FDOT

LRFR Modifications

July 2006

1 – INTRODUCTION

1.1 PURPOSE

Add the following:

Florida Department of Transportation revisions and additions to LRFR address requirements to load rate bridges in Florida.

C1.1

Add the following:

Unless there is a change in condition of the bridge, an existing load rating using allowable stress method or load factor design is not required to be load rated with LRFR.

1.2 SCOPE

Add the following:

Additional Sections and procedures have been added to address Florida's unique bridges

1.3 APPLICABILITY

Add the following:

Florida Administrative Code 14-15.002, Manual of Uniform Standards for Design, Construction, and Maintenance for Streets and Highways (Commonly known as the "Florida Greenbook") requires load rating for all bridges in Florida.

C1.3

Add the following:

Do not use previous editions of the AASHTO Manual for Condition Evaluation of Bridges. The load rating methods from these earlier publications are incorporated in LRFR Appendix D.6.

1.5 DEFINITIONS AND TERMINOLOGIES

Add the following:

Posting Avoidance Techniques – Applying engineering judgment to a load rating by modifying the specification defined procedures through use of Variances and Exceptions (as defined in the FDOT Plan Preparation Manual). See Appendix F.6 for Posting Avoidance details and requirements

2 – BRIDGE FILE (RECORDS)

2.2 COMPONENTS OF BRIDGE RECORDS

2.2.15 Structure Inventory and Appraisal Sheets

Add the following:

In addition to the requirements of the State Maintenance Office, report the LRFR ratings on the load capacity information form as follows:

1. Longitudinal design load ratings (inventory and operating) as rating factors.
2. FL120 permit vehicle (Table 6-1, Permit load) longitudinal permit ratings in tons.
3. For transversely prestressed concrete bridge decks provide the transverse capacity of the deck at the design load operating level. Load rate both the design truck single axle and the design tandem axles.
4. If the design load rating at operating, for either longitudinal or transverse capacity expressed as rating factor, is less than 1.0, calculate the legal load ratings for the SU4, C5 and ST5 Florida legal trucks in tons.

For both the longitudinal and transverse ratings, provide a sketch indicating the location of the controlling components for both the transverse and longitudinal analysis.

2.2.17 Rating Records

Add the following:

Perform load ratings in accordance with the FDOT Bridge Load Rating, Permitting, and Posting Manual. Report the date of the Bridge Load Rating, Permitting, and Posting Manual used in the rating calculations. Complete the Bridge Load Capacity Summary form found in the manual. For new bridges and bridges receiving a new rating, include the appropriate structures load rating summary sheets in the plans or load rating documents. See FDOT CADD Software.

6 – LOAD RATING ANALYSIS (REVISED TITLE)

Was previously titled Section 6 - Load and Resistance Factor Rating

6.0 (NEW) OVERVIEW OF LOAD RATING METHODS AND PROCEDURES

The load rating of existing structures shall be in accordance with Table 2-1. The order of preference in rating methodologies is: (1) load and resistance factor rating (LRFR), (2) load factor rating (LFR) and (3) allowable stress rating.

C6.0

Add the following:

In 1993 an agreement was reached between the FHWA and the FDOT concerning the use of allowable stress method for load rating bridges. In summary, the agreement states allowable stress rating is not permitted for bridges on the National Highway System if the bridge is either structurally deficient or functionally obsolete.

Table 2-1 Acceptable Load Rating Methodologies

DESIGN METHODOLOGY	LOAD-RATING METHODOLOGY		
	Allowable Stress Rating - ASR (Appendix D.6)	Load Factor Rating – LFR (Appendix D.6)	Load & Resistance Factor Rating - LRFR (Section 6)
Allowable Stress Design (ASD)	√1	√	√
Load Factor Design (LFD)		√	√
Load & Resistance Factor Design (LRFD)			√2
1 – Allowable stress rating is not permitted for bridges on the National Highway System if the bridge is either structurally deficient or functionally obsolete.			
2 – Bridges designed using the LRFD methodology before January 7, 2005 may be load rated using either the LFR or LRFR methodologies. For new designs (January 7, 2005 and after), the Department will not allow the use of an alternative load rating methodology (Appendix D.6) or posting avoidance techniques, with the exception of curved steel bridges (see 6.6.1).			
The analysis shall include reference to the dated Structures Manual.			

6.1 INTRODUCTION

6.1.7 Load Rating (revised title)

Delete the last two sentences and add the following:

The routine FDOT rating process is shown in FDOT Figure 6-1. Rate bridges designed January 2005 and after using LRFR. For bridges other than prestressed concrete segmental box girders, designed before January 2005, use Appendix D.6 for rating. For bridges designed using the LFD methodology before January 2005, LRFR may be used as an alternative.

Replace Figure 6-1, Flow Chart for Load Rating, with FDOT Figure 6-1.

6.1.7.1 Design Load Rating

Replace the 3rd sentence of the 1st paragraph with the following:

Under this check, bridges are screened for both the strength and service limit states.

Delete the 4th and 5th sentences of the 1st paragraph.

