0.01 ft</td>
</tr>
<tr>
<td>Haunch Table</td>
<td>Nearest 0.01 ft</td>
</tr>
<tr>
<td>Design Load Table</td>
<td>Nearest 0.01 kip/ft</td>
</tr>
<tr>
<td>Moment Table</td>
<td>Nearest 0.01 kip-ft</td>
</tr>
<tr>
<td>Shear Table</td>
<td>Nearest 0.01 kips</td>
</tr>
<tr>
<td>Skew Angle</td>
<td>Nearest 1 second</td>
</tr>
<tr>
<td>Bearing Azimuth</td>
<td>Nearest 1 second</td>
</tr>
</tbody>
</table>

Table 14-2
Dimension Rounding Guidelines
ESTIMATE OF QUANTITIES AND INDEX OF DRAWINGS

This drawing shall include the Estimate of Quantities and the Index of Drawings tables. The Estimate of Quantities table shall be created using the Estimate Wizard program and the estimate file from Trns-port Estimator. It is not necessary to list all the pay items contained in the bridge fiscal share in this table. Overhead items such as mobilization, survey and stakeout, Work Zone Traffic Control, construction signs, etc. do not need to be included.

GENERAL NOTES

This drawing shall include all standard notes from Chapter 17 that pertain to the proposed work. These standard notes must be checked, and in some cases edited, to insure that they specifically pertain to the proposed structure.

BORING LOCATION PLAN

This drawing shall show the geotechnical boring hole locations relative to the bridge and will be provided by the Geotechnical Engineering Bureau.

GENERAL SUBSURFACE PROFILE

This drawing shall show a generalized geotechnical profile at the borings and will be provided by the Geotechnical Engineering Bureau.

EXCAVATION AND EMBANKMENT

The intent of this drawing is to illustrate all earthwork proposed in the area of the bridge. This includes excavations, designed excavation support, backfills, embankments, substructure removals, proprietary wall systems and geosynthetically reinforced soil systems (GRSS). This drawing shall show sufficient plan views and sections to convey construction details and pay limits for all bridge earthwork items. The legend of earthwork symbols shall be shown on the first sheet of the excavation and embankment drawing series and shall show the earthwork items, where possible. In the case of stage construction, plan views and sections shall be shown for each stage of construction. In the event that the necessary substructure removal cannot be completely shown in the plan and section views, the designer may show separate isometric views of existing substructure with areas of removal hatched. In this case, it is not necessary to completely detail the existing substructure’s dimensions and elevations. Only the dimensions and elevations necessary to perform the substructure removal should be shown.

ABUTMENT/PIER PLAN AND ELEVATION

The intent of this drawing is to locate and detail concrete dimensions of a single substructure. It shall contain a plan view, elevation view and any necessary tables and notes. All substructure elevation views except the begin abutment shall be taken looking up station.
ABUTMENT/PIER DETAILS

The intent of this drawing is to provide all details necessary to construct the substructure not shown on the Plan and Elevation drawing. This drawing shall include pile layout, reinforcement plans, reinforcement elevations, sections, details, and any necessary tables and notes. When two or more substructures share an identical detail the detail may be shown only on the first substructure drawing and then referred to later by note. The designer shall ensure that the drawing includes enough sections to clearly define where all reinforcement is located. When indicating applicable bar marks, if corrosion protection is applicable, designate epoxy (E), galvanized (G), stainless steel clad (C) or solid stainless steel (S).

BEARINGS

This drawing shall include all information required for the bearing manufacturer to produce the proposed bearings. If the bearings consist of plain rubber pads or elastomeric bearings without masonry plates, as used with prestressed box beams and slab units, then they can be detailed on the Beam Details drawings.

TRANSVERSE SECTION

This drawing shall show the transverse section and the diaphragm details. Diaphragm details should be shown in a separate detail but may also be shown in the transverse section as an example. A fascia detail should also be provided.

FRAMING PLAN (steel and spread prestressed concrete superstructures)

This drawing shall show a plan view line drawing representation of the girders or beams and cross frames.

BEAM LAYOUT (adjacent prestressed concrete superstructures)

This drawing shall show a plan view representation of the proposed beams.

GIRDER DETAILS (steel superstructures)

The intent of this drawing is to provide all details necessary to fabricate the girders that are not shown in the framing plan. This drawing shall include girder elevation, girder sections, miscellaneous steel details, camber table, camber diagram, moment and shear table combined for both HL-93 and NYSDOT design permit vehicle, design load table, field splice details, and necessary notes.

BEAM DETAILS (prestressed concrete superstructures)

The intent of this drawing is to provide all details necessary to fabricate the prestressed beams that are not shown in the framing plan or beam layout. This drawing shall include beam plan, beam reinforcement plan, beam reinforcement elevation, beam sections, end block reinforcement detail, design load table; beam reinforcement table and bar bending diagrams, miscellaneous prestressed beam details, camber table, design load table and necessary notes.
ABUTMENT DETAILS

PILE LAYOUT

☐ North arrow
☐ Any notes required from the FDR
☐ Outline of footing plan
☐ Station of intersection of the centerline of bearings and station line
☐ Tie the pile spacing to the intersection of the centerline of bearings and station line
☐ Show pile batter and location of battered piles
☐ Splice detail
☐ Reinforced tip for steel piles detail
☐ Reinforcement details for concrete piles
☐
☐ Estimated pile length
☐ Pile cut off elevation
☐ Number all piles and include table for actual driven length
☐ Pile item number

FOOTING REINFORCEMENT PLAN (Omit for integral abutments)

☐ Outline of footing
☐ All applicable bar marks of all bars totally contained in or originating in the footing
☐ Cover to exposed faces (if different from standard cover note)
☐ Laps lengths
☐ Indicate if a bar is lapped to a bar with a different bar mark
☐ Spacing of reinforcement tied down to an exposed face

STEM AND LOWER WINGWALL REINFORCEMENT PLAN

☐ Outline of stem and lower wingwalls (Include dashed outlines of piles and partial dashed outlines of girders/beams for integral abutments)
☐ All applicable bar marks of all bars totally contained in the stem and lower wingwall except bars extending into the pedestal (lower wingwall bars in flared wingwalls are normally omitted and referenced to the wingwall reinforcement elevation)
☐ Cover to exposed faces (if different from standard cover note)
☐ Lap lengths
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of reinforcement tied down to an exposed face
BACKWALL AND UPPER WINGWALL REINFORCEMENT PLAN

☐ Outline of backwall and upper wingwalls (Include partial outlines of girders/beams for integral abutments)
☐ All applicable bar marks of all bars totally contained in or originating in the backwall and wingwall (upper wingwall bars in flared wingwalls are normally omitted and referenced to the wingwall reinforcement elevation)
☐ If the bridge has concrete barriers, add note: Barrier bars originating in u-wingwalls not shown, refer to barrier reinforcement plans.
☐ Cover to exposed faces (if different from standard cover note)
☐ Lap lengths
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of reinforcement tied down to an exposed face
☐ Header and approach slab blockout for bridges with joint systems

HEADER REINFORCEMENT PLAN

☐ Outline of header
☐ All applicable bar marks of all bars totally contained in the header
☐ Cover to exposed faces (if different from standard cover note)
☐ Lap lengths
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of reinforcement tied down to an exposed face

ABUTMENT AND WINGWALL REINFORCEMENT ELEVATION (integral abutments only)

☐ Outline of abutment and wingwalls
☐ All applicable bar marks of all bars totally contained or originating in the abutment and wingwalls that can’t be called out in the plan views. Usually this consists of horizontal reinforcement bars that can’t be called out with clarity in the plan views.
☐ Cover to exposed faces (if different from standard cover note)
☐ Lap lengths
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of reinforcement tied down to an exposed face

WINGWALL REINFORCEMENT ELEVATIONS (flared wingwalls only)

☐ Outline of wingwalls
☐ All applicable bar marks of all bars totally contained in the wingwalls
☐ Cover to exposed faces (if different from standard cover note)
☐ Lap lengths
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of reinforcement tied down to an exposed face
PIER PLAN AND ELEVATION

MISCELLANEOUS

☐ Concrete Table of placement numbers, item numbers and volume estimates
☐ See Foundation Design Report (FDR) for appropriate notes.

PLAN

☐ North arrow
☐ Outline of the pier
☐ Station line
☐ Tangent azimuth of station line at the centerline of bearings
☐ Centerline of bearing station
☐ Azimuth of centerline of bearings
☐ Skew angle
☐ Azimuth of stringers or angle stringers make with centerline of bearings
☐ Center to center spacing of the centerline of the beams measured perpendicular to the beam azimuth
☐ Center to center spacing of the centerline of the beams measured along the centerline of bearings azimuth and tied to a working line
☐ Girders/beams numbered
☐ Pedestal widths
☐ All dimensions required to construct the pier tied to the centerline of bearings and station line
☐ Expansion, construction or contraction joints labeled and tied down to working line
☐ Anchor bolt location
☐ Wash requirements of pier cap

ELEVATION

☐ Outline of the pier
☐ Indicate concrete placement numbers
☐ Column spacing
☐ All elevations and dimensions required to construct the pier
☐ Wash requirements of pier cap

SECTION OR END ELEVATION

☐ Outline of section or end of pier elevation
☐ Indicate concrete placement numbers
☐ All elevations and dimensions required to construct the pier
☐ Wash requirements of pier cap
☐ Keyway between footing and column/plinth/pier stem
PIER DETAILS

PILE LAYOUT

☐ North arrow
☐ Outline of footing plan
☐ Station of intersection of the centerline of bearings and station line
☐ Tie the pile spacing to the intersection of the centerline of bearings and station line
☐ Show pile batter and location of battered piles
☐ Splice detail (if not shown on abutment sheets, otherwise reference where detail is located)
☐ Reinforced tip for steel piles detail (if not shown on abutment sheets, otherwise reference where detail is located) (per FDR)
☐ Reinforcement details for concrete piles (if not shown on abutment sheets, otherwise reference where detail is located)
☐ Any note required from the FDR
☐ Estimated pile length (per FDR)
☐ Pile item number
☐ Pile cut off elevation
☐ Number all piles and include table for actual driven length (per FDR)

FOOTING REINFORCEMENT PLAN

☐ Outline of footing
☐ All applicable bar marks of all bars totally contained in or originating in the footing
☐ Cover to exposed faces (if different from standard cover note)
☐ Laps lengths
☐ Indicate if a bar is lapped to a bar with a different bar mark
☐ Spacing of reinforcement tied down to an exposed face

PIER REINFORCEMENT ELEVATION

☐ Outline of pier
☐ All applicable bar marks of all bars totally contained in or originating in the pier except the bars extending into the pedestals
☐ Cover to exposed faces (if different from standard cover note)
☐ Lap lengths
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of reinforcement tied down to an exposed face
☐ Separate Cap Beam Reinforcement Elevation may be required for clarity.

PIER REINFORCEMENT SECTION

☐ Outline of pier section
BEAM DETAILS
(Concrete Bulb Tee and I-Beam Superstructures)

BEAM PLAN
☐ Overall beam length
☐ Span length(s)
☐ Centerline of bearings
☐ Diaphragm lengths
☐ Beam overhang over the centerline of bearings
☐ Overall beam length
☐ Flange clipping detail (skews over 15°)
☐ Indicate Beam Item number
☐ Continuous connection details

BEAM REINFORCEMENT PLAN
☐ Outline of beam
☐ All applicable bar marks
☐ Cover to exposed faces
☐ Lap lengths
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of reinforcement tied down to an exposed face

BEAM REINFORCEMENT ELEVATION
☐ Outline of beam
☐ All applicable bar marks
☐ Cover to exposed faces
☐ Lap lengths
☐ Indicate if a bar is lapped to another bar with a different mark
☐ Spacing of reinforcement tied down to an exposed face
☐ Enough sections taken to clearly define the beam and its reinforcement

BEAM SECTIONS
☐ Reinforcement details
☐ Strand pattern
☐ Dimensioned
☐ Cover
☐ Composite shear bars
END ZONE REINFORCEMENT DETAIL

☐ Outline of beam end
☐ All applicable bar marks
☐ Cover to exposed faces
☐ Lap lengths
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of reinforcement tied down to an exposed face

DESIGN LOAD TABLE

Dead loads (kips/ft), max. shear (kips) at support and moment (kips-ft) at midspan:

☐ Beam
☐ Slab
☐ Diaphragms
☐ Haunch
☐ SIP/FSIP forms
☐ Utilities

Superimposed dead loads (kips/ft), max. shear (kips) at support and moment (kips-ft) at midspan:

☐ Sidewalk
☐ Railing or Barrier
☐ Future wearing surface

Live load in HL-93 truck notation and NYSDOT Permit Vehicle:

☐ Live load information denoted below table

BEAM REINFORCEMENT TABLE AND BAR BENDING DIAGRAMS

☐ All bar marks and bar bending diagrams required to construct the beam

CAMBER TABLE

☐ Camber due to prestressed force and beam dead load at transfer
☐ Camber due to deflection due to slab dead load
☐ Camber due to deflection due to superimposed dead load
☐ Total camber
HAUNCH/SLAB THICKNESS TABLES

HAUNCH TABLE (Steel and Spread Prestressed Concrete Superstructures)

Separate groups of the following rows for each girder at 1/10 points:

☐ A. Required bottom of slab elevation
☐ B. Top of steel elevation (Field measure)
☐ C = A – B. (Difference between bottom of slab and top of steel elevation)
☐ D. Concrete + Superimposed dead load deflection
☐ E. = C + D. Depth of haunch required equal to the sum of the concrete and
superimposed dead load deflections and the difference between the bottom of slab
and top of steel elevations

GIRDER HAUNCH DETAIL (Steel and Spread Prestressed Concrete Superstructures)

☐ Actual dimension measured from top of web to bottom of slab at the centerline of
bearings

SLAB THICKNESS TABLE (Adjacent Prestressed Concrete Beams)

Separate groups of the following rows for each beam at 1/4 or 1/10 points:
(number of points depends upon length of structure and amount of change occurring)

☐ A. Required top of slab elevation @ centerline of beam
☐ B. Top of beam elevation (field measure)
☐ C = A – B. (Difference between top of slab and top of beam elevation)
☐ D. Slab and SDL deflection
☐ E. Actual slab thickness = C + D
SUPERSTRUCTURE SLAB

