# CHAPTER 3 - INTERIM REVISIONS

3.1.3.3 Deck Replacements, if practical, should meet the requirements of Paragraph 3.1.3.1 above. However, when this is not practical or may reduce the service life of the bridge (i.e. need to eliminate or reduce the wearing surface), the design live load shall be determined using the following methodology for the superstructure:

1. Check the existing superstructure rating for HL93 live load and the proposed dead loads using LRFD and all applicable load and resistance factors.
2. If the existing superstructure rating does not rate for the HL93 vehicle loading, check rating of HS20 vehicle using the same methodology that was used in the original design.
3. If the existing superstructure does not rate for the HS20 truck, rate for the original design live load and the Posting Vehicles, as defined in Chapter 7 of Part I of this Bridge Manual, using the same methodology that was used in the original design.

Results of the ratings with the various potential cross sections for the new deck shall be presented and MassDOT will select the desired alternative and appropriate design live load based upon the results.

Typically, substructures need not be evaluated. In cases where MassDOT determines that the substructure needs to be evaluated, it shall be done in accordance with Paragraph 2.4.2.8 of Part I of this Bridge Manual.

3.1.3.5 Historic structures that are being rehabilitated or preserved may be exempted from complying with Paragraph 3.1.3.4 if the structure's inventory rating can be upgraded to meet the anticipated truck traffic loadings. These exemptions shall require prior written approval from MassDOT. Substructures of rehabilitated historic structures shall be in accordance with Paragraph 2.4.2.8 of Part I of this Bridge Manual.

3.1.4.2 Existing highway bridges that are being rehabilitated, including superstructure replacements, should be upgraded consistent with the provisions of Paragraph 2.1.2.3 of Part I of this Bridge Manual..

3.1.4.3 For deck replacement projects, the deck shall be designed using the Load and Resistance Factor Design (LRFD) method and the requirements of this Bridge Manual. The existing components to remain shall be designed using the LRFD or the 17th Edition of the AASHTO Standard Specifications for Highway Bridges, as applicable for the design live load specified in Paragraph 3.1.3.3.

3.1.4.4 Other bridge preservation projects, such as Bridge Superstructure Repair, Bridge Substructure Repair, Joint Replacement, Painting, and other Bridge Preservation or Repair Projects, are primarily maintenance projects and need not bridge the entire bridge up to current AASHTO design code and Bridge Manual standards. Therefore, the 17th Edition of the AASHTO Standard Specifications for Highway Bridges may be used in place of the LRFD method.

3.5.7.2 Design Methodology. Method B shall be used to design all steel-reinforced elastomeric bearings and should be used for design. Method A shall be used to plain elastomeric pads if design is required.

3.5.7.7 Bearings shall also be designed for all longitudinal and lateral movements. Longitudinal translation due to dead load girder rotation about the neutral axis may need to be accounted for beams with large rotations or for deep beams. This translation should be added to the design longitudinal movement. The *AASHTO LRFD* outline requirements for calculation of thermal movement. The following are general guidelines that are intended to supplement the *AASHTO LRFD*:

 Standard Bridges:

 In this context a standard bridge is defined as a bridge that has the following geometric conditions:

1. Straight beams;
2. Skew angle  30 degrees;
3. Span length to width ratio greater than 2;
4. The bridge has 3 or less travel lanes.

 The major contributor to thermal movements is the bridge deck. This portion of the bridge structure is exposed to the highest temperature extremes and is a continuous flat plate. A flat plate will expand and contract in two directions, and will not be significantly affected by other components of the superstructure below, i.e. beams, diaphragms and cross frames. For bridges that meet the general criteria listed above, the calculations for thermal movement can be based on the assumption that the bridge expands along its major axis, which is along the span length.

Non-Standard Bridges:

 The treatment of non-standard bridges requires careful design and planning. A refined analysis may be required for non-standard bridges in order to determine the thermal movements, beam rotations (transverse and longitudinal), as well as the structural behavior of the system. The stiffness of substructure elements may also have an effect on the thermal movement at bearings. The following are general basic guidelines outlining the thermal movement behavior for non-standard bridges:

* Curved Girder Bridges:

 It has been well documented that curved girder bridges do not expand and contract along the girder lines. The most often used approach is to design bearing devices to expand along a chord that runs from the point of zero movement (usually a fixed substructure element) to the bearing element under consideration.

* Large Skew Bridges:
* Thermal movements should be evaluated with a refined analysis to better understand their magnitude and direction. In this analysis the bridge can be modeled as a simple plate representing the deck plan area with a temperature change applied to it. Bridges with small span-to-width ratios:

 Bridges with widths that approach and sometimes exceed their lengths are subject to unusual thermal movements. A square bridge will expand equally in both directions, and bridges that are wider than they are long will expand more in the transverse direction than in the longitudinal direction. The design of bearing devices and keeper assemblies should take into account this movement.

* Wide bridges:

 Bridges that are wider than three lanes will experience transverse thermal movements that can become excessive. Care should be taken along lines of bearings as to not to guide or fix all bearings along the line. Guides and keeper assemblies should be limited to the interior portions of the bridge that do not experience large transverse movements.