Replace the 2nd sentence of the second

C6.1.7

Add the following:

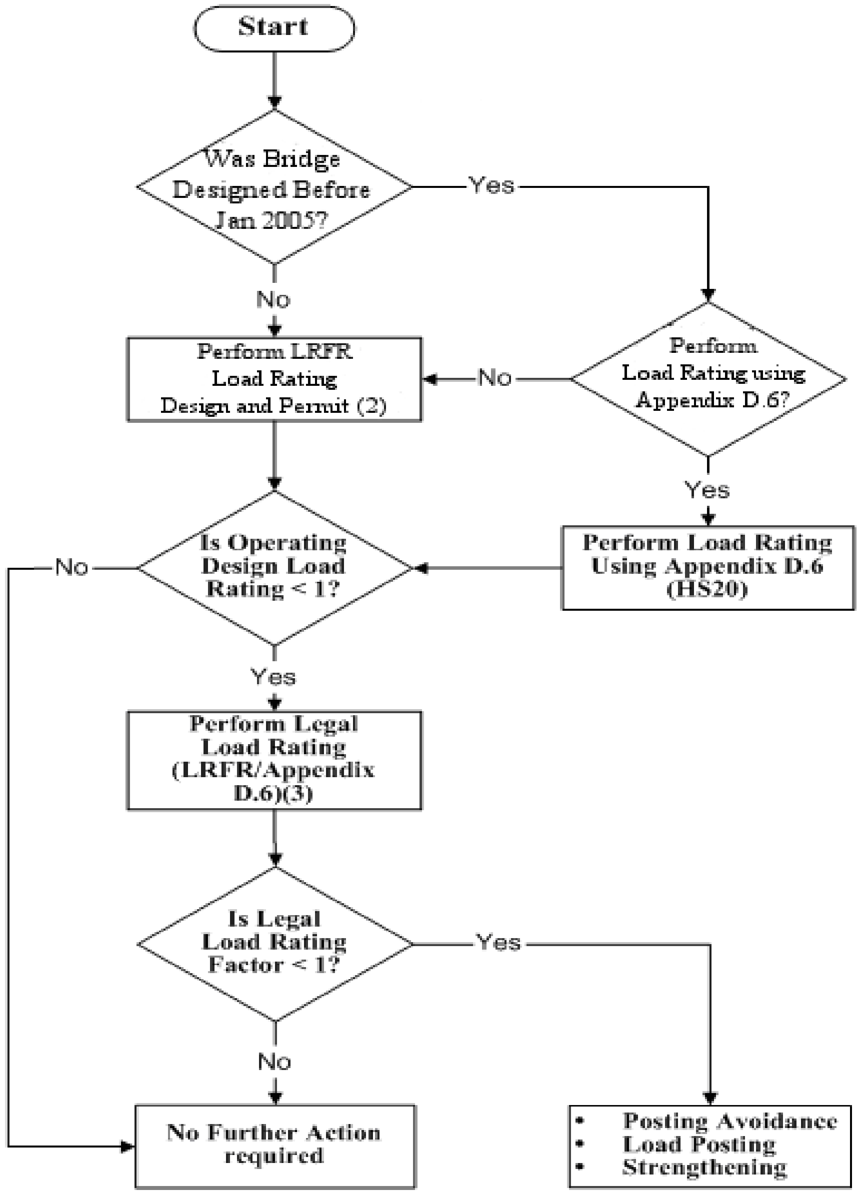
The rating process of AASHTO LRFR suggests that each permit vehicle be evaluated individually. Such is not the case with FDOT or with most other States. Traditionally, annual blanket permits were issued based upon a comparison of force effects of the permit vehicle in question to that of the HS20 operating rating. To continue the practice of having information available to easily judge permit applications, FDOT's rating process includes an FL120 permit-load rating as part of the routine rating of bridges. Single-trip permit vehicles will be evaluated outside of the routine FDOT rating process.

Since Appendix D.6 does not specifically address prestressed concrete segmental box girders, perform all rating analysis for this bridge type, using LRFR procedures. For this bridge type, a minimum acceptable rating factor of 1.0 is required for all legal loads and the FL120 Permit load.

paragraph with the following:

Bridges that have a design load rating factor equal to or greater than 1.0 at the operating level will have satisfactory load rating for all three Florida legal loads.

FDOT Figure 6-1, Flowchart for Load Rating



(1) References 6.0 and 6.1.7
(2) References 6.1.7.1, 6.1.7.2, 6.4.3 and 6.4.5
(3) References 6.1.7.2, 6.2.3.1, 6.4.4 or Appendix D.6

6.1.7.2 Legal Load Rating

Replace the 3rd sentence of the 1st paragraph with the following:

Using this check, bridges are screened for both the strength and service limit states as noted in Table 6-1.

Delete the 4th and 5th sentences of the 1st paragraph.

6.1.8 Component-Specific Evaluation

Add the following:

Bridges may contain local details that must be appropriately designed to carry local loads or distribute forces to the main bridge components (beams). Although forces in these details can vary as a function of the applied live loads (with the exception of in-span beam splices), it is recommended that they not be included in the load rating. Rather, the capacities of such details should be check only for critical loads or ratings and then only if there is evidence of distress (e.g. cracks).