SLAB REINFORCEMENT PLAN

☐ Overall length of structure
☐ TGL
☐ Station line
☐ Limits of structural slab, sawcut grooving and protective sealing items
☐ All applicable bar marks of all bars totally contained or originating in the slab
☐ If the bridge has concrete barriers, add note: Barrier bars originating in slab not shown, refer to barrier reinforcement plans.
☐ Cover to exposed faces
☐ Lap lengths
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of slab reinforcement tied down to an exposed face
☐ Indicate section marks (end section)
☐ Centerline of bearing stations

END SECTION

☐ Outline of the slab, top of the abutment and the beginning of the approach slab
☐ All applicable bar marks of all bars
☐ Limits of sawcut grooving
☐ Cover to exposed faces
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of slab reinforcement tied down to an exposed face
☐ Gap between the slab and the backwall (conventional abutment only)

MISCELLANEOUS SLAB DETAILS

☐ Continuous deck slab placement detail
☐ Concrete table of area of superstructure slab, area of sawcut grooving and the area of protective sealer with item numbers
☐ Do not haunch slab down to end diaphragm at jointless abutments
☐ Indicate direction of placement if true grade exceeds 3%
☐ Haunch reinforcement detail
☐ Sidewalk reinforcement plan with item number

SUPERSTRUCTURE SLAB OPTIONAL FORMING SYSTEMS

☐ Permanent corrugated metal form detail
☐ Prestressed concrete form unit details (Omit for Isotropic Deck Reinforcement or when their use isn’t required (most cases))
☐ Form unit notes
APPROACH SLABS

APPROACH SLAB REINFORCEMENT PLAN

☐ Length and width of approach slabs and sleeper slabs (if required)
☐ TGL
☐ Station line
☐ Limits of approach slab and protective sealer items
☐ Limits of sawcut grooving item
☐ All applicable bar marks of all bars totally contained in the approach slabs and sleeper slabs
☐ Cover to exposed faces
☐ Lap lengths
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of approach slab reinforcement tied down to an exposed face
☐ Indicate section marks (taken transversely through the end of the approach slabs and sleeper slabs)

END SECTION

☐ Outline of the slab and sleeper slabs from the abutment to the beginning of the approach roadway
☐ Thickness of approach slab
☐ All applicable bar marks of all bars
☐ Cover to exposed faces
☐ Indicate if a bar is lapped to another bar with a different bar mark
☐ Spacing of slab reinforcement tied down to an exposed face

MISCELLANEOUS APPROACH SLAB DETAILS

☐ Provide table of area of approach slab and sleeper slabs, area of sawcut grooving and area of protective sealer with the appropriate item numbers
☐ Corner plan details
☐ Connection detail to abutment for integral and jointless details
☐ Joint recess/sealing detail
JOINT SYSTEM

JOINT DETAILS

☐ Plan view(s)
☐ Sections; longitudinal and transverse
☐ End and miscellaneous details
☐ Fascia, barrier and sidewalk details
☐ Joint table
☐ Indicate each joint location and item number
BARRIER/RAILING

BARRIER LAYOUT PLAN
☐ Outline of superstructure slab and abutments
☐ Outline of barriers
☐ TGL and Station/Horizontal Control Line
☐ Centerline of bearings
☐ Pay limits of the barrier item
☐ Pay limits of the railing transition item

BARRIER PLANS
☐ Outline of barriers
☐ All applicable bar marks of all barrier bars (this includes barrier bars originating in the superstructure slab or abutment u-walls)
☐ Length of barriers and barrier transitions dimensioned
☐ Indicate item number

BARRIER TRANSITION ELEVATION
☐ Outline of barrier transition
☐ Pipe sleeves indicated and located for attaching box beam guide rail transition
☐ Dimensions required to construct barrier transition

BARRIER REINFORCEMENT SECTIONS
☐ Outline of barrier at sections
☐ All applicable bar marks of all barrier bars (this includes barrier bars originating in the superstructure slab or abutment u-walls)

BARRIER SECTIONS
☐ Outline of barrier at sections
☐ All dimensions required to construct the barrier and barrier transition
☐ Dimension the location of box beam guide rails and indicate it’s attachment to barrier at transition

CONCRETE BARRIER GROOVE SPACING
☐ Outline of barrier in elevation and section showing construction groove spacing, details and notes

PLAN AND ELEVATION OF RAILING/BARRIER TRANSITION TO HIGHWAY BOX BEAM
☐ Indicate and locate all transition railing components
☐ Indicate item number
RAILING LAYOUT PLAN

☐ Outline of superstructure slab and abutments
☐ TGL
☐ Station line
☐ Centerline of end posts tied down to the front face of the backwall
☐ Even spacing between the posts
☐ Pay limits of the railing item
☐ Centerline of railing anchorage
☐ Station and offset distance to post from HCL
☐ Indicate item numbers

RAILING DETAILS

☐ Outline of railing in section and elevation showing anchorage into superstructure
☐ Indicate, locate and dimension all railing and railing anchorage components
☐ Show anchor plate(s) and base plate details

RAILING SPLICE ELEVATION

☐ Show minimum distance from railing post to centerline of fixed and expansion splice assembly

RAILING SPLICE DETAILS

☐ Indicate and dimension all railing splice assembly components

SPECIAL POST DETAILS

☐ Indicate and locate on abutment backwall in plan view
☐ Show elevation at post, indicate and dimension all components
☐ Show anchor plate and base plate details

SNOW AND PEDESTRIAN FENCING DETAILS

☐ Outline of fencing in section and elevation showing attachment to railing/barrier
☐ Show fencing pay limits and item number on railing layout sheet or in case of barriers, show pay limits dimensioned from end of barrier in the elevation view
☐ Indicate, locate and dimension fencing and fencing attachment/anchorage components
☐ Show post anchor plate or pipe clamp anchor details, whichever is applicable
☐ Indicate and dimension all railing splice components
17.3 **General Notes Sheet/Superstructure Slab Sheet**

The following is a compilation of the standard notes that are usually placed on the General Notes sheet and the Superstructure sheet of the contract plans. Standard notes to be placed on the plans are in bold upper case font. Commentary and advice to designers are in normal lower case font. Notes are numbered here; they shall generally not be numbered on the plans.

An index of the standard note numbers is given below:

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| SUPERSTRUCTURE SLAB SHEET                   |          |
| Deck Placement Notes                       | 155 - 170|
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GENERAL NOTES SHEET

1. GENERAL NOTES

In the following notes, insert the month and year of the PS & E:

2. DESIGN SPECIFICATIONS: NEW YORK STATE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES WITH ALL PROVISIONS IN EFFECT AS OF __________. (FOR DESIGN PURPOSES, COMPRESSIVE STRENGTH OF CONCRETE FOR SUBSTRUCTURES AND DECK SLABS AT 28 DAYS: $f'c = 3000$ psi.)

or

3. DESIGN SPECIFICATIONS: NYSDOT LRFD BRIDGE DESIGN SPECIFICATIONS WITH ALL PROVISIONS IN EFFECT AS OF __________ (FOR DESIGN PURPOSES, COMPRESSIVE STRENGTH OF CONCRETE FOR SUBSTRUCTURES AND DECK SLABS AT 28 DAYS: $f'c = 3000$ psi.)

The following live load notes are to be used for new and replacement bridges. On superstructure replacements, the existing substructures shall not be upgraded solely to accommodate these live load criteria.

4. LIVE LOAD: HS25 OR TWO 24,000 LB AXLES SPACED 4 FEET ON CTRS. (Use only for bridges carrying either the mainline of Interstate highways or the Southern Tier Expressway designed with NYSDOT Standard Specifications for Highway Bridges.)

5. LIVE LOAD: HS25 (Use for all other highway bridges designed with NYSDOT Standard Specifications for Highway Bridges.)

6. LIVE LOAD: AASHTO HL - 93 AND NYSDOT DESIGN PERMIT VEHICLE. (Use for bridges designed by the LRFD specifications.)

7. THE TEMPORARY STRUCTURE SHALL BE DESIGNED IN ACCORDANCE WITH THE CURRENT STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES FOR A DESIGN LOAD OF __________.

Use the following two notes for structures carrying railroads.

8. DESIGN SPECIFICATIONS: CURRENT AMERICAN RAILWAY ENGINEERING AND MAINTENANCE ASSOCIATION MANUAL FOR RAILWAY ENGINEERING.

9. RAILROAD LIVE LOAD: COOPER E80.

10. CONSTRUCTION AND MATERIALS SPECIFICATIONS: STANDARD SPECIFICATIONS, CONSTRUCTION AND MATERIALS, NEW YORK STATE DEPARTMENT OF TRANSPORTATION, OFFICE OF ENGINEERING, DATED MAY 1, 2008, WITH CURRENT ADDITIONS AND MODIFICATIONS.
63. FOR THE VARIOUS LUMP SUM STRUCTURAL STEEL ITEMS IN THE CONTRACT, THE "TOTAL WEIGHT FOR PROGRESS PAYMENT" IS AS FOLLOWS:

<table>
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<th>ITEM</th>
<th>TOTAL WEIGHT FOR PROGRESS PAYMENT</th>
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These weights shall be used in determining partial payments and progress. Under no circumstances shall the "TOTAL WEIGHT FOR PROGRESS PAYMENT" be used for final payment purposes. The contractor is advised not to use the "TOTAL WEIGHT FOR PROGRESS PAYMENT" as a bidding tool. Discrepancies which may occur between the total weight shipped and "TOTAL WEIGHT FOR PROGRESS PAYMENT" shall not be a basis for additional compensation.

One of the following notes shall be included with the superstructure for all steel bridges with straight girders that do not have integral abutments:

64. DIAPHRAGMS FOR SKEWED STRAIGHT GIRDER SUPERSTRUCTURES SHALL BE FABRICATED TO FIT GIRDERs ERECTED WITH THEIR WEBS LAID OVER (OUT OF PLUMB) UNDER THE STEEL DEAD LOAD CONDITION. GIRDER WEBS SHALL BE VERTICAL AFTER APPLICATION OF FULL DEAD LOAD.

or

65. DIAPHRAGMS FOR NONSKEWED STRAIGHT GIRDER SUPERSTRUCTURES SHALL BE FABRICATED TO FIT GIRDERs ERECTED WITH THEIR WEBS VERTICAL UNDER STEEL AND FULL DEAD LOAD CONDITIONS.

The following note shall be included with the superstructure for all steel bridges with curved girders that do not have integral abutments:

66. DIAPHRAGMS FOR ALL CURVED GIRDER SUPERSTRUCTURES SHALL BE FABRICATED TO FIT GIRDERs ERECTED WITH THEIR WEBS LAID OVER (OUT OF PLUMB) UNDER THE STEEL DEAD LOAD CONDITION. GIRDER WEBS SHALL BE VERTICAL AFTER APPLICATION OF FULL DEAD LOAD.

The following notes A1 or A2 and note B shall be used when structural steel is to be erected. Use note A1 if the girder fails the stability check or A2 if the girder passes the stability check based on the results required by NYSDOT LRFD Blue Page 6.10.3.1a:

67. STEEL ERECTION NOTES:

A1. THE CONTRACTOR SHALL PROVIDE FOR THE STABILITY OF STRUCTURAL STEEL DURING ALL PHASES OF ERECTION AND CONSTRUCTION, AS PROVIDED IN SUBSECTION 204 OF THE NEW YORK STATE STEEL CONSTRUCTION MANUAL (SCM). THE GIRDERs ON THIS BRIDGE SHALL BE STABILIZED DURING ERECTION BY USE OF FALSEWORK, TEMPORARY BRACING, COMPRESSION FLANGE STIFFENING TRUSSES, CHOOSING ALTERNATE PICKING POINTS, OR BY USE OF A HOLDING CRANE UNTIL A SUFFICIENT NUMBER OF GIRDERs HAVE BEEN ERECTED AND CROSS FRAMES INSTALLED. THE METHODS USED BY THE CONTRACTOR SHALL BE...
DOCUMENTED ON THE ERECTION DRAWINGS WITH ALL SUPPORTING STABILITY CALCULATIONS SUBMITTED AND STAMPED BY A LICENSED NEW YORK STATE PROFESSIONAL ENGINEER AND SUBMITTED TO THE DCES IN ACCORDANCE WITH THE SCM.

A2. THE CONTRACTOR SHALL PROVIDE FOR THE STABILITY OF STRUCTURAL STEEL DURING ALL PHASES OF ERECTION AND CONSTRUCTION, AS PROVIDED IN SUBSECTION 204 OF THE NEW YORK STATE STEEL CONSTRUCTION MANUAL (SCM). THE METHODS USED BY THE CONTRACTOR SHALL BE DOCUMENTED ON THE ERECTION DRAWINGS WITH ALL SUPPORTING STABILITY CALCULATIONS SUBMITTED AND STAMPED BY A LICENSED NEW YORK STATE PROFESSIONAL ENGINEER AND SUBMITTED TO THE DCES IN ACCORDANCE WITH THE SCM.

B. THE DESIGN OF THIS STRUCTURE ASSUMES THAT THE STRUCTURAL STEEL IS COMPLETELY ERECTED BEFORE IT IS ALLOWED TO DEFLECT UNDER ITS OWN DEAD LOAD. DEFLECTIONS INCURRED DURING THE VARIOUS STAGES OF THE ERECTION METHOD ARE NOT CONSIDERED. THEREFORE, THE ACTUAL ERECTION METHODS AND SEQUENCES EMPLOYED BY THE CONTRACTOR MAY HAVE A SUBSTANTIAL EFFECT ON THE FINAL STEEL PROFILE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR TAKING ALL NECESSARY COMPENSATORY ACTION TO ENSURE THAT THE FINAL ALIGNMENT AND PROFILE OF THE ERECTED STEEL CONFORMS TO SUBSECTION 1213, 1214, AND 1215 OF THE NEW YORK STATE STEEL CONSTRUCTION MANUAL (SCM). ANY CORRECTIVE WORK NECESSARY TO RE-POSITION PREVIOUSLY ERECTED STEEL TO ACHIEVE ACCEPTABLE ALIGNMENT AND PROFILE MUST BE APPROVED BY THE D.C.E.S., AND SHALL BE PERFORMED AT NO ADDITIONAL COST TO THE STATE.