 The Designer should specify on the Construction Drawings a range of temperatures for setting the bearings based on their design. Provisions should also be included for jacking the structure in order to reset the bearings if this range cannot be met during construction. A recommended temperature range is the average ambient temperature range for the bridge location plus or minus 10 °F. Larger values can be specified provided that the bearing is designed for the additional movement.

 For continuous span bridges, bearings will see both minimum and maximum loads, depending on the location of the truck along the span of the bridge. In these situations, a bearing shall be designed and detailed for the maximum loading combination. The minimum loading combination shall be ignored in the bearing design.

  Where anchor bolts are used to resist lateral forces, they shall be located outside the bearing pads and shall be designed for bending as well as shear. The sole plates shall also be checked for shear and bending.

#### 3.6.1.6 Fracture critical members (FCM), or as they are now being called Nonredundant Steel Tension Members (NSTM), or member components, are primary members subject to net tension or tension components of bending members (including those that subject to the reversal of stress) whose failure may result in the collapse of the bridge. All NSTM members and components, as defined in the *AASHTO Guide Specifications for Analysis and Identification of Fracture Critical Members and System Redundant Members,* shall be clearly designated on the contract drawings. All members and components designated as NSTM are subject to the additional requirements of the Fracture Control Plan in the *AASHTO/AWS Bridge Welding Code*. Members and components not subject to net tensile stress under Strength I Limit State are not NSTM.

If a bridge has NSTM members, the Designer must also prepare and submit, as part of the design deliverables, a Nonredundant Steel Tension Member Inspection Procedure prepared in accordance with the requirements of Subsection 3.13.2 of this Bridge Manual.

For bridges with a truss-floorbeam(-stringer) or girder-floorbeam(-stringer) floor systems, the floorbeams shall not be considered NSTM if the spacing of the floorbeams is 12 feet or less and:

* The deck slab is designed to be continuous over the floorbeams with the main reinforcing placed parallel to the main trusses or girders.
* Or the stringers are placed on top of the floorbeams and at least every other stringer is continuous over a floorbeam.

In general, depending upon how they are connected to the primary members, secondary members, such as intermediate diaphragms on straight girder bridges, connection plates of diaphragms, transverse stiffeners, and lateral bracing should not be designated as NSTM. Fracture critical requirements do not apply to temporary stages in construction.

### Materials and Fabrication

3.7.2.1 Concrete Strength. Designs of prestressed concrete shall be based on a concrete compressive strength (f ′c) of 8000 psi. Use of concrete strengths other than this is discouraged, since this will require the Fabricators to prepare a special mix design and receive approval for it by MassDOT prior to fabrication, which will delay the start of fabrication and add to the cost of the beams. For a design concrete compressive strength (f ′c) of 8000 psi, a concrete compressive strength at release (f ′ci) shall generally be taken as 6000 psi. Higher concrete release strengths, up to 0.8 f ′c, may be used only if required by design in order to avoid going to a deeper beam. Concrete release strengths greater than 0.8 f ′c shall not be used.

### Nonredundant Steel Tension Member (NSTM) Bridge Inspection Procedures

#### 3.13.2.1 If a bridge is designed with NSTM members, the Designer must prepare and submit a NSTM Inspection Procedure as part of the design process in addition to the contract documents. This procedure will be used to properly inspect these structures in accordance with federal regulations, 23 CFR Part 650, Subpart C, §650.313 (f).

#### 3.13.2.2 The NSTM Inspection Procedure shall be prepared on standard MassDOT forms as supplied by the Bridge Inspection Unit and shall consist of the following parts:

1. Index
2. Identification of NSTM Members

Where NSTM portions of members (such as tension zones of non-redundant plate girders or floorbeams) exist, the entirety of the member is considered as a NSTM Member. Identify these members both by text and visually by using key Construction Drawings, diagrams and elevation views of members. This list will be used by the inspectors to identify and inspect all NSTM members on the bridge. The required inspection frequency shall also be noted.

1. Identification of Fatigue Sensitive Details

Identify all Fatigue Sensitive details, including constraint-induced fracture prone details, on the NSTM members both by text and through the use of the standard Fatigue Sensitive category diagrams. This list will be used by inspectors to identify and inspect all Fatigue Sensitive details on the NSTM members. The required inspection frequency shall also be noted.

1. Inspection Procedure for Inspection of NSTM Members

Outline the procedure the inspectors are to follow when inspecting NSTM members. The required inspection frequency shall also be noted.

1. Inspection Procedure for Inspection of Fatigue Sensitive Details

Outline the procedure the inspectors are to follow when inspecting Fatigue Sensitive details or other details known to be susceptible to fracture, such as constraint-induced fracture prone details. The required inspection frequency shall also be noted.

1. Photographs

Provide inventory photographs of the bridge structure and photographs of the typical Fracture Critical members and Fatigue Sensitive details for identification purposes.

The Federal Highway Administration Report No. FHWA-IP-86-26, “Inspection of Fracture Critical Bridge Members”, dated September 1986, can be used as a reference and guide in preparing the inspection procedures of parts 3 and 4.

#### 3.13.2.3 Since a NSTM Inspection requires a very detailed, close visual “hands-on” inspection as a means of detecting cracks, the Designer shall make sure that all NSTM members of the bridge can be accessed in accordance with Subsection 3.13.1.