C6.1.8

Add the following:

Important local details in concrete bridges include diaphragms and details, such as corbels, that support expansion joint devices and anchorages for post-tensioning tendons. The behavior of these details and the forces to which they are subjected may be determined by appropriate models or hand calculations. Analysis methods and design procedures are available in LRFD (e.g. strut and tie analysis).

6.1.8.3 (new) Diaphragms

The main purpose of transverse diaphragms is to provide lateral stability to girders during construction and wind loading.

Transverse diaphragms themselves need not be analyzed as part of a routine load rating. Only if there is evidence of distress (e.g. efflorescence, rust stains or buckling), or at the discretion of the engineer, should it be necessary to more closely consider the forces and stresses in a diaphragm.

The stiffness of any transverse diaphragms should be included, if significant and appropriate, in any finite element analysis program used to establish Live Load Distribution Factors.

6.1.8.4 (new) Support for Expansion Joint Devices

Expansion joint devices are usually contained in a recess formed in the top of the end of the top slab and transverse diaphragm. Occasionally, depending upon the need to accommodate other details, such as drainage systems, this may involve a corbel - usually as a contiguous part of the expansion joint diaphragm. It is not necessary to analyze such a detail for routine load rating. Only if there is evidence of distress (e.g. cracks, efflorescence or rust stains), or at the discretion of the engineer, should it be necessary to more closely consider the forces and stresses in such a detail.

6.1.8.5 (new) Anchorages for Post-Tensioning Tendons

Anchorages are normally contained in a widened portion of the web at the ends of a beam. It is not necessary to analyze anchorage details for routine load rating. Only if there is evidence of distress (e.g. cracks, efflorescence or rust stains) should it be necessary to more closely consider the forces and stresses in such a detail itself.

Changes in the gross section properties at anchor block zones should be properly accounted for in any finite element analysis program used to establish principal tension/bursting.

6.1.8.6 (new) Post Tensioned Concrete Beam Splices within a Span

Beam splices within a span are frequently used to connect portions of continuous girders. Such splices usually require reinforcing bars projecting from the ends of the precast beams and into a reinforced, cast-in-place transverse diaphragm. Longitudinal post-tensioning ducts are connected and tendons pass through the splice.

Beam splices are typically near inflection points; consequently, live load effects may induce longitudinal tensile stress in the top or bottom. Therefore, the longitudinal tendons are approximately concentric, i.e. at mid-depth of the composite section. It is necessary to check longitudinal flexure and shear effects at in-span beam splices.

6.1.8.7 (new) Post Tensioned Concrete Beam Dapped Hinges within a Span

Dapped hinges are rarely used in beam bridges in Florida. Forces acting through dapped hinges within a span should be calculated for statically determinate structures or be determined as a part of the time-dependent construction analysis for indeterminate structures. Maximum live load reactions should also be calculated. Once all reaction forces are known, local analyses should be performed to develop the hinge forces into the main beam components using suitable strut-and-tie techniques. An alternate approach would be to develop three-dimensional finite element models to analyze the flow of forces.

6.2 LOADS FOR EVALUATION

6.2.3 Transient Loads

6.2.3.1 Vehicular Live Loads (Gravity Loads): LL

Replace the vehicles given after Legal Loads: with the following:

Florida Legal Loads (SU4, C5, and ST5, see 6.4.4.2.1 for vehicle configurations).

Replace the vehicle given after Permit Loads: with the following:

Florida Permit Load (FL120, see 6.4.5.4.2.1 for vehicle configurations). For new bridges the minimum rating factor for the FL120 is 1.0.

C6.2.3.1

Add the following:

For simple span bridges, see figure C6-4 for a comparison of legal loads and HL-93.

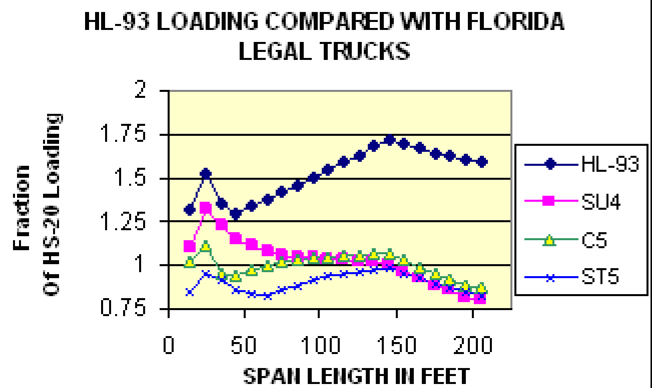


Figure C6-4

6.3 STRUCTURAL ANALYSIS

Add the following:

Transverse and longitudinal ratings shall be reported for post-tensioned concrete segmental bridges. All bridge decks designed with transverse prestressing require transverse ratings. For all other bridges, only longitudinal ratings are typically required.

6.3.2 Approximate Methods of Structural Analysis

Add the following:

Approximate methods include one-dimensional line-girder analysis using LRFD distribution factors.