68. IF THE CONTRACTOR ELECTS TO MOVE THE SPLICE LOCATION SHOWN ON THE PLANS, IT IS THE CONTRACTOR’S RESPONSIBILITY TO HAVE A NEW YORK STATE PROFESSIONAL ENGINEER REDESIGN THE SPLICE. COST OF REDESIGN TO BE INCLUDED IN THE STEEL BID ITEM.

Use one of the following two notes if a Concrete Barrier, the payment for which includes its reinforcement, is used on the bridge:

69. THE DETAILS FOR THE BARRIER REINFORCEMENT ARE FOR THE SLIP-FORMED OR CAST-IN-PLACE OPTION ONLY. COST OF BARRIER AND ANCHORAGE REINFORCEMENT ORIGINATING IN THE SLAB SHALL BE INCLUDED IN THE UNIT PRICE BID FOR THE BARRIER ITEM.

or

70. THE DETAILS FOR THE BARRIER REINFORCEMENT ARE FOR THE SLIP-FORMED OR CAST-IN-PLACE OPTION ONLY. COST OF BARRIER AND ANCHORAGE REINFORCEMENT ORIGINATING IN THE SLAB SHALL BE INCLUDED IN THE UNIT PRICE BID FOR THE BARRIER ITEM. COST OF BARRIER ANCHORAGE REINFORCEMENT ORIGINATING IN THE PRESTRESSED UNIT SHALL BE INCLUDED IN THE UNIT PRICE BID FOR THE PRESTRESSED UNIT ITEM.
Use the following note if single slope concrete barrier is specified and service level TL-5 is required:

71. **THE CONTRACTOR'S ATTENTION IS DIRECTED TO THE PROVISIONS OF THE CURRENT SPECIFICATIONS FOR PERMANENT CONCRETE TRAFFIC BARRIER FOR STRUCTURES, WHICH ALLOWS THE OPTION OF THREE CONSTRUCTION METHODS: CAST-IN-PLACE, SLIP FORMED, OR PRECAST. HOWEVER, ON THIS BRIDGE, ONLY CAST-IN-PLACE AND SLIP FORMING ARE ALLOWED.**

Use the following note if steel bridge railing is used on the bridge and any of the situations described in section 6.9 of this manual occur:

72. **FOR BIN XXXXXXX, SHOP DRAWING SUBMITTALS ARE REQUIRED FOR THE FOLLOWING BRIDGE RAIL/TRANSITION ITEMS: 568.XX,**

Use the following note when Protective Sealer is to be applied to new bridge decks and approach slabs:

73. **TOP SURFACES OF NEW BRIDGE DECKS AND APPROACH SLABS SHALL BE SEALED ACCORDING TO ITEM 559.1896 18–PROTECTIVE SEALING OF STRUCTURAL CONCRETE ON NEW BRIDGE DECKS AND BRIDGE DECK OVERLAYS.**

Use the following note whenever Open Steel Floor Grating is used on structures. If the grating is specified to be painted, Note 61 shall also be used.

74. **OPEN STEEL FLOOR GRATING SHALL BE GALVANIZED IN ACCORDANCE WITH THE REQUIREMENTS OF 719-01 GALVANIZED COATINGS AND REPAIR METHODS OF THE STANDARD SPECIFICATIONS.**

75. **REMOVAL NOTES**

The following two notes shall be used when the project is replacing an existing structure. The preliminary bridge plans must indicate location on General Plan or Location Plan:

76. **EXISTING SUBSTRUCTURE SHALL BE REMOVED WITHIN THE LIMITS SHOWN ON THE PLANS UNDER ITEM 202.19 IN THE BRIDGE ESTIMATE.**

77. **EXISTING SUPERSTRUCTURE SHALL BE REMOVED UNDER ITEM 202.12nnnn IN THE BRIDGE ESTIMATE.**

Use one of the following two notes when structures longer than 20 ft. are being removed. Refer to Appendix 17A for guidance on determining whether a removal plan prepared by a Professional Engineer is required.

78. **THE CONTRACTOR'S ATTENTION IS DIRECTED TO THE REQUIREMENTS OF SUBSECTION 202-3.01 GENERAL AND SAFETY REQUIREMENTS. A REMOVAL PLAN, SIGNED BY A REGISTERED PROFESSIONAL ENGINEER IN THE STATE OF NEW YORK, SHALL BE SUBMITTED TO THE ENGINEER THIRTY (30) DAYS PRIOR TO BEGINNING THE DEMOLITION.**
79. THE CONTRACTOR'S ATTENTION IS DIRECTED TO THE REQUIREMENTS OF SUBSECTION 202-3.01 GENERAL AND SAFETY REQUIREMENTS. A REMOVAL PLAN SHALL BE SUBMITTED TO THE ENGINEER FIFTEEN (15) DAYS PRIOR TO BEGINNING THE DEMOLITION. THE REQUIREMENT THAT IT BE SIGNED BY A REGISTERED PROFESSIONAL ENGINEER IS WAIVED.

In addition to one of the above notes, either of the following should also be placed on the Contract Plans:

80. RECORD PLANS FOR THIS STRUCTURE ARE AVAILABLE AT THE REGIONAL OFFICE OF THE DEPARTMENT OF TRANSPORTATION.

or

81. RECORD PLANS FOR THIS STRUCTURE ARE NOT AVAILABLE.

Use Note 82, and, if applicable, Note 83 and Note 84 if a steel superstructure containing lead-based paint is being removed:

82. SUPERSTRUCTURE (OR SUBSTRUCTURE) REMOVAL NOTES:

LIMITS AND METHODS FOR REMOVAL OF PAINT AT LOCATIONS OF FASTENER REMOVAL OR FLAME CUTTING SHALL BE AS DESCRIBED IN SUBSECTIONS 202-3.05 AND 574 OF THE STANDARD SPECIFICATIONS. THE COST OF PAINT REMOVAL SHALL BE INCLUDED IN THE LUMP SUM PRICE(S) BID FOR THE SUPERSTRUCTURE REMOVAL ITEM(S) (OR THE UNIT PRICE BID FOR THE SUBSTRUCTURE REMOVAL ITEM). PAINT WASTE NOT COLLECTED BY VACUUM METHODS SHALL BE COLLECTED USING THE ENVIRONMENTAL GROUND AND/OR WATERWAY PROTECTION ITEM(S). WASTE SHALL BE DISPOSED OF USING THE TREATMENT AND DISPOSAL OF PAINT REMOVAL WASTE ITEM.

In addition to paint removal described above at locations of dismantling and removal operations, there may exist areas of loose or peeling paint on various steel surfaces which are likely to become dislodged during removal operations or during transportation from the site. If this condition is confirmed, either by referring to the latest Bridge Inspection Report, by observation by the designer or by Regional personnel at the request of the designer, the following note should be placed on either the General Notes sheet or the Superstructure (or Substructure) Removal sheet:

83. LOOSE AND/OR PEELING PAINT ON STEEL SURFACES MAY BECOME DISLODGED DURING REMOVAL OPERATIONS OR DURING TRANSPORTATION FROM THE SITE UNLESS APPROPRIATE MEASURES ARE TAKEN. THE CONTRACTOR SHALL FORMULATE AND SUBMIT A METHOD OF REMEDIATING THE CONDITION FOR APPROVAL BY THE ENGINEER. WORKER LEAD PROTECTION IN ACCORDANCE WITH OSHA 1926.62 MUST BE SATISFIED. ALTERNATIVES COULD INCLUDE TRANSPORTING AFFECTED MEMBERS IN CLOSED TRUCKS, WRAPPING AFFECTED MEMBERS PRIOR TO REMOVAL, ENCAPSULATING THE LOOSE PAINT OR REMOVAL OF LOOSE PAINT PRIOR TO DISMANTLING OPERATIONS. THE COST OF REMEDIATING THIS CONDITION SHALL BE INCLUDED IN THE LUMP SUM PRICE(S) BID FOR THE SUPERSTRUCTURE REMOVAL ITEM(S) (OR THE UNIT PRICE BID FOR THE SUBSTRUCTURE REMOVAL ITEM.) THE USE OF ENVIRONMENTAL GROUND AND/OR

84. REFER TO SUBSECTION 107-05 OF THE STANDARD SPECIFICATIONS FOR SAFETY AND HEALTH REQUIREMENTS.

85. RECONSTRUCTION NOTES

Use Notes 86-92 on all reconstruction projects.

86. THE CONTRACTOR'S ATTENTION IS DIRECTED TO THE FACT THAT, DUE TO THE NATURE OF RECONSTRUCTION PROJECTS, THE EXACT EXTENT OF RECONSTRUCTION WORK CANNOT ALWAYS BE ACCURATELY DETERMINED PRIOR TO THE COMMENCEMENT OF WORK. THESE CONTRACT DOCUMENTS HAVE BEEN PREPARED BASED ON FIELD INSPECTION AND OTHER INFORMATION AVAILABLE AT THE TIME. ACTUAL FIELD CONDITIONS MAY REQUIRE MODIFICATIONS TO CONSTRUCTION DETAILS AND WORK QUANTITIES. THE CONTRACTOR SHALL PERFORM THE WORK IN ACCORDANCE WITH FIELD CONDITIONS.

87. THE CONTRACTOR SHALL VERIFY DIMENSIONS NECESSARY FOR THE PROPER FIT OF STEEL PIECES PRIOR TO THE FABRICATION OF THE STEEL. THE COST OF FIELD VERIFYING DIMENSIONS SHALL BE INCLUDED IN THE PRICE BID FOR STRUCTURAL STEEL ITEMS.

88. THE CONTRACTOR SHALL PERFORM ALL WORK WITH CARE SO THAT ANY MATERIALS WHICH ARE TO REMAIN IN PLACE, OR WHICH ARE TO REMAIN THE PROPERTY OF THE STATE, WILL NOT BE DAMAGED. IF THE CONTRACTOR DAMAGES ANY MATERIALS WHICH ARE TO REMAIN IN PLACE OR WHICH ARE TO REMAIN THE PROPERTY OF THE STATE, THE DAMAGED MATERIALS SHALL BE REPAIRED OR REPLACED IN A MANNER SATISFACTORY TO THE ENGINEER AT THE EXPENSE OF THE CONTRACTOR.

89. WHenever ITEMS IN THE CONTRACT REQUIRE MATERIALS TO BE REMOVED AND DISPOSED OF, THE COST OF SUPPLYING A DISPOSAL AREA AND TRANSPORTATION TO THAT AREA SHALL BE INCLUDED IN THE UNIT PRICES BID FOR THOSE ITEMS.

90. DURING REMOVAL OPERATIONS, THE CONTRACTOR SHALL NOT BE ALLOWED TO DROP WASTE CONCRETE, DEBRIS AND OTHER MATERIAL TO THE AREA BELOW THE BRIDGE EXCEPT WHERE THE PLANS SPECIFICALLY PERMIT THE DROPPING OF MATERIAL. PLATFORMS, NETS, SCREENS OR OTHER PROTECTIVE DEVICES SHALL BE USED TO CATCH THE MATERIAL. IF THE ENGINEER DETERMINES THAT ADEQUATE PROTECTIVE DEVICES ARE NOT BEING EMPLOYED, THE WORK SHALL BE SUSPENDED UNTIL ADEQUATE PROTECTION IS PROVIDED.

91. ALL MATERIAL FALLING ON THE AREA BELOW AND ADJACENT TO THE BRIDGE SHALL BE REMOVED AND DISPOSED OF BY THE CONTRACTOR AT NO COST TO THE STATE.
92. THE COST OF FURNISHING, INSTALLING, MAINTAINING, REMOVING AND DISPOSING OF ALL PLATFORMS, NETS, SCREENS OR OTHER PROTECTIVE DEVICES SHALL BE INCLUDED IN THE UNIT PRICES BID FOR THE APPROPRIATE ITEMS OF THE CONTRACT.

Use Notes 93-100 as needed on reconstruction contracts:

93. THE DETAILS ON DRAWING NO. ___ INDICATE THE SPALLS, SCALES AND CRACKS NOTED ON A FIELD INSPECTION BY THE DESIGNER. ALL OF THE MAJOR AREAS OF SPALLING, SCALING AND CRACKING KNOWN TO EXIST AT THE TIME OF CONTRACT PREPARATION HAVE BEEN SHOWN TO INDICATE THE APPROXIMATE EXTENT OF DETERIORATION THAT WILL HAVE TO BE REPAIRED BY THE CONTRACTOR.

If the designer determines there is sufficient volume of concrete repair work required to justify the use of Shotcrete (40 - 60 bags of cement minimum), the following note should be used:

94. AREAS OF CONCRETE DETERIORATION THAT ARE GENERALLY 5 INCHES OR LESS IN DEPTH (LOCALIZED POCKETS MAY BE UP TO 12 INCHES DEEP) SHALL BE REPAIRED USING ITEM 583.02 – REMOVAL OF STRUCTURAL CONCRETE – REPLACEMENT WITH SHOTCRETE, NO REINFORCEMENT BAR ENCASEMENT OR ITEM 583.03 – REMOVAL OF STRUCTURAL CONCRETE-REPLACEMENT WITH SHOTCRETE, REINFORCEMENT BAR ENCASEMENT, AS APPROPRIATE.

AREAS THAT ARE GREATER IN DEPTH SHALL BE REPAIRED USING ITEM 582.05 – REMOVAL OF STRUCTURAL CONCRETE REPLACEMENT WITH CLASS A CONCRETE. THESE GUIDELINES ARE APPROXIMATE, AND THE FINAL DETERMINATION OF WHICH ITEM TO USE SHALL BE MADE BY THE ENGINEER.

If the designer determines there is not sufficient volume of concrete repair work required to justify the use of Shotcrete, the following note should be used:

95. AREAS OF CONCRETE DETERIORATION SHALL BE REPAIRED USING ITEM 582.05 - REMOVAL OF STRUCTURAL CONCRETE - REPLACEMENT WITH CLASS A CONCRETE, ITEM 582.06 - REMOVAL OF STRUCTURAL CONCRETE - REPLACEMENT WITH CLASS D CONCRETE, OR ITEM 582.07 - REMOVAL OF STRUCTURAL CONCRETE - REPLACEMENT WITH VERTICAL AND OVERHEAD PATCHING MATERIAL AS SHOWN ON THE PLANS OR AS ORDERED BY THE ENGINEER.