For bridges constructed with composite prestressed deck panels, the live load distribution factors will be increased by a factor of 1.1 thus increasing the load and reducing the capacity.

C6.3.2

Add the following:

Deck superstructures, utilizing composite prestressed deck panels have performed poorly. The deck cracked around the perimeter of the panel and the deck stiffness is softened therefore, a reduction in stiffness occurs. If conditions are severe, the live load distribution can be calculated as if the deck panels are simple supported on the girders.

6.3.3 Refined Methods of Analysis

Add the following:

Refined methods of analysis include two or three dimensional models using grid or finite-element analysis.

All analyses will be performed assuming no benefit from the stiffening effects of any traffic railing barrier or other appurtenances.

C6.3.3

Delete the second paragraph of the commentary in its entirety

6.4 LOADS RATING PROCEDURES

6.4.2 General Load Rating Equation

Add the following:

When calculating the Service Limit State capacity for prestressed concrete flat slabs and girders with bonded tendons/strands, use the transformed section properties when calculating stresses as follows: at strand transfer; for calculation of prestress losses; for live load application. Use the refined estimates of time-dependent losses (LRFD 5.9.5.4) with a 180 day differential between girder concrete casting and placement of the deck concrete.

C6.4.2

Add the following:

For a detailed explanation of stress calculations in prestressed concrete girders, see NCHRP 496. The correct use of transformed section properties and the refined method for calculation of prestress losses is essential for the precise calculation of stresses at service limit state.

6.4.2.2 Limit States

Replace Table 6-1 with FDOT Table 6-1

6.4.2.3 Condition Factor

Delete the first sentence.

Add the following after Table 6-2:

The Florida DOT prefers load ratings be performed taking account of field measured deterioration. However, in the absence of measurements, global condition factors shall be used.

6.4.2.4 System Factor

Delete the third paragraph.

Replace Table 6-3 with FDOT Tables 6-3A, B, C and D.

Replace the second paragraph with the following:

The system factors of FDOT Tables 6-3A, 6-3B, 6-3C, and 6-3D shall apply for flexural and axial effects at the Strength limit states. Higher values than those tabulated may be considered on a case-by-case basis with the approval of the Department. System factors need not be less than 0.85. In no case shall the system factor exceed 1.3.

6.4.4 Legal Load Ratings

6.4.4.1 Purpose

Replace the 1st sentence of the 1st paragraph with the following:

Bridges that do not have sufficient capacity under the design-load rating operating level (i.e. RF 1.0 or less) shall be load rated for the SU4, C5, and ST5 legal loads to establish the potential need for load posting or strengthening.

6.4.4.2.1 Live Loads

Replace this article with the following:

Use the SU4, C5, and ST5 Florida legal loads defined in Figure 6-3 for legal load rating. Assume the SU4, C5, and ST5 trucks are in each loaded lane; do not mix trucks.

For negative moment loading and loading of spans greater than 200 feet use Appendix B.6.2 b) and B.6.2 c).

6.4.4.2.3 Generalized Live Load Factors

Revise Table 6-5 as follows:

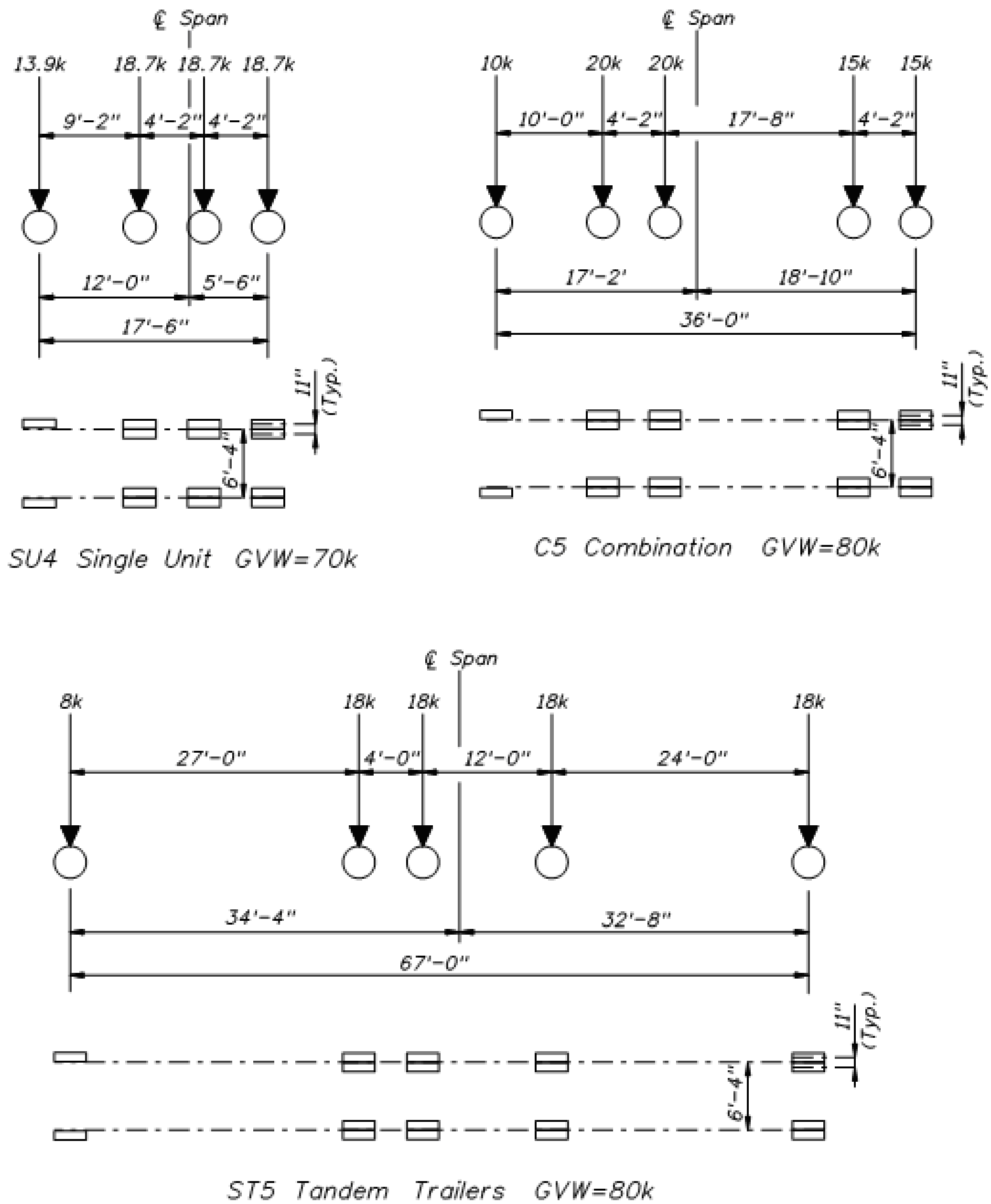
For all Traffic Volumes, revise all Load Factors to 1.35.

C6.4.4.2.3

Add the following:

The LRFD HL-93 live-load model envelopes FDOT legal loads. As such, if the live load factor of 1.35 for the design-load operating rating yields a reliability index consistent with traditional operating ratings, this live load factor can be used for legal-load rating of the FDOT legal loads.

Live load factors for FDOT legal loads are not specified as a function of ADTT.



℄ Span
13.9k 18.7k 18.7k 18.7k
9'-2" 4'-2" 4'-2"
12'-0" 5'-6"
17'-6"
11" (Typ.)
6'-4"
SU4 Single Unit GVW=70k
℄ Span
10k 20k 20k 15k 15k
10'-0" 4'-2" 17'-8" 4'-2"
17'-2' 18'-10"
36'-0"
11" (Typ.)
6'-4"
C5 Combination GVW=80k
℄ Span
8k 18k 18k 18k 18k
27'-0" 4'-0" 12'-0" 24'-0"
34'-4" 32'-8"
67'-0"
11" (Typ.)
6'-4"
ST5 Tandem Trailers GVW=80k

Figure 6-3

FDOT Table 6-1

Bridge Type	Direction	Limit State	Load Factors									
			Permanent Load			Transient Load			Design Load		Legal Load	Permit Load
									Inventory	Operating		
			DC	DW	EL	FR	TU(2) CR SH	TG(2)	*LL*	*LL*	*LL*	*LL*
Steel	Longitudinal	Str I	1.25	1.50	n/a	n/a	n/a	n/a	1.75	1.35	1.35	n/a
		Str II	1.25	1.50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.35
		Ser I (3)	1.00	1.00	n/a	n/a	n/a	n/a	1.3	1.00	1.30	0.90
Reinforced Concrete	Longitudinal	Str I	1.25	1.5	n/a	n/a	n/a	n/a	1.75	1.35	1.35	n/a
		Str II	1.25	1.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.35
Prestressed Concrete (Flat Slab and Deck/Girder)	Longitudinal	Str I	1.25	1.5	n/a	n/a	n/a	n/a	1.75	1.35	1.35	n/a
		Str II	1.25	1.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.35
		Ser III (1)	1.00	1.00	n/a	n/a	n/a	n/a	0.80	0.80	0.80	0.70
Wood	Longitudinal	Str II	1.25	1.5	n/a	n/a	n/a	n/a	1.75	1.35	1.35	n/a
		Str I	1.25	1.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.35
Post-tensioned Concrete	Longitudinal	Str I	1.25	1.5	1.00	1.00	0.50	n/a	1.75	1.35	1.35	n/a
		Str II	1.25	1.5	1.00	1.00	0.50	n/a	n/a	n/a	n/a	1.35
		Ser III (1)	1.00	1.00	1.00	1.00	1.00	0.50	0.80 or SL (4)	0.80 or SL (4)	0.80 or SL (4)	0.70 or 0.90 SL (4)
	Transverse	Str I	1.25	1.50	1.00	n/a	n/a	n/a	1.75	1.35	1.35	n/a
		Str II	1.25	1.50	1.00	n/a	n/a	n/a	n/a	n/a	n/a	1.35
		Ser II	1.00	1.00	1.00	n/a	n/a	n/a	1.00	1.00	1.00	1.00

(1) Service III Design Inventory tensile stress limit = $3\sqrt{f`c}$ or $6\sqrt{f'c}$; Service III Design Operating, Legal, and Permit tensile stress limit = $7.5\sqrt{f`c}$.