96. ALL CONCRETE SURFACES RECEIVING NEW CONCRETE SHALL BE SANDBLASTED. PRIOR TO THE APPLICATION OF NEW CONCRETE, THE SURFACES SHALL BE AIR CLEANED THEN PRE-WET FOR 12 HOURS. THERE WILL BE NO SEPARATE PAYMENT FOR THIS WORK. THE COST SHALL BE INCLUDED IN THE UNIT PRICES BID FOR THE VARIOUS CONCRETE ITEMS IN THE CONTRACT.

The following two Notes shall be used with caution, as this work is normally covered in the specifications. They should be used only if a special weight of hammer is necessary for limited areas. Use Note 97 for partial removals if the concrete to be removed is unsound. Use Note 98 for partial removals if the concrete to be removed is sound. Generally for concrete to be considered sound, the aggregate must fracture when struck with a hammer.
97. **CHIPPING HAMMERS USED TO REMOVE CONCRETE FROM THE FOLLOWING STRUCTURAL COMPONENTS SHALL NOT EXCEED 25 LB. IN WEIGHT WITH THE BIT REMOVED.**

or

98. **CHIPPING HAMMERS USED TO REMOVE CONCRETE FROM THE FOLLOWING STRUCTURAL COMPONENTS SHALL NOT EXCEED 40 LB. IN WEIGHT WITH THE BIT REMOVED.**

Use the following note when Protective Sealer is to be applied to existing bridge decks.

99. **TOP SURFACES OF EXISTING BRIDGE DECKS SHALL BE SEALED ACCORDING TO ITEM 559.1796 18 – PROTECTIVE SEALING OF STRUCTURAL CONCRETE FOR EXISTING BRIDGE DECKS.**

Use the following note when Protective Sealer is to be applied to existing concrete elements, other than bridge deck surfaces, containing uncoated bar reinforcement or having less than 3 inches of concrete cover (refer to 5.1.10 for additional guidelines). Complete the note so as to list the appropriate concrete elements for the particular bridge, and whether a penetrating type or coating type sealer is to be used on that element.

100. **THE FOLLOWING CONCRETE ELEMENTS SHALL BE SEALED ACCORDING TO ITEM 559.1696 18 - PROTECTIVE SEALING OF STRUCTURAL CONCRETE:**

Use the following note whenever a structural steel or prestressed concrete superstructure is to be replaced utilizing the existing substructures:

101. **IT SHALL BE THE CONTRACTOR’S RESPONSIBILITY TO CONFIRM THE FOLLOWING DIMENSIONS IN THE FIELD PRIOR TO THE FABRICATION OF NEW SUPERSTRUCTURE COMPONENTS:**

A. **EXISTING SPAN LENGTHS (CHECK AT MULTIPLE APPROPRIATE POINTS IF SUBSTRUCTURES ARE NONPARALLEL).**

B. **EXISTING LENGTHS OF INDIVIDUAL STRINGERS (IF ONLY CERTAIN STRINGERS ARE TO BE REPLACED).**

Use the following note whenever individual structural steel components are to be replaced:

102. **IT SHALL BE THE CONTRACTOR’S RESPONSIBILITY TO CONFIRM THE LENGTHS OF EXISTING STRUCTURAL STEEL COMPONENTS TO BE REPLACED PRIOR TO THE FABRICATION OF THE REPLACEMENT COMPONENTS.**

Use the following note whenever bearings are to be replaced on new or reconstructed pedestals:

103. **IT SHALL BE THE CONTRACTOR’S RESPONSIBILITY TO CONFIRM THE TOP OF PEDESTAL ELEVATIONS PRIOR TO CASTING THE NEW PEDESTALS AND INSTALLING THE NEW BEARINGS.**
Use the following note whenever bearings are to be replaced on the existing pedestals:

104. **THE COST OF FURNISHING AND INSTALLING SHIM PLATES FOR ADJUSTING BEARING HEIGHTS SHALL BE INCLUDED IN ITEM 564.51.nnnn, STRUCTURAL STEEL. THIS IS A CONTINGENCY ITEM THAT WILL ONLY BE PAID IF ACTUAL FIELD CONDITIONS CONFLICT WITH THE CONTRACT DOCUMENTS. THE SHIM PLATE MATERIAL SHALL BE CONSIDERED A MINOR ITEM AND THE UNIT PRICE BID IS NOT SUBJECT TO RENEGOTIATION IF THE QUANTITY VARIES FROM THE ESTIMATED QUANTITY.**

OFF SITE FABRICATION INSPECTION WILL USUALLY BE WAIVED FOR THE SHIM MATERIAL. MATERIAL CERTIFICATION AND DOCUMENTATION SHALL BE SUBMITTED TO THE EIC FOR ACCEPTANCE OF THE MATERIAL.

See Section 8.2.7 to determine which items and when to use the following two notes.

105. **SHOP DRAWINGS SHALL BE SUBMITTED TO THE D.C.E.S. FOR APPROVAL FOR THE FOLLOWING STRUCTURAL STEEL REPLACEMENT ITEMS:** (List the items.)

106. **SHOP DRAWINGS SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL FOR THE FOLLOWING STRUCTURAL STEEL REPLACEMENT ITEMS:** (List the items.)

Use the following note for rehabilitation contracts:

107. **IF THE STRUCTURE HAS A BRIDGE IDENTIFICATION NUMBER (B.I.N.) PLATE ATTACHED, IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO PROTECT IT DURING CONSTRUCTION OR REMOVE AND REMOUNT IT AFTER CONSTRUCTION IS COMPLETED.**

The following special note shall be included in the PS&E for each structure unless the field inspection indicates that less than 30% of the steel will require Near White Metal Blast Cleaning: (The designer should arrange for this field inspection not more than 1 year before the PS&E date. SSPC specifications should be used to determine the percent of steel surface area requiring Near White Metal Blast Cleaning to the nearest 20 percent, i.e., 0-20-40-60-80-100.)

108. **CLEANING STRUCTURAL STEEL ON EXISTING BRIDGES:**

**BIN # __________**

IT IS ANTICIPATED THAT A SIGNIFICANT PORTION OF THE STRUCTURAL STEEL IN THE BRIDGE(S) IDENTIFIED ABOVE WILL REQUIRE NEAR WHITE METAL BLAST CLEANING IN ACCORDANCE WITH SECTION 573 OF THE STANDARD SPECIFICATIONS. THEREFORE, BIDDERS SHOULD INSPECT THE BRIDGE(S) CAREFULLY PRIOR TO SUBMITTING BIDS.

Use the following note, if applicable, whenever Structural Lifting is part of the contract:

110. **VEHICULAR TRAFFIC OR CONSTRUCTION EQUIPMENT SHALL NOT BE PERMITTED ON THE LIFTED SPAN UNTIL SHIMS, CRIBBING, BOLSTERS OR OTHER SUITABLE SUPPORTS ARE IN THEIR REQUIRED POSITION.**

Use the following note if Conduits are encased, or are suspected to be encased, in the superstructure of a bridge undergoing rehabilitation:

111. **CONDUIT CAUTION NOTE:**

THE CONTRACTOR’S ATTENTION IS DIRECTED TO THE FACT THAT CONDUITS MAY BE PRESENT IN THE STRUCTURAL SLABS, PARAPETS OR SIDEWALKS OF BRIDGES RECEIVING NEW OR REWORKED JOINT SYSTEMS. THEIR EXISTENCE AND LOCATIONS SHALL BE FIELD VERIFIED. IF CONDUITS ARE PRESENT AND ARE ENCOUNTERED DURING CONSTRUCTION OPERATIONS, CARE SHALL BE EXERCISED NOT TO DAMAGE CONDUITS, EXPANSION COUPLINGS, OR CONTENTS OF CONDUITS. ANY DAMAGE SHALL BE REPAIRED TO THE SATISFACTION OF THE ENGINEER, AT NO COST TO THE STATE.

112. **STRUCTURAL SLAB CONCRETE OVERLAY NOTES.**

113. THE MINIMUM THICKNESS OF THE MICRO SILICA CONCRETE OVERLAY SHALL BE 1½ INCHES.

114. THE MINIMUM THICKNESS OF THE DP CONCRETE OVERLAY SHALL BE 1½ INCHES.

115. THE MINIMUM TOTAL COVER (EXISTING CONCRETE OR SLAB RECONSTRUCTION CONCRETE PLUS THICKNESS OF DP OR MICRO-SILICA OVERLAY) SHALL BE 2⅛ INCHES.

116. THE TRANSITION LENGTHS BETWEEN THE EXISTING PROFILE AND REVISED FINISHED PROFILE SHALL BE THE SAME AS THOSE SHOWN ON THE PLANS.

117. SHOULD THE TYPE OF RECONSTRUCTION WORK REQUIRED TO BE PERFORMED ON THE STRUCTURAL SLAB, TOGETHER WITH APPLICATION OF THE CONTRACTOR’S CHOICE OF SPECIALIZED CONCRETE OVERLAY, RESULT IN A REVISED FINISHED PROFILE HIGHER THAN THAT SHOWN ON THE PLANS, THE CONTRACTOR SHALL SUBMIT THE REVISED PROFILE TO THE REGIONAL DIRECTOR FOR APPROVAL AT LEAST TWO WEEKS PRIOR TO PLACEMENT OF THE CONCRETE OVERLAY.

118. THE CONTRACTOR’S PROPOSAL MAY INCLUDE ADDITIONAL GRADE TRANSITIONS SUBJECT TO THE FOLLOWING:

A. THE MINIMUM LENGTH BETWEEN GRADE TRANSITIONS SHALL BE _____* FEET.

C. THE SLOPE CHANGES DO NOT CREATE DRAINAGE PROBLEMS ON THE BRIDGE DECK.

NO OVERLAY MATERIAL SHALL BE PLACED UNTIL THE REGIONAL DIRECTOR HAS APPROVED THE CONTRACTOR'S PROPOSED REVISIONS.

* The designer should select values for the length between and the difference in slope of the grade transitions considering design speed, rider comfort, and bridge geometry. Suggested values are 60 ft. and 0.5 percent.

119. ALL ROADWAY SURFACES RECEIVING A SPECIALIZED CONCRETE OVERLAY SHALL BE GROOVED UNDER THE SAWCUT GROOVING OF STRUCTURAL SLAB SURFACE ITEM AND SEALED UNDER THE PROTECTIVE SEALING OF STRUCTURAL CONCRETE ON NEW BRIDGE DECKS AND BRIDGE DECK OVERLAYS ITEM.

120. MISCELLANEOUS NOTES

121. LUMBER AND TIMBER NOTES

122. STRESS GRADED LUMBER AND TIMBER HAVE BEEN DESIGNED FOR THE FOLLOWING ALLOWABLE STRESSES, AND THE TYPE USED MUST MEET THESE MINIMUM REQUIREMENTS:

123. EXTREME FIBER IN BENDING AND TENSION PARALLEL TO GRAIN ________ COMPRESSION PERPENDICULAR TO GRAIN ________ MODULUS OF ELASTICITY ________.

124. STREAM PROTECTION NOTE

Use the following note only if requested by Dept. of Environmental Conservation or the Regional Office.

125. DURING THE COURSE OF CONSTRUCTION, THE CONTRACTOR SHALL CONDUCT OPERATIONS IN SUCH A MANNER AS TO PREVENT OR REDUCE TO A MINIMUM ANY DAMAGE TO ANY STREAM FROM POLLUTION BY DEBRIS, SEDIMENT, OR OTHER FOREIGN MATERIAL, OR FROM MANIPULATION OF EQUIPMENT AND/OR MATERIALS IN OR NEAR SUCH STREAMS. THE CONTRACTOR SHALL NOT RETURN DIRECTLY TO A STREAM ANY WATER WHICH HAS BEEN USED FOR WASH PURPOSES OR OTHER SIMILAR OPERATIONS WHICH CAUSE THIS WATER TO BECOME POLLUTED WITH SAND, SILT, CEMENT, OIL, OR OTHER IMPURITIES. IF THE CONTRACTOR USES WATER FROM A STREAM, THE CONTRACTOR SHALL CONSTRUCT AN INTAKE OR TEMPORARY DAM REQUIRED TO PROTECT AND MAINTAIN WATER RIGHTS AND TO SUSTAIN FISH LIFE DOWNSTREAM.
126. CONCRETE ANCHOR STUD NOTE

Use the following note when pier nosing is used.

127. ALL CONCRETE ANCHOR STUDS WHICH ARE ATTACHED TO THE PIER NOSING SHALL MEET THE REQUIREMENTS LISTED IN MATERIAL SUBSECTION 709-05, STUD SHEAR CONNECTORS. PAYMENT FOR FURNISHING AND PLACING THE CONCRETE ANCHORS AND ANGLE WILL BE INCLUDED IN THE UNIT PRICE BID FOR THE CONCRETE ITEM TO WHICH THE ANCHORS ARE ATTACHED.

Use one of the following notes when concrete box culverts are used.


or


130. STONE MASONRY

131. JOINTS FOR STONE MASONRY MAY VARY FROM ½ INCH TO 1 INCH THICKNESS.

132. FINISH OF STONE MASONRY SHALL BE AS FOLLOWS:

133. DIMENSION MASONRY

134. RINGSTONE, QUOINS, COPINGS AND OTHER STONES, IF SO DESIGNATED, SHALL BE DIMENSION MASONRY.

135. ALL JOINTS FOR DIMENSION MASONRY SHALL BE ½ INCH THICKNESS.

136. FINISH OF DIMENSION MASONRY SHALL BE AS FOLLOWS:
137. **PRECAST PRECOMPRESSED CONCRETE/STEEL COMPOSITE SUPERSTRUCTURE NOTES**

When a Precast Precompressed Concrete/Steel Composite Superstructure (Inverset™) bridge is specified, the designer shall place the following applicable notes in the contract plans.

138. **CONCRETE IN THE DECK SLAB SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF ________ PSI AT 28 DAYS. THE UNITS SHALL NOT BE HANDLED UNTIL CONCRETE STRENGTH REACHES A MINIMUM OF 3000 PSI.**

139. **ASTM A709 GRADE 50W STEEL SHALL BE USED AS STRUCTURAL STEEL.**

or

140. **ASTM A709 GRADE 50 STEEL SHALL BE USED AS STRUCTURAL STEEL.**

141. **HIGH STRENGTH BOLTS USED IN DIAPHRAGM CONNECTIONS SHALL BE ASTM A325. (USE TYPE 1 FOR PAINTED STEEL, TYPE 3 FOR WEATHERING STEEL).**

142. **TO ENSURE FULL AND EVEN BEARING BETWEEN BOTTOM OF BEAMS AND MASONRY PLATES, THE BOTTOM SURFACES OF BEAMS IN THE BEARING AREAS SHALL, WITHIN EACH PANEL, BE FABRICATED TO BE TRULY IN ONE PLANE.**

143. **ALL REINFORCEMENT SHALL HAVE A COVER OF 2 INCHES (TO BOTTOM OF LONGITUDINAL GROOVES) UNLESS SHOWN OTHERWISE. THE TOP BARS IN THE DECK AND APPROACH SLAB SHALL BE EPOXY COATED. NO CHAIRS, BOLSTERS OR OTHER SUPPORT DEVICES SHALL BE IN PLACE AGAINST THE BOTTOM SURFACE OF THE FORM (TOP OF DECK IN FIELD) DURING CASTING.**

144. **ANCHOR BOLTS MAY BE CAST INTO THE BRIDGE SEATS, OR AT THE CONTRACTOR’S OPTION, DRILLED AND GROUTED INTO THE ABUTMENTS AT NO ADDITIONAL COST TO THE STATE.**

145. **THE INVERSET UNITS MAY BE CONSTRUCTED WITHOUT DIAPHRAGMS. HOWEVER, PRIOR TO TRANSPORTATION TO THE BRIDGE SITE, ALL DIAPHRAGMS INTEGRAL TO ANY ONE UNIT SHALL BE INSTALLED.**

146. **GRIND ALL EDGES OF STEEL AS NEEDED TO REMOVE SHARP EDGES PRIOR TO CLEANING FOR PAINTING.**

147. **STRUCTURAL STEEL SHALL BE CLEANED AND PAINTED UNDER THE SHOP APPLIED STRUCTURAL STEEL PAINT SYSTEM ITEM. AFTER CLEANING, MILL SCALE SHALL NOT BE PRESENT. AT THE TIME OF SHIPMENT OF THE UNITS TO THE JOB SITE, THE 3 COATS OF PAINT SHALL HAVE BEEN APPLIED. THE COLOR OF THE FINISH COATING SHALL BE __________. THE COLOR SHALL CONFORM TO __________. VIEWING SHALL BE DONE UNDER NORTH STANDARD DAYLIGHT.**

(Designer shall designate color and either Federal Color Standard Number 595 Number or Munsell Book Notation Number to which color conforms).

or

149. **CLEANING CONTROLLED OXIDIZING STRUCTURAL STEEL ASTM A709 GRADE 50W.**

A. **IN THE FABRICATION SHOP**

GIRDERS SHALL BE BLAST CLEANED IN ACCORDANCE WITH SSPC-SP6 (COMMERCIAL BLAST CLEANING). HEAVY COATINGS OF OIL OR GREASE SHALL BE REMOVED BEFORE BLASTING IN ACCORDANCE WITH SSPC-SP1 (SOLVENT CLEANING).

B. **IN THE FIELD**

THE OUTSIDE SURFACE OF THE FASCIA STRINGERS SHALL BE CLEANED SO THAT ALL DIRT, GREASE, PAINT OR OTHER FOREIGN MATERIAL IS REMOVED AT THE COMPLETION OF THE BRIDGE CONSTRUCTION. THE PURPOSE OF THE CLEANING IS TO RETURN THE FASCIA SURFACES TO THE CONDITION IN WHICH THEY LEFT THE FABRICATION SHOP.

THE COST OF CLEANING THIS STEEL IN THE FABRICATION SHOP AND THE FIELD SHALL BE INCLUDED IN THE UNIT PRICES BID FOR THE VARIOUS ITEMS IN THE CONTRACT.

150. **BEARING ANCHOR BOLT NUTS SHALL BE SNUG TIGHT AS PER THE NYS STEEL CONSTRUCTION MANUAL.**

151. **THIS IS A NON-MATCH CAST SEGMENTAL CONSTRUCTION. HENCE, ALL PROVISIONS OF ‘SECTION 2.3 INSTALLATION DRAWINGS AND SUPPORTING DOCUMENTS’ OF THE PCCM, EXCEPT PROVISIONS RELATED TO POST-TENSIONING, SHALL APPLY.**

152. **PROVISIONS OF SECTION 8.4.5. SHEAR KEY JOINTS OF THE PCCM SHALL NOT APPLY. THE CONTRACTOR SHALL PROPOSE A LEAK PROOF LONGITUDINAL JOINT SYSTEM BETWEEN THE UNITS. ALL NECESSARY INFORMATION SUCH AS PREPARATION OF SHEAR KEY SURFACE, MATERIAL FOR SHEAR KEY GROUT, PLACEMENT AND CURING OF SHEAR KEYS AND PLACEMENT OF LEAK PROOFING SYSTEM SHALL BE SHOWN ON THE INSTALLATION DRAWINGS.**

153. **PROCEDURE FOR PREPARING BLOCKOUT SURFACES, PLACING AND CURING BACKFILL, ETC. SHALL BE SHOWN ON INSTALLATION DRAWINGS.**

154. **THE COST OF FURNISHING AND INSTALLING SHIM PLATES UNDER THE BEARINGS SHALL BE INCLUDED IN THE UNIT PRICE BID FOR THE BEARINGS.**

Note: Designers shall allow ¾ inch thickness for shim plates when setting pedestal elevations for reinforced concrete three-sided structures.
SUPERSTRUCTURE SLAB SHEET

The following notes shall be placed in the contract plans on the superstructure slab sheet. The slab placement sequence diagram from Section 5.1.8 shall also be included.

155. DECK PLACEMENT NOTES

The following notes shall be shown on the plans for all simple and continuous span structures:

156. CONCRETE PLACEMENT AND FINISHING OPERATIONS SHALL BE PERFORMED AS RAPIDLY AS POSSIBLE. THE ENGINEER MAY ORDER THE CONTRACTOR TO STOP PLACEMENT OPERATIONS AT ANY TIME IF, IN THE ENGINEER'S OPINION, CONCRETE PLACED DURING THE PLACEMENT HAS STARTED TO SET, OR IS ABOUT TO SET, AND FURTHER PLACEMENT OF CONCRETE WILL CAUSE DEFLECTION CRACKING.

157. LONGITUDINAL CONSTRUCTION JOINTS WILL NOT BE PERMITTED.

158. FINISHING MACHINE(S) SHALL BE OPERATED AS CLOSE TO THE SKEW ANGLE AS PRACTICABLE FOR SKEW ANGLES BETWEEN 0° AND 50°. WHEN THE SKEW ANGLE IS GREATER THAN 50° THE FINISHING MACHINE(S) SHALL BE OPERATED AT AN ANGLE OF 50°.

159. WET BURLAP CURING BLANKETS ARE REQUIRED TO BE PLACED ON THE CONCRETE DECK WITHIN 30 MINUTES OF THE CONCRETE BEING DEPOSITED INTO THE FORMS OR 5 MINUTES AFTER FINISHING, WHICHEREVER COMES FIRST. THE PLACEMENT OF THE TURF DRAG TEXTURE SHALL NOT INTERFERE WITH THESE REQUIREMENTS.

160. IN THE EVENT THE CONTRACTOR'S DECK PLACEMENT OPERATION IS STOPPED PRIOR TO COMPLETION, WHETHER BY THE CONTRACTOR'S OWN DECISION OR BY ORDER OF THE ENGINEER, THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING A FINISHED DECK GRADE WHICH MATCHES THE PLANNED PROFILE. ANY SUBSEQUENT REVISIONS TO DECK FORMS MADE NECESSARY BY SUCH ACTION SHALL BE AT THE CONTRACTOR'S EXPENSE.

Include the following note when the structure has a cross slope transition:

161. SINCE THIS STRUCTURE HAS A CROSS SLOPE TRANSITION, IT MAY BE ADVISABLE TO PLACE THE FINISHING MACHINE PERPENDICULAR TO THE STATION LINE.

Include the following note when two finishing machines are required:

162. (Insert "PLACEMENT 1" or "THE CONTINUOUS") PLACEMENT SHALL BE ACCOMPLISHED BY THE SIMULTANEOUS OPERATION OF TWO FINISHING MACHINES AND CREWS. A MINIMUM RATE OF 30 CUBIC YARDS PER HOUR SHALL BE MAINTAINED BY EACH MACHINE.
The following notes shall be shown on the plans for all continuous spans (whether the deck is placed in one or multiple placements) as appropriate.

When there will be no exceptions to the pouring sequence allowed, use the following Note.

163. **THERE WILL BE NO EXCEPTIONS MADE TO THE POURING SEQUENCE AS SHOWN ON THE CONTRACT PLANS.**

When exceptions to the pouring sequence are possible pending review by the Department (refer to Department’s “Procedure for Approval of Alternate Deck Pouring Sequence on Continuous Bridges”) use the following three notes:

164. **THE CONCRETE DECK SLAB FOR THIS STRUCTURE SHALL BE PLACED ACCORDING TO THE POURING SEQUENCE SHOWN ON THE CONTRACT PLANS. REQUESTS FOR ANY ALTERNATE DECK POURING SEQUENCE SHALL BE SUBMITTED TO THE EIC. THE SUBMITTAL REQUIREMENTS ARE PROVIDED IN THE DEPARTMENT’S “PROCEDURE FOR APPROVAL OF ALTERNATE DECK POURING SEQUENCE ON CONTINUOUS BRIDGES” IN THE CONSTRUCTION INSPECTION MANUAL. NO RELATED WORK MAY BE PROGRESSED BY THE CONTRACTOR UNTIL THE WRITTEN APPROVAL OF THE ALTERNATE PROCEDURE IS RECEIVED FROM THE DEPARTMENT (REGIONAL OFFICE). THE DEPARTMENT WILL REVIEW THE REQUEST AND REPLY WITHIN (15) WORK DAYS AFTER RECEIPT OF ALL THE REQUIRED SUBMITTAL DOCUMENTS FROM THE CONTRACTOR.**

165. **THE CONTRACTOR SHALL PROVIDE TO THE ENGINEER THE PROPOSED SET RETARDING WATER ADMIXTURE (ASTM TYPE D, SRWR) AND A COPY OF THE MANUFACTURER’S LITERATURE SPECIFYING THE RECOMMENDED RANGE TO PROVIDE SUFFICIENT RETARDATION. THIS SRWR DOSAGE SHALL NOT BE REDUCED AS THE PLACEMENT PROGRESSES. THE ENGINEER WILL REJECT ANY CONCRETE TRUCK THAT CALLS FOR AN ADMIXTURE DOSAGE RATE BEYOND THE MANUFACTURER’S RECOMMENDED RANGE. ANY SUPPLIER CODES DENOTING SRWR SHALL BE GIVEN TO THE ENGINEER FOR MONITORING PURPOSES.**

166. **THE VALUES SHOWN IN THE CAMBER AND HAUNCH TABLES ARE BASED ON THE DECK PLACEMENT SEQUENCE SHOWN ON THE PLANS. IF THE DECK PLACEMENT SEQUENCE IS ALTERED, THE CAMBER AND HAUNCH TABLES NEED TO BE RECOMPUTED. THE CONTRACTOR IS RESPONSIBLE TO HAVE A PROFESSIONAL ENGINEER RECOMPUTE THESE TABLES AND SUBMIT THEM TO THE D.C.E.S FOR APPROVAL.**

The following notes shall be shown on the plans for continuous spans when a two placement sequence is used:

167. **CONSTRUCTION JOINTS SHALL BE PLACED PARALLEL TO THE SKEW ANGLE. DECK CONCRETE SHALL BE PLACED SO THAT THE LEADING EDGE PARALLELS THE SKEW. FINISHING MACHINE(S) SHALL BE OPERATED AS CLOSE TO THE SKEW ANGLE AS PRACTICABLE. TEXTURING MAY BE DONE LONGITUDINAL, TRANSVERSE OR PARALLEL TO THE ALIGNMENT OF THE FINISHING MACHINE.**
168. ALL AREAS SHOWN ON THE PLANS AS “PLACEMENT 1” MUST BE PLACED DURING THE INITIAL CONTINUOUS WORK PERIOD. SUBSEQUENT PLACEMENTS (CONTINUOUS PLACEMENTS) WILL NOT BE PERMITTED UNTIL 72 HOURS OF ACCEPTABLE CURING AFTER THE COMPLETION OF THE PREVIOUS PLACEMENT.

Include the following note when the structure contains three or more spans.

169. THE CONTRACTOR MAY DIVIDE PLACEMENT 2 INTO SEPARATE SEGMENTS PROVIDED THE 72 HOUR WAITING PERIOD BETWEEN PLACEMENTS IS OBSERVED.

Add the following note to contract plans for projects involving prestressed concrete beams on integral abutment bridges and for continuous for live load designs:

170. ALL PRESTRESSED CONCRETE BRIDGE BEAMS SHALL HAVE A MINIMUM AGE OF 60 DAYS AT THE TIME OF CONCRETE DECK PLACEMENT.

171. STAGE CONSTRUCTION NOTES

The following notes shall be used, where applicable, for stage construction projects on bridges with steel superstructures.

172. THE STRUCTURAL SLAB AND SLAB OVERHANG FOR EACH STAGE OF CONSTRUCTION HAVE BEEN DESIGNED FOR THE LOADING CONDITIONS SHOWN IN THE DETAILS.

173. THE COST OF FURNISHING AND PLACING MECHANICAL CONNECTORS, MATERIAL SPECIFICATION, SECTION 709-10, SHALL BE INCLUDED IN THE UNIT PRICES BID FOR THE SUPERSTRUCTURE SLAB ITEM.

In some instances, geometry may require the use of a large overhang during stage construction. Special temporary bracing may be required in order to prevent the rotation of the temporary fascia girder during the deck placement.

174. THE CONTRACTOR’S ATTENTION IS DIRECTED TO THE UNUSUALLY LARGE TEMPORARY OVERHANG PRESENT DURING THE STAGE ___ STRUCTURAL SLAB PLACEMENT. THE CONTRACTOR SHALL PROVIDE ADEQUATE TEMPORARY SUPPORT AND BRACING TO PREVENT THE TEMPORARY FASCIA STRINGER FROM TWISTING UNDER THE LOADS OF THE CONCRETE DEAD LOAD AND THE CONSTRUCTION LOADS. THE CONTRACTOR MUST SUBMIT OVERHANG FORMING DESIGN AND DETAILS TO THE D.C.E.S. FOR APPROVAL.