(2) TU and TG is considered for Service I and Service III Design Inventory only.

(3) The Service II limit state need only be checked for compact steel girders. For all other steel girders, the Strength limit states will govern.

(4) For I-girders use a fractional load factor; for segmental box girders use striped lanes (SL).

FDOT Table 6-3A General System Factors (φ_s)	
Superstructure Type	System Factors (φ_s)
Welded Members in Two Truss/Arch Bridges	0.85
Riveted Members in Two Truss/Arch Bridges	0.90
Multiple Eye bar Members in Truss Bridges	0.90
Floor beams with Spacing > 12 feet and Non-continuous Stringers and Deck	0.85
Floor beams with Spacing > 12 feet and Non-continuous Stringers but with continuous deck	0.90
Redundant Stringer subsystems between Floor beams	1.00
All beams in non-spliced concrete girder bridges	1.00
Steel Straddle Bents	0.85

FDOT Table 6-3B System Factors (φ_s) for Post-Tensioned Concrete Beams						
Number of Girders in Cross Section	**Span Type**	**Number of Hinges Required for Mechanism**	**System Factors (φ_s)**			
			Number of Tendons per Web			
			1	2	3	4
2	Interior	3	0.85	0.90	0.95	1.00
	End	2	0.85	0.85	0.90	0.95
	Simple	1	0.85	0.85	0.85	0.90
3 or 4	Interior	3	1.00	1.05	1.10	1.15
	End	2	0.95	1.00	1.05	1.10
	Simple	1	0.90	0.95	1.00	1.05
5 or more	Interior	3	1.05	1.10	1.15	1.20
	End	2	1.00	1.05	1.10	1.15
	Simple	1	0.95	1.00	1.05	1.10
• The tabularized values above may be increased by 0.05 for spans containing more than three intermediate, evenly spaced, diaphragms in addition to the diaphragms at the end of each span.						

FDOT Table 6-3C System Factors (φ_s) for Steel Girder Bridges			
Number of Girders in Cross Section	**Span Type**	**# of Hinges required for Mechanism**	**System Factors (φ_s)**
2	Interior	3	0.85
	End	2	0.85
	Simple	1	0.85
3 or 4	Interior	3	1.00
	End	2	0.95
	Simple	1	0.90
5 or more	Interior	3	1.05
	Simple	2	1.00
	End	1	0.95

• The tabularized values above may be increased by 0.10 for spans containing more than three evenly spaced intermediate diaphragms in addition to the diaphragms at the end of each span.
• The above tabularized values may be increased by 0.05 for riveted members

FDOT Table 6-3D System Factors (φ_s) for Concrete Box Girder Bridges						
Bridge Type	**Span Type**	**# of Hinges to Failure**	**System Factors (φ_s)**			
			No. of Tendons per Web			
			1/web	2/web	3/web	4/web
Precast Balanced Cantilever Type A Joints	Interior Span	3	0.90	1.05	1.15	1.20
	End or Hinge Span	2	0.85	1.00	1.10	1.15
	Statically Determinate	1	n/a	0.90	1.00	1.10
Precast Span-by-Span Type A Joints	Interior Span	3	n/a	1.00	1.10	1.20
	End or Hinge Span	2	n/a	0.95	1.05	1.15
	Statically Determinate	1	n/a	n/a	1.00	1.10
Precast Span-by-Span Type B Joints	Interior Span	3	n/a	1.00	1.10	1.20
	End or Hinge Span	2	n/a	0.95	1.05	1.15
	Statically Determinate	1	n/a	n/a	1.00	1.10
Cast-in-Place Balanced Cantilever	Interior Span	3	0.90	1.05	1.15	1.20
	End or Hinge Span	2	0.85	1.00	1.10	1.15
	Statically Determinate	1	n/a	0.90	1.00	1.10
For box girders with 3 or more webs, table values may be increased by 0.10.						

6.4.5 Permit Load Ratings

6.4.5.1 Background

Add the following:

Calculate the capacity for permit trucks using "one lane" distribution factor for single trip permits and "two or more lanes" distribution factor for routine or annual permits as shown in Table 6-6. The "two or more lanes" distribution factor assumes the permit vehicle is present in all loaded lanes and LRFD live load distribution equations are used. Do not use LRFD formula 4.6.2.2.4-1 since mixed traffic calculations are not performed.

C6.4.5.1

Add the following:

Florida has chosen to apply a service limit state rating for permitting overload vehicles using load factors that include a reduced reliability factor. The live load factor is applied to a capacity calculated with the rating vehicle placed in all lanes. The load factor was developed to simulate a rating vehicle in the rating lane with adjoining lanes filled with legal vehicles (tractor trailers). The combined effect of these loads is multiplied by the multiple presence factor of 0.9 (Ontario Bridge Code).