175. DUE TO THE NATURE OF STAGE CONSTRUCTION AND THE PROBLEMS INHERENT WITH DIFFERENTIAL DEFLECTIONS, THE HOLES FOR ONE SIDE OF THE STAGE DIAPHRAGM CONNECTION PLATES SHALL BE FIELD DRILLED. NO ADDITIONAL COMPENSATION SHALL BE MADE FOR FIELD DRILLING.
In cases where more than two stages are used, the following notes will have to be modified:

176. **THE INTERMEDIATE DIAPHRAGMS, END DIAPHRAGMS AND ANY OTHER CROSS FRAMES THAT MAY BE PRESENT BETWEEN STAGE 1 AND STAGE 2 STRINGERS SHALL NOT BE INSTALLED UNTIL 72 HOURS FOLLOWING THE PLACEMENT OF THE STAGE 2 STRUCTURAL SLAB.**

If a closure placement is called for, the following sentence must be added to this note:

177. **THE INTERMEDIATE DIAPHRAGMS AND END DIAPHRAGMS MUST BE IN PLACE AND BOLTS TIGHTENED PRIOR TO PROCEEDING WITH THE CLOSURE PLACEMENT.**

178. **THE CONTRACTOR SHALL WAIT A MINIMUM OF 72 HOURS FOLLOWING COMPLETION OF THE SECOND STAGE DECK PLACEMENT BEFORE BEGINNING THE CLOSURE PLACEMENT.**

179. **FORM WORK FOR THE STAGE 2 DECK PLACEMENT SHALL BE SUPPORTED ONLY BY THE STAGE 2 STRINGERS, NOT BY THE STAGE 1 STRINGER IMMEDIATELY ADJACENT.**

180. **PRIOR TO PLACING THE STAGE 2 DECK PLACEMENT AND FOR 72 HOURS FOLLOWING ITS COMPLETION, NO REINFORCING BAR WITHIN THE CLOSURE PLACEMENT SHALL BE WIRED.**

181. **THE TEMPORARY FASCIAS OF THE STAGE 1 AND STAGE 2 DECK SHALL BE THOROUGHLY WET FOR 12 HOURS IMMEDIATELY PRIOR TO PROCEEDING WITH THE CLOSURE PLACEMENT. THE CONTRACTOR SHALL REMOVE ALL STANDING WATER WITH OIL-FREE COMPRESSED AIR AND SHALL PROTECT THE FASCIA SURFACES FROM DRYING, SO THE EXISTING CONCRETE REMAINS IN A CLEAN, SATURATED SURFACE DRY CONDITION UNTIL PLACEMENT OF THE NEW CONCRETE.**

The following note shall be used for stage construction projects using adjacent precast prestressed beams when anticipated camber as per Section 9.14 is greater than 1 inch:

182. **STAGE 1 OF THE DECK HAS BEEN DETAILED WITH A 7 INCH MINIMUM DECK THICKNESS TO DEAL WITH A SMALL AMOUNT OF CAMBER GROWTH FOR STAGE 2 UNITS. IF THE CONTRACTOR’S SCHEDULE PLANS SIGNIFICANTLY MORE (14 DAYS) STORAGE TIME FOR STAGE 2 UNITS THAN STAGE 1 UNITS, CAMBER GROWTH CONTROL MEASURES SHALL BE PROPOSED BY THE CONTRACTOR IN THE SHOP DRAWINGS. SUGGESTED CAMBER GROWTH CONTROL MEASURES ARE:**

   1. **BOTH STAGE 1 AND STAGE 2 UNITS SHALL BE STORED FOR A MINIMUM OF 60 DAYS (PRIOR TO SHIPMENT) TO ALLOW MOST OF THE CAMBER GROWTH TO OCCUR PRIOR TO SHIPMENT.**

   2. **PRELOAD THE STAGE 2 BEAMS (IN STORAGE) TO RESTRRAIN GROWTH. THE CONTRACTOR SHALL SUBMIT DESIGN CALCULATIONS ALONG WITH THE SHOP DRAWINGS.**

183. PRESTRESSED CONCRETE BEAM NOTES

184. THE CONTRACTOR MAY PROPOSE DEBONDING OF PRETENSIONING STRANDS FOR 6 INCHES FROM ENDS OF BEAMS TO REDUCE THE TENDENCY FOR BEAM ENDS TO CRACK. TOTAL NUMBER OF DEBONDED STANDS (DESIGN BONDING SHOWN ON THE CONTRACT PLANS AND CRACK CONTROL DEBONDING COMBINED) SHALL NOT EXCEED 50% OF TOTAL NUMBER OF STRANDS.

Add the following note to contract plans for projects that use PCEF Bulb Tee prestressed concrete girders:

185. THE CONTRACTOR MAY PROPOSE TO SUBSTITUTE NEW ENGLAND BULB TEE GIRDERS OF EQUIVALENT SECTION PROPERTIES FOR THE PCEF GIRDERS SHOWN ON THE CONTRACT PLANS. ALL ADDITIONAL COSTS ASSOCIATED WITH THE SUBSTITUTION INCLUDING DESIGN, CONSTRUCTION, AND DETAILING CHANGES SHALL BE AT THE CONTRACTORS EXPENSE.

Add the following note to contract plans for projects that use New England Bulb Tee prestressed concrete girders:

186. THE CONTRACTOR MAY PROPOSE TO SUBSTITUTE PCEF BULB TEE GIRDERS OF EQUIVALENT SECTION PROPERTIES FOR THE NEBT GIRDERS SHOWN ON THE CONTRACT PLANS. ALL ADDITIONAL COSTS ASSOCIATED WITH THE SUBSTITUTION INCLUDING DESIGN, CONSTRUCTION, AND DETAILING CHANGES SHALL BE AT THE CONTRACTORS EXPENSE.
When the scope of a bridge rehabilitation project does not involve evaluation of alternatives, but addresses specific bridge deficiencies, the Scoping Closure Document may also serve as a Design Approval Document (DAD). This may necessitate that some preliminary engineering activities be done prior to the closure of scoping activities. See the Project Development Manual for when this process is appropriate.

19.1.2 Preliminary Design

Preliminary Design refines proposed design alternates, compares them, and selects the most appropriate alternate to be advanced to final design. This phase culminates in the issuance of a Design Approval Document for the chosen alternate. The technical activities in this stage serve to collect and analyze data required to define the appropriate design alternate. The applicability of each activity to the development of a given alternate should be discussed with the appropriate functional manager. Experienced interpretation of existing conditions can either eliminate or highlight the importance of certain activities.

1. Collect Detailed Structure Condition Data

   Purpose: Collect sufficient data to assess the viability of the work alternates. The data should be detailed enough to allow the completion of a Level 1 Load Rating.

   Method: Perform an In-depth bridge inspection in accordance with requirements of the Department’s Specifications for In-depth Bridge Inspection (See Section 19.2.1). This activity could include taking cores of existing concrete elements.

2. Assess Condition of the Structural Deck

   Purpose: Determine whether a bridge deck can be rehabilitated or must be replaced.

   Method: Perform a bridge deck evaluation in accordance with the current Bridge Deck Evaluation Manual. The decision to rehabilitate or replace a deck can significantly impact associated rehabilitative work, design criteria and resulting costs. It is therefore imperative to accurately define the condition of the structural deck.

3. Assess Structural Integrity of the Existing Bridge and the Potential for Restoring Full Capacity Through Rehabilitation Actions

   Purpose: Assure serviceability of the structure during construction and define the extent of rehabilitative work required.

   Method: Perform a Level 1 Load Rating. The Level 1 Load Rating will provide a base structural capacity for the bridge from which the necessity of and potential for improvement can be judged.

4. Assess the Structure’s Vulnerabilities to Potential Modes of Failure

   Purpose: Identify the impact to the project scope and cost of any work to address a structure’s vulnerabilities prior to the issuance of design approval.

   Method: Evaluate the structure and its details using the procedures provided in the Bridge Safety Assurance Policy.
5. **Assess Feasibility of Rehabilitation versus Replacement**

   **Purpose:** Refine project cost and further assess the alternate's cost effectiveness and technical feasibility.

   **Method:** Update project costs and schedule based on more detailed information. Perform a rehabilitation versus replacement evaluation as outlined in Section 19.2.2. This evaluation provides direction concerning reasonable costs of various alternates and technical considerations that correspond to feasibility.

6. **Perform a Technical Progress Review**

   **Purpose:** Provide general advice to ensure that bridge projects are developed in accordance with appropriate policies, standard practice, and sound engineering judgment.

   **Method:** The draft Design Approval Document should be submitted to all parties that have a role in the final design of the project. Functional managers will review the document for standards compliance, scope, cost, and schedule. See Section 20 for technical progress review responsibility for bridge projects.

7. **Summarize Key Design Features of the Chosen Alternate**

   **Purpose:** Provide the grantee of design approval with a concise representation of the important project features.

   **Method:** Prepare a Design Approval Document. For bridge rehabilitations, also prepare a Structure Rehabilitation Concept Plan Package. This package should include a 250-scale project plan with horizontal alignment control data, a representation of the vertical alignment with appropriate control data, existing and proposed transverse sections, and a Temporary Traffic Control strategy. This package is a portion of the Design Approval Document and aids in the project control decision. The information gathered and the conclusions reached through these activities must be appropriately represented in the project's Design Approval Document.

   The format of the Design Approval Document should correspond with the appropriate sections of the *NYSDOT Project Development Manual*.

### 19.1.3 Final Design

Final Design adds necessary engineering and detailing to the design alternate selected from the Preliminary Engineering stage and culminates with submission of the Plans, Specifications, and Estimate (PS&E) package. Technical activities of this phase serve to develop a contract package that enables the Department to advertise, let, award, and construct the project.

1. **Prepare Structure Study Plan (Bridge Widening and Superstructure Replacement Projects only)**

   **Purpose:** Ensure conformance to accepted standards and policies or highlight the need to consider exceptions; allow an initial constructability review; provide a means for the designer to acquire information necessary to advance the proposed design.
19.2.2 Bridge Rehabilitation vs. Replacement Selection Guidelines

These guidelines are for use during project scoping, after a decision has been made to progress the project. The rationale presented is appropriate any time these two alternatives are possible. For the purposes of these guidelines, bridge rehabilitation is defined as a complete rehabilitation removing all deficiencies or justifying their retention.

These guidelines were developed to provide guidance in this difficult decision area, and are not absolutes. It is expected, however, that when they are not followed, it is for compelling reasons which are to be documented in the project file.

Several factors must be considered in a rehabilitation vs. replacement decision. These factors are all interrelated; each factor must be investigated and considered both individually and collectively. All conclusions reached shall be fully documented in the project file and in all other appropriate documents, such as the Design Approval Document.

The following factors are presented for rehabilitation vs. replacement consideration. They are presented one at a time and are not necessarily in any particular order of importance.

**Cost** - The estimating of both rehabilitation and replacement costs is usually performed after all other factors have been investigated, because the other factors may affect or determine the scope of the rehabilitation or replacement option. The replacement estimate is to be done in accordance with current NYSDOT procedures. The current system is a shoulder break square foot unit cost basis developed by the Office of Structures for use early in projects where bridge particulars, such as abutment heights and locations are not known (see Section 3.5.1). This methodology compensates for positioning abutments anywhere within the shoulder break length along the shoulder break slope line. This replacement estimating process provides the user with project level information.

When considering rehabilitation, the first step is to check the load rating. If the bridge is posted or if the current load rating appears suspect, rerate the bridge before proceeding with the estimate.

The rehabilitation estimate is much more difficult to develop. This estimate **cannot** be developed from the biennial inspection report. It requires close reinspection and examination of the bridge. This inspection must be of sufficient detail to develop a practical idea of the extent of the necessary work. The inspector should keep in mind that the actual rehabilitation construction work will most likely not be done for several years. Consequently, the estimate of quantities should have reasonable projections to compensate for continued deterioration.

The rehabilitation reinspection should examine the type and extent of deterioration of all bridge components (e.g., abutments, piers, beams and decks) with the intent of developing contract plans and a reasonable estimate for the work. Reinspection should include actual measurements of section loss in the beams to determine the current load rating. Also, the reinspection should include the location and depth of areas of concrete in the abutments and piers that require removal and replacement to restore them to like-new condition. The inspector must examine abutments and piers by sounding to locate possible delaminations and chipping to determine the depth of the poor concrete. Unless these investigations convince the inspector that the concrete is sound and needs only insignificant repairs, such as a spot patch on a pier column during a deck replacement project, cores should be taken. Significant repair is defined
as more than isolated repairs or more than a nominal amount of money. Substructure cores should not be taken when concrete condition is obviously beyond rehabilitation.

In addition to the reinspection, concrete cores of the structural deck are commonly required to determine if the deck is to be retained and repaired. The policy and procedure for deck coring are given in the *Bridge Deck Evaluation Manual*.

Taking and testing concrete cores confirms the depth of poor concrete and the presence of delaminations, and provides a measure of the concrete’s strength and durability against freeze thaw cycles. Cores should be taken to finalize the type and amount of rehabilitation work unless the amount of work is insignificant or the concrete element is clearly in need of replacement.

Like the replacement estimate, the bridge rehabilitation estimate should include all highway and project costs necessary to develop the complete cost estimate.

All rehabilitation and replacement costs shall include the cost for the appropriate Temporary Traffic Control plan chosen for that alternate.

The next step is to compare rehabilitation and replacement costs of the portion of the project directly related to the structure assuming both are viable possibilities. This relationship should be established in terms of the rehabilitation cost being a percentage of the replacement cost (RH/RP percentage). Due to the inherent uncertainties of estimating practices, the cost percentage determinations between rehabilitation and replacement are broken down into three ranges. These ranges were developed by examining the life cycle costs of rehabilitation and replacement for several bridge models. These models varied the type of work to determine the effect on annualized costs. The models assumed a gradually increasing annual maintenance cost and a 4% discount rate.

First range: RH/RP percentage less than 65%. The preliminary choice is rehabilitation. Other factors, such as bridge type, must be examined to ensure compatibility with rehabilitation.

Second range: RH/RP percentage between 65% and 85%. Rehabilitation or replacement may be the preliminary choice. Other factors must be examined to establish the appropriate type of work.

Third range: RH/RP percentage greater than 85%. The preliminary choice is replacement. Other factors must again be examined for compatibility with replacement. For example, detouring traffic in highly urbanized areas may not be feasible from a capacity point of view and constructing a temporary structure may not be possible from a right-of-way point of view. Construction of a replacement bridge alongside the existing bridge may not be possible due to right-of-way restrictions, even with stage construction. In this case, an expensive rehabilitation would be done rather than a replacement.
There has been discussion whether "user costs" should be included in the estimate. For the purposes of this guideline, user costs are not included in the total costs associated with rehabilitation or replacement because, in both cases, traffic is usually restored to the same condition that existed before construction. It may be necessary to take user costs into account on bridge removal and bridge capacity improvement projects since there would be a change that would impact the traveling public on a permanent basis. These costs would be considered on an individual project basis as they are only significant in a small percentage of situations.

**Safety** - Accident history and potential must be examined for the project bridge. In terms of safety for the RH/RP decision, accident history is the most important element. Accident history can be determined by examining the accident reports on file. Although sometimes inconclusive, this review should look for trends in accident patterns that would point to whether the bridge caused or contributed to the accidents.

While not as significant as accident history, accident potential should also be considered. Geometrics which contain clear potential for accident problems should be considered for improvement. That improvement may have a direct impact on the RH/RP decision. The review of geometrics should include, but not be limited to: sight distance, bridge width, horizontal clearances, alignments, etc. These elements should be compared to the standards and evaluated with regard to accident potential. Current bridge standards are shown in Table 19-1.

<table>
<thead>
<tr>
<th>FUND SOURCE</th>
<th>Functional Class</th>
<th>Interstates</th>
<th>Non-Interstate NHS*</th>
<th>Non NHS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>B</td>
<td>B</td>
<td>C</td>
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</table>

A - Current AASHTO Policy on Design Standards: Interstate System
B - Current AASHTO Policy on Geometric Design of Highways and Streets
C - Current NYSDOT Geometric Design Policy for Bridges
*National Highway System

**Table 19-1**

Current Bridge Standards

If either the accident history or accident potential indicates the bridge geometrics are unacceptable, the safety problem must be addressed by either widening the structure under a rehabilitation or replacing the existing bridge with a wider structure.
Type of Bridge - Some bridges, by their very type, will signal a probable rehabilitation or replacement strategy. One significant factor is redundancy. NYSDOT gives special consideration to nonredundant bridges where failure of one principal load carrying member would result in probable collapse of the bridge. This consideration includes a review of the type of nonredundant structure and its sensitivity to being nonredundant, the consequences of no action, and the possibility of adding redundancy to the bridge. Some nonredundant structures, such as trusses, are of less concern regarding failure than others, such as two girder bridges with welded construction. The rehabilitation vs. replacement decision should take into account the redundancy of the bridge. Non-redundancy should be a factor in favor of replacement.

Other bridges should also be considered for replacement because of their type of construction, but for a different reason. For example, concrete arches, concrete rigid frames and jack arches are difficult and expensive to rehabilitate because of their monolithic construction. Past rehabilitation work on these types of bridges has been quite costly, so they should generally not be rehabilitated. Also, because of their long life, it is often most cost effective to simply let these bridges "live out" their full useful life.

Another example of construction type impacting rehabilitation vs. replacement decisions are existing stream substructure units without piles that exhibit scour problems. The "no pile" situation may push the decision toward replacement.

Bridge Safety Assurance vulnerability also needs to be taken into account in any rehabilitation/replacement decision. The six vulnerability manuals (Overload, Hydraulics, Steel Details, Concrete Details, Collision and Seismic) should be consulted for further information.

Bridge Standards - When any bridge is considered for rehabilitation, that bridge should be reviewed for compliance with current standards. Existing vertical clearance, horizontal clearance, load capacity, free board, seismic capacity, lane width and shoulder width should be compared to current standards. The hydraulic history of the bridge should also be reviewed. If the existing features are nonstandard, consideration should be given to improving them under rehabilitation or by replacing the bridge. If improvements cannot be made or the improvements that can be made will not meet current standards, a nonstandard feature justification will be required. This should be taken into account when making the rehabilitation vs. replacement decision. See Chapter 2 of the Highway Design Manual for further information on justification of nonstandard features.

Temporary Traffic Control - All bridge work involves managing existing traffic during construction. There may be several feasible alternatives, including detouring traffic around the project site. They may include maintaining traffic on a temporary bridge, maintaining traffic on the existing structure while a new structure is constructed on a new alignment, or maintaining traffic on a portion of the existing structure by stage construction. These alternatives must be carefully considered as to their practicality, overall cost, delay to traffic, and impact on the surrounding community. In some cases, the type of bridge work will be driven by the fact that there is only one practical solution to managing the traffic.
### V. Feature Crossed

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<tbody>
<tr>
<td>A.</td>
<td>If existing bridge is over water, have there been hydraulic problems indicating an inadequate opening or poor stream alignment which would require a span adjustment?</td>
<td>Yes ...................................................... RP</td>
<td>No ............................................. RP or RH</td>
</tr>
<tr>
<td>B.</td>
<td>Does existing bridge span anything that requires special treatment or are special conditions associated with it, such as a railroad, historic feature, environmentally or politically sensitive feature?</td>
<td>Yes ...................................................... RP or RH*</td>
<td>No ............................................. RP or RH</td>
</tr>
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*The sensitive feature must be thoroughly examined and considered in RH/RP analysis with special attention to the cost necessary to accommodate the sensitivity.

### VI. WZTC

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<tbody>
<tr>
<td>A.</td>
<td>Can traffic be detoured off the project site?</td>
<td>Yes ...................................................... RP or RH</td>
<td>No ............................................. Proceed to VI.B</td>
</tr>
<tr>
<td>B.</td>
<td>Can traffic be maintained on the existing bridge with a new bridge built alongside?</td>
<td>Yes ...................................................... RP</td>
<td>No ............................................. Proceed to VI.C</td>
</tr>
<tr>
<td>C.</td>
<td>Can construction be staged?</td>
<td>Yes ...................................................... RP or RH</td>
<td>No ............................................. Proceed to VI.D</td>
</tr>
<tr>
<td>D.</td>
<td>Can a temporary structure be used on the project site?</td>
<td>Yes ...................................................... RP or RH</td>
<td>No. STOP. All traffic strategies have been rejected.</td>
</tr>
</tbody>
</table>

* RH = Rehabilitate  
RP = Replace

### Table 19-2
Bridge Rehabilitation vs Replacement Worksheet

#### 19.3 Concrete Rehabilitation

Repair of concrete in rehabilitated structures can be a very complex subject. Only a few topics are discussed in this manual. For information on specific applications and repair techniques, the designer is urged to contact the Materials Bureau. Also, for information on Fiber Reinforced Polymer repair, see Structures Design Advisory 02-002 and Engineering Instruction EI 05-001.

An important factor to keep in mind for a rehabilitation project is that the quantity of concrete repair necessary will almost always increase between the time of inspection and the time the work is performed. The designer needs to exercise judgment in the rate of deterioration when preparing the estimate of quantities.
19.3.1 Concrete Scaling

There are two kinds of hardened concrete scaling: surface and deep. The probable causes of deep scaling are lack of entrained air or an improper water to cement ratio. Treatment options are to either place a bonded concrete encasement around the affected area or to replace the concrete entirely.

Surface scaling is generally caused by improper construction techniques, such as watering the concrete during finishing. If detected early, regular sealing of the surface may inhibit scaling. Otherwise, a bonded concrete encasement can be placed or the concrete surface can be ground out and a new surface installed. Another possible option is to ignore the problem until the scaling becomes severe enough to warrant replacement.

When concrete is placed against soil with a high sulfate content, the chemical attack causes surface scaling that progresses to deep scaling. The only treatments for this type of attack are to place a bonded concrete encasement or complete replacement.

19.3.2 Concrete Spalling

When reinforcing steel in concrete corrodes, the volume of the reinforcing bar increases. This expansion causes tensile stresses on the concrete surface which leads to a regular pattern of cracks and spalls over the entire surface. The possible treatments are to patch the surface, replace the concrete with a thicker cover, or completely replace the concrete.

If the concrete is batched with aggregate that is not chemically inert with the cement, a pattern of map cracking and spalling can develop. Treatments for this condition are either to place a thicker cover over the reinforcing bars or the complete replacement of the concrete.

Another cause of concrete spalling is the combination of freezing temperatures and water penetration into the pores, cracks, voids, or porous stone aggregates of the concrete. This cycle of freezing and thawing causes spalls and popouts of the concrete surface as the water freezes and expands below the surface of the concrete. Treatment for this condition is to provide proper drainage to prevent ponding of water on the surface, patch or replace all cracks and spalls, or to provide a bonded concrete encasement or overlay.

19.3.3 Concrete Cracking

The causes of cracking are the same as for spalling, with the addition of drying shrinkage and structural distress. Under drying shrinkage, tension develops on the surface of the concrete as the volume of the concrete decreases as the concrete cures and water evaporates from the surface. These cracks can range from singular cracks in thin narrow members, to craze or map cracking for deeper members. Singular cracks can be treated by epoxy injection, flexible sealant, complete replacement, or encasement with reflective crack control. Craze or map cracking can be treated by either surface replacement or placement of bonded concrete.
(Simplified) Method and the Jumikis (Conventional) Method in the analysis of cantilever walls, and the Free Earth Support Method to analyze anchored flexible walls. The program makes provisions for cohesive or cohesionless soils, resistance reduction factors, soil slopes, ground water, and surcharges.

- **CULVERT** will design and/or analyze a one-, two-, three-, or four-cell reinforced concrete box culvert with prismatic members (precast or cast-in-place) with or without a bottom slab, using either the working stress or load factor method. All cells are assumed to be the same size for any one culvert and the clear opening dimensions remain constant during the design process. By knowing the span, rise, and fill height, the program will design the box culvert by either service load or load factor design. It will display the bar schedule for the entire length of a cast-in-place box culvert or simply one unit of a precast box culvert.

**Mathcad Worksheets.** The following worksheets, available on our website (nysdot.gov), were created in-house:

- LRFD Bearing Design worksheets that were previously published as Appendices to Section 12.
- LRFD Abutment and Retaining Wall worksheets.
- LRFD Gusset Plate Design and Analysis worksheet is for use on new structures. See Structures Design Advisory 08-001 for more information.
- LFD Gusset Plate Analysis and LFR Load Rating worksheet is for use on existing structures. See Structures Technical Advisory 09-001 for more information.

**STRAPPS** (**STRuctures APPlicationS**) is a group of programs written and maintained by personnel of the Office of Structures of NYSDOT to aid in structural design and analysis. They include PIERRUN, CAPBEAM, CONTFTG, INDVFTG, WALL, SUPGEOM, SCUPPER, SPLICED, VERTCL, and COLUMNU. A Windows interface has been created for the SUPGEOM, SCUPPER, CULVERT, WALLRUN and VERTCL programs.

- **COLUMNU** is a program to design reinforced concrete compression members to resist a given combination of loadings or to investigate the adequacy of a given cross section to resist a similar set of loadings. Each loading case consists of an axial compressive load combined with uniaxial or biaxial bending. The method of solution is based on ultimate strength theories for reinforced concrete design.

- **PIERRUN** (Pier Analysis Program) is a control program for a software suite that also provides data to three other subprograms: CAPBEAM, CONTFTG, and INDVFTG. This suite handles input and will completely analyze and design a reinforced concrete, multiple column, rigid frame bridge pier of up to six columns, or a single-column, hammerhead bridge pier. PIERRUN analyzes the input using an exact method of indeterminate frame analysis and stores the moments, shears, and axial loads resulting from the analysis in a data file.
Input for PIERRUN includes a description of the frame and superstructure geometries, and the magnitudes of the various applied loads, or sufficient information necessary to compute these loads. The frame may consist of one to six columns. The columns may be round or rectangular in cross section, and may be tapered in either direction. The capbeam may consist of interior spans and cantilevers, all of which may be haunched linearly or parabolically. The superstructure which the frame supports may consist of up to 30 stringers positioned anywhere on the pier. Up to ten vehicle or sidewalk lanes may be positioned anywhere on the superstructure. Column fixities at the base may be assigned a value which may vary from pinned to fully rigid. The program assembles the individual loadings into AASHTO group loadings and an analysis of these AASHTO group loadings is performed based on either service load or load factor criteria. The design option for PIERRUN and its subprograms uses working stress theory.

- **CAPBEAM** program uses the data produced by PIERRUN to design the positive and negative longitudinal steel reinforcement in the capbeam, and will design double vertical stirrups for diagonal tension shear.

- **CONTFTG** is a Continuous Footing Design program. It will design the pile pattern in a rectangular grid for pile footings, will determine all footing dimensions, and will design the positive and negative reinforcing steel along the parallel axis and the top and bottom steel along the normal axis. The footing length is determined so that the positive and negative moments are balanced. The pile pattern will be a rectangular grid which results in the minimum number of piles. For spread footings, the width will be the minimum required for the length. The footing depth will be sufficient so that diagonal tension reinforcement is not required.

- **INDVFTG** is an Individual Footing Design program. It will determine the pile pattern for pile footings, the footing dimensions, and will design the top and bottom steel along both axes. For pile footings, the pile pattern will be that which results in the minimum number of piles. For spread footings, the footing area will be a minimum, but in no case will one dimension be larger than twice the other. The footing depth will be sufficient so that diagonal tension reinforcement is not required.

- **SCUPPER** is a program that designs bridge deck and bridge end drainage facilities based on user input describing the rain intensity and the length, slope and cross-section of the structure.

- **SPLICED** (SPLICE Design Program) was developed for the design and review of bolted splices in both plate girders and rolled beams designed to handle loads and stresses induced by highway loadings. Details such as plate and bolt clearances as well as additional plate thickening for corrosion are considered. Use of the program should be coordinated through the Metals Engineering Unit.