6.4.5.2 Purpose

Add the following:

Bridges designed after January 1, 2005 are required to have rating factors for the FL120 permit truck. Rate the FL120 for both Strength and Service Limit State.

6.4.5.4.2 Load Factors

C6.4.5.4.2

Add the following:

Since routine permits are evaluated using the FL120 permit truck and values of ADTT are not well known, a single load factor is specified for routine permit load rating. Similarly, a single load factor is specified for single-trip permits.

6.4.5.4.2.1 Routine (Annual) Permits

Revise Table 6-6 as follows:

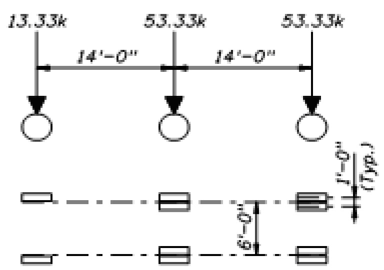
For all Permit Types, revise all the Load Factors by Permit Type to 1.35 except the escorted single trip load factor will remain 1.15.

Add the following:

The FL120 permit truck shall be considered as routine annual permit vehicle to be used to verify overload capacity of Florida bridges. The FL120 shall be checked at Strength Limit State and Service Limit State as noted in FDOT Table 6-1 and the minimum rating factor for new bridges is 1.0.

For spans over 200 feet assume the FL120 permit truck with coincident 0.20 kips per foot lane load. Assume the permit trucks are in each lane; do not mix trucks.

The FL120 permit truck configuration is shown in the figure below:



FL120 Permit Vehicle – GVW=120k

6.4.5.5 Dynamic Load Allowance

End the first sentence after "legal loads".

Add the following:

For exclusive-use vehicles with escort and speeds less than or equal to 5 mph, IM may be decreased to 0%.

6.4.5.8 (new) Adjoining Lane Loading

When performing refined analysis for permit vehicles, combine the permit vehicle with the same permit vehicle in the adjoining lanes. For spans over 200 feet, add a 0.20 kip per foot lane load to all vehicle loadings.

6.4.5.9 (new) Multiple Presence Factors

For Permit load ratings, the LRFD multiple presence factors shall be equal to or less than 1.0.

6.5 CONCRETE STRUCTURES

6.5.2 Material

Add the following:

For concrete made with Florida aggregate calculate the modulus of elasticity by applying a 0.9 factor times the value found in the specifications.

C6.4.5.4.2.1

Add the following:

The FL120 permit truck is conceived to be a benchmark to past load factor design (LFD) practice in which the HS-20 truck was rated at the operating level with a load factor of 1.3. A LRFR Permit Load rating for the FL120 permit truck equal to 1.0 is equivalent to an LFD operating rating for the HS-20 truck equal to 1.67. The axle spacing of the FL120 is not changed to emulate a truck crane.

It is reasonable to use the multiple-lane distribution factor for the permit load rating since the force effects of the permit trucks are similar to the HL-93 notional load have been shown to be very similar. Thus, this application is close to the intent of the AASHTO LRFR methodology where the HL-93 is placed in remote lanes.

The FL120 is intended to replicate the traditional HS20 operating rating where all lanes were occupied by the same truck. Thus, the use of multiple-lane distribution factors is equally appropriate for the FL120 permit load rating.

6.5.4 Limit States

6.5.4.1 Design-Load Rating

Add the following:

For prestressed concrete bridges, perform Permit-Load ratings for:

1. Service I transverse compressive and tensile stress checks in the deck of transversely prestressed bridges.
2. Service III tensile stress checks in the longitudinal direction of all prestressed concrete bridges.

The stress limits given in FDOT Table 6-9B shall be satisfied by all prestressed concrete bridges.

C6.5.4.1

Delete the first sentence of the commentary.

6.5.4.2 Legal Load Rating and Permit Load Rating

6.5.4.2.2.1 Legal load Rating

Delete both sentences and replace with the following:

Legal load rating of prestressed concrete bridges is based on satisfying strength and service limit states (see FDOT Table 6-1)

C6.5.4.2.2.1

Delete the entire commentary.

FDOT Table 6-9B Stress Limits for All Prestressed Concrete Bridges		
Condition	**Design Inventory**	**Design, Operating Legal, and Permit**
Compressive Stress (Longitudinal or Transverse)		
Compressive stress under effective prestress, permanent loads, and transient loads (Allowable compressive stress shall be reduced according to LRFD 5.9.4.2.1 when slenderness of flange or web is greater than 15)	0.60f'c	0.60f'c
Longitudinal Tensile Stress in Precompressed Tensile Zone		
For components with bonded prestressing tendons or reinforcement that are subject to not worse than: (a) an aggressive corrosion environment (b) moderately aggressive corrosion environment	 3√f'c psi 6√f'c psi	 7.5√f'c psi 7.5√f'c psi
For components with unbonded prestressing tendons	No Tension	No Tension
For components with Type B joints (dry joints, no epoxy)	100 psi comp	No Tension
Tensile Stress in Other Areas		
Areas without bonded reinforcement	No tension	No tension
Areas with bonded reinforcement sufficient to carry the tensile force in the concrete calculated on the assumption of an uncracked section is provided at a stress of 0.5fy (<30 ksi)	6√f'c psi tension	6√f'c psi tension
Transverse Tension, Bonded PT:		
Tension in the transverse direction in the precompressed tensile zone calculated on the basis of an uncracked section (i.e. top prestressed slab) for: (a) an aggressive corrosion environment (b) moderately aggressive corrosion environment	 3√f'c psi 6√f'c psi	 6√f'c psi 6√f'c psi
Principal Tensile Stress at Neutral Axis in Webs		
All types of segmental or spliced girder construction with internal and/or external tendons.	3√f'c psi tension	4√f'c psi tension