- **SUPGEOM** (Bridge SUPerstructure GEOMetry Program) is a bridge layout program that processes user input to compute the azimuth of each beam, length between working lines, span length, and elevations at a chosen interval. Haunch, camber, offsets along the working line of each end of the beam, and normal or radial offsets of the beam at the designated points from the station line are also computed. In the case of a fascia beam, the overhangs at designated points along the beam will also be computed.
Computer Programs

- **VERTCL (Shoulder Break and VERTical CLearance Program)** is used to calculate the vertical clearance under a structure, the allowable beam depth, and the shoulder break points of the over roadway for the preliminary layout of a structure over a highway, stream, or railroad. The program’s input data must consist of horizontal and vertical alignment as well as cross-section information on both the over and under roadways.

- **WALL** uses working stress to design or analyze the major elements of a stub abutment, high (or solid) abutment, or a retaining wall. For each type of structure, the program designs stem steel at critical points, footing dimensions, footing steel, and the number of pile rows and pile spacing if piles are used. The type of footing must be predetermined and the permissible soil pressure or pile loads known.

### 21.3.2 Commercial Programs

The following software have been obtained by NYSDOT from commercial providers, and are currently in use by the Department:

- **AISIsplice**
  
  AISIsplice is a program that was used for the analysis and design of bolted field splices for straight, I-shaped steel girders on the basis of AASHTO LRFD specifications. However, this program is no longer available. We are currently working on a Mathcad worksheet for splice design as a replacement.

- **BRADD (BRidge Automated Design and Drafting System)** is a computer software system that was developed for NYSDOT to automate the bridge design and drafting process. BRADD is no longer used for finished designs. It may be used to get preliminary data.

- **BRASS (Bridge Rating and Analysis of Structural Systems)** is a software package consisting of multiple modules capable of designing or analyzing girders (BRASS-GIRDER), piers (BRASS-PIER), culverts (BRASS-CULVERT), trusses (BRASS-TRUSS), splices (BRASS-SPLICE), elastomeric bearings (BRASS-PAD), and luminaire poles (BRASS-POLE), as well as a module for the determination of wheel distribution factors (BRASS-DIST). The Office of Structures currently supports the use of BRASS-GIRDER. BRASS-GIRDER accomplishes the design and load capacity determination of highway bridges. The program utilizes finite element theory and AASHTO specifications, and accommodates straight steel, concrete, and timber beams. The system computes moments, shears, axial forces, deflections and rotations caused by dead loads, live loads, settlements and temperature changes. These actions are used to design or rate user-specified sections of the deck, girder and integral columns.

- **CANDE-2007 (Culvert ANalysis and DEsign)** is a public-domain finite element design and analysis tool for all types and sizes of buried structures (culverts).
- **CONSPAN LA** is a Windows-based program for the analysis and design of single-span and multiple-span bridges constructed with simple-span, prestressed concrete girders and made continuous by reinforcing the cast-in-place top deck with mild steel in regions of negative moment.

The program possesses a predefined library of strand and section types which can be modified by the user. Standard LFD and LRFD trucks can be selected from the live load library or a configuration can be manually entered to perform an automatic moving load analysis of the structure. Input wizards are used to define beam layout and material properties, dead loads, select specific limit states for analysis and design, customize load and resistance specified factors, select limiting stresses for concrete, and specify percentage of debonded or draped strands. The program checks design status at critical points for release and final stresses as well as for ultimate loads. It automatically generates straight or draped strand patterns for a specific beam. Cracking load criteria is also checked. Vertical and horizontal shear steel is designed as well as negative reinforcement in the deck and restraint moment connections at the piers.

- **Consplice**

Consplice is a Windows-based program for the analysis and design of spliced prestressed/precast bridge girders. Splices are cast-in-place with longitudinal post-tensioning. Available precast beams include l-girder, box beam, open box/bathtub beam, tee, or double-tee beam. The user can specify variable depth precast beam segments and end blocks at either or both beam ends. The tendon profile can be linear, general, or parabolic (two-, three- or four-span). Jacking can be specified from either or both ends and can be done in single or multiple stages.

The program can easily switch between English and metric unit systems. To save input time, there are built-in libraries for precast beam sections, prestressing stands, post-tensioning tendons and live load vehicles.

The program performs a time dependent analysis using either 1990 CEB-FIP, AASHTO LRFD or ACI-209 committee model codes for concrete creep, shrinkage, and steel relaxation effects. This analysis is dependent on the construction stage sequence. For each stage, the user specifies the duration, which elements are active (beam, slab, cast-in-place splices, post-tensioning, or support elements), and which loads are being applied. The program provides a graphical depiction of each stage.

The program automatically performs a moving live load analysis using AASHTO vehicles. The program can also analyze the structure for a temperature gradient (positive and negative).

A design check is done using either AASHTO LFD or LRFD specifications for ultimate moment, shear and service load stresses. The user can view the results of the analysis (moments, shears, stresses and deflections) in either tabular or graphical form. A capacity/demand ratio is calculated for ultimate moment and cracking load. The program can design or analyze vertical shear reinforcement. It can also design prestressing strand and debonding for variable support conditions at release.
- **DESCUS I** (DESign and Analysis of CUrved I-Girder Bridge Systems) is an analysis and design (partial design) software for horizontally curved composite or noncomposite I-girder steel bridges. The user can specify the use of either WSD, LFD or LRFD (loading only) methods. The input can be in English or SI units. The bridge can be continuous and skewed over supports. The girders can have a high degree of curvature, can be nonconcentric, and may contain hinges.

The program models the bridge as a two-dimensional grid structure with three degrees of freedom at each nodal point. All dead load computations are performed automatically within the program to satisfy the construction conditions specified by AASHTO. The user can input additional dead loads as desired. All live load computations are also performed automatically where the AASHTO truck and lane loadings are applied to an influence surface previously generated for the entire bridge. Dynamic impact effects are also included. Arbitrary truck configurations can also be specified and analyzed.

The program output contains the positive and negative maximum moments, shear and torsion along with the corresponding primary and warping stresses for each girder and beam or truss diaphragm element. These maximums are given along with all AASHTO loading combinations. The output also includes deformations along each girder for dead load and maximum dead load plus impact along with the allowable recommended by AASHTO. The program will also perform rating calculations using either working stress rating (WSR), Load Factor Rating (LFR), or Load and Resistance Factor Rating (LRFR) methods.

- **DESCUS II** possesses the same features and functions as DESCUS I, but was specifically written to analyze a horizontally curved structure composed of steel box sections.

- **ETCulvert** will design and analyze a one-cell precast reinforced concrete culvert with prismatic members with or without a bottom slab in accordance with the design criteria in *NYSDOT LRFD Bridge Design Specifications or AASHTO Standard Specifications for Highway Bridges*.

- **Mathcad Professional**

  Mathcad Professional is a general purpose computational tool. Mathcad allows text and math to be combined in the same document. Since the program uses real math notation, worksheets created in Mathcad look just like computations made with paper and pencil. Formulas in a Mathcad worksheet are “live” in the sense that if a change to a variable is made, all equations are recomputed automatically. Therefore, Mathcad worksheets can replace hand-calculations where changes are frequently necessary.

  Mathcad has extensive computational ability. Equations can be solved numerically or symbolically. Two- and three-dimensional plots can be readily created. Mathcad can also handle variables and equations that have units associated with them. More advanced features include matrices and vectors, derivation and integration, built-in and user defined functions, solving blocks of equations, programming, and symbolic evaluation.
• **MDX** is an analysis, design, and rating software for horizontally curved and straight composite or non-composite steel I girders, box girders, or rolled shapes. The user can specify ASD, LFD, or LRFD design including use of standard live loads, user defined live loads (e.g. NYSDOT permit loads) or rail loadings. The software offers flexible nodal coordinate input feature to accommodate complex girder system framing plans, roadway profile, variable horizontal curvature, and skewed supports. The user can specify a line girder approach, grid analysis, or plate and eccentric beam finite analysis model for girder system analysis, design and load rating. The software can accommodate up to 20 spans and 60 girders of complex girder web profile of uniform and hybrid steel girders.

The MDX design and analysis software is also capable of performing design and analysis of various girder attachments such as bearing stiffeners, intermediate transverse web stiffeners, longitudinal web stiffeners, box girder bottom flange stiffeners, shear connectors, welds, bolted splices, and variety of bracing types and members. The software allows for slab pour sequence analysis with an output for camber data, stress, load deflections, and performance ratios to ensure compliance with AASHTO code.

The MDX design and analysis software complements other curved girder design and analysis software allowing designer higher level of confidence and comfort while reducing possible errors in design and analysis of horizontally curved girders.

• **MERLIN-DASH (Design, Analysis and Rating of StraigHt Girder Bridge Systems)** is a steel beam and plate girder design and analysis program that offers a Windows-based pull-down menu system, indexed output tables, the ability to perform a complete code check, rating capabilities, and graphics plots to interpret the numeric output. Various code specification methods are available in MERLIN-DASH including the AASHTO WSD, LFD, and LRFD alternates for design, analysis and rating. The user has the option of choosing either English or metric input and output. The program incorporates a wide range of live load analysis capabilities including standard and nonstandard AASHTO truck and lane loadings, interstate (or military) vehicle, and user-defined truck up to 20 axles where direction of travel may be specified. All dead load conditions, including dead load stage analysis, are given automatically for both composite and non-composite construction.

MERLIN-DASH can perform detailed steel designs for a wide range of configurations. Among the various features available to the user is design recycling, placement of lateral bracing, the shear/moment interactions, stiffener requirements, and minimum weight or minimum cost optimization. MERLIN-DASH also performs a detailed code check including a comparison of all actual stresses or stress resultants (moments, shears, etc.) and stress ranges to allowables generated automatically by the program. Supplementing all code check results, the program output lists the applicable code equation numbers, the code provisions, and the constants which are used to calculate the allowables. The results are given for all fatigue and nonfatigue details. Flags highlight all overstress conditions.

• **OPIS**

Opis is the analysis and design component of the Virtis/Opis software. The program uses AASHTO LRFD or LFD specifications for analysis and design. The program has a database component for storing all the input information (geometry, material properties, loads, etc.). This information is used by the different modules to analyze a structure. At the present time, OPIS has a module for steel girders and prestressed girders (Brass Girder).
• **RC-Pier LA**

RC-Pier LA is a Windows-based program for the analysis and design of reinforced concrete piers based on AASHTO LFD and LRFD codes. Wall, multi-column and hammerhead piers are all handled by the program. Footings can be either isolated, combined or strap and they can be either spread or on piles. The program can easily switch between English and metric unit systems.

The user specifies the geometry of the pier. Cap beams can be straight or tapered. Up to two lines of bearings can be specified. Columns can be rectangular or circular and can be tapered in either direction if rectangular. The program provides a three-dimensional visualization of the substructure.

Substructure dead loads are automatically calculated and the program can also generate live loads, wind loads and earthquake loads. Users can input bearing, column and cap loads for any load type. The user can also specify which load groups to include in the analysis. The results of the analysis can be viewed in tabular form or graphically for a specific load type or load group. These results include axial forces, shears, moments, displacements and rotations.

Reinforcement can be input by the user or automatically designed by the program. The cap is checked for flexure, shear, torsion, cracking and fatigue. Columns are checked for flexure and axial loads. Slender columns can be analyzed using P-delta or moment magnification methods. Interaction diagrams for the column can also be viewed. Footings are checked for flexure, one-way shear, two-way shear, crack control and fatigue. There is an optional strut-and-tie method for the analysis of hammerhead piers.

• **SEISAB (SEISmic Analysis of Bridges)** can be used to analyze simply-supported or continuous deck girder-type bridges for seismic response with no practical limitation on the number of spans or the number of columns at a bent. SEISAB contains both the single mode and multimode response spectrum analysis techniques included in AASHTO. In addition, earthquake restrainer units may be placed between adjacent structural segments. Horizontal alignments composed of a combination of tangent and curved segments are accommodated. Connections between the superstructure and the substructure and between adjacent superstructure segments at span hinges can be specified with either a keyword force release or by using bearing elements on a point by point basis. The flexibility of the soil and foundations at the abutments and column bottoms is included using stiffness coefficients or individual piles grouped into pile footings.

SEISAB has generating capabilities that will automatically build a model consistent with the modeling techniques used to conduct dynamic analyses. Seismic loadings in the form of acceleration response spectra are stored within SEISAB and may be referenced by the user, or a site specific spectrum can be utilized. A dead load analysis option can be requested for model verification or to obtain dead load forces for the Group VII loading. The user interacts with SEISAB by using the built-in menu system or by supplying an existing input file and data can be in either English or SI units.
• **STAAD-PRO (STructural Analysis And Design)** is a powerful software for static, dynamic, p-delta, nonlinear, buckling or cable analysis of structures. The program accepts truss, plane, floor, and space structural types. STAAD is capable of steel, concrete and timber design. The program uses a common language-based input format which can be created through an editor, a graphics input generator, or through CADD-based input generators. Modeling of the structure consists of two steps: identification of joints and nodes, and modeling of members or elements through specification of connectivity between joints. The structure is defined as an assemblage of elements. The graphics input generator facilitates viewing of structural models for both 2D and 3D situations, and allows the user to specify section properties, material constants, supports, loads, analysis/design requirements, and printing/plotting requirements. The program also allows member properties to be described using prismatic property specifications, standard steel shapes from the built-in section library, and through user-created steel tables, tapered sections, or assigned values. Graphical post-processing is available for verification of the model and display of the results, including display and plotting of structure geometry, deflected/mode shapes, bending moment/shear force diagrams, and stress contours. In addition to STAAD-Pro, the Office of Structures has also acquired the following ancillary programs:

  - **STAAD.beava**: Bridge Engineering Automated Vehicle Application, is used to automatically generate Live Load effects on 3-D models, using influence surfaces.

  - **STAAD.foundation**: a program for analysis and design of various types of foundations, such as isolated or combined spread footings, mat foundations, and pile footings.

  - **STAAD.etc**: a set of modules for analysis and design of structural components such as base plates, bolt groups, cantilever retaining walls, moment connections, masonry walls, rectangular footing, etc.

  - **Section Wizard**: creates custom shapes and calculates section properties. Can also calculate stress at any point of a cross section based on an applied Axial forces and Moments about principal axes.

• **VIRTIS**

  Virtis is the load rating component of the Virtis/Opis software. Virtis can provide bridge ratings using either AASHTO ASD or LFD specifications.