6.5.4.2.2.2 Permit load Rating

Delete the first sentence and replace with the following:

Permit load rating of prestressed concrete bridges is based on satisfying Strength and Service limit states (see FDOT Table 6-1). *Delete the second paragraph.*

6.5.7 Minimum Reinforcement

Delete equation 6-4 and use LRFD Equation 5.7.3.3.2-1.

6.5.9 Evaluation for Shear

Delete the second sentence and replace with the following:

Design and legal loads shall be checked for shear.

6.5.12 Temperature, Creep and Shrinkage Effects

Delete the sentence and replace with the following:

At the service limit state, all prestressed concrete bridges shall include the effect of uniform temperature (TU), when appropriate), creep (CR), and shrinkage (SH). In addition, temperature gradient (TG) shall be included for post-tensioned beam and box girder structures. See FDOT Table 6-1 for clarification.

C6.5.4.2.2.2

Delete the first and second paragraphs.

Florida has elected to use a service limit state for permit analysis and has removed the check for stress in the reinforcing at the strength limit state.

6.6 STEEL STRUCTURES

6.6.1 Limit States

Add the following:

Curved steel bridges shall be load rated using Appendix D.6 and the 2003 AASHTO Guide Specification for Horizontally Curved Highway Bridges.

6.6.4 Limit States

6.6.4.1 Design-Load Rating

Delete both paragraphs and replace with the following:

Bridges shall not be rated for fatigue. If the fatigue crack growth is anticipated, Section 7 of the Guide Manual for Condition Evaluation and Load and Resistance Factor Rating of Highway Bridges can be used to estimate the remaining fatigue life.

C6.6.4.1

Add the Following:

The estimate of the remaining fatigue life of Section 7 of the Guide Manual requires a historical record of past truck traffic in terms of average daily truck traffic (ADTT) and projected future traffic. Many times, conservative recreation and projection of traffic volumes produces a worst case scenario which results in low remaining fatigue lives or totally exhausted fatigue lives. As fatigue life estimates are based upon statistical evaluation of laboratory tests, different levels of confidence are presented in Section 7. The minimum expected fatigue life, the evaluation fatigue life and the mean fatigue life are based upon approximately 98%, 85% and 50% probabilities of cracking, respectively. Judgment must be used in evaluating the results of the fatigue-life estimates.

6.6.13 Fracture-Critical Members (FCM's) (new)

As with all other steel members, the appropriate system factors of FDOT Tables 6-3A or 6-3C shall be applied in the ratings of FCM's.

Steel members which are traditionally classified as FCM's may be declassified through analysis if the material satisfies the FCM fracture-toughness of LRFD Table 6.6.2-2. After the approval of an exception based upon an approved refined analysis demonstrating that the bridge with the fractured member can continue to carry a significant portion of the design load, the member may be declassified and treated as a redundant member. See LRFD Article C6.6.2. After declassification, the member may be rated using a system factor of 1.0.

C6.6.13 (new)

Only FCM's which are fabricated from material meeting the FCM fracture-toughness requirements are candidates for declassification. Newer bridges designed, fabricated and constructed since the concept of FCM's was introduced should meet this material requirement. The demonstration of non-fracture criticality must include an analysis of the damaged bridge with the member in question fractured and a corresponding dynamic load representing the energy release of the fracture. Acceptable remaining load carrying capacity may be considered equal to the full factored load of the strength I load combination associated with the number of striped lanes.

6.6.14 Double-Leaf Bascule with Span Locks (New)

Evaluate all appropriate load combinations at Strength Limit State II. Apply the full load to the cantilever leaf of the bascule bridge assuming the span locks are not engaged to transmit live load to the opposite leaf.

6.8 POSTING OF BRIDGES

Add the following:

Posting avoidance is the application of engineering judgment to a load rating by modifying the specification defined procedures through use of variances and exceptions.

A.6.1 LOAD AND RESISTANCE FACTOR RATING FLOW CHART

Replace the flowchart with FDOT Figure 6-1.

A.6.2 LIMIT STATES AND LOAD FACTORS FOR LOAD RATING

Delete all three tables and use FDOT Table 6-1.

B.6.2 AASHTO LEGAL LOADS

Delete section a) and use the Florida legal trucks defined in article 6.4.4.2.1.

D.6 - ALTERNATE LOAD RATING

D.6.1 GENERAL

Add the following paragraph:

Use the 17th Edition of the AASHTO Standard Specification with the allowable stresses shown in FDOT Table 6-9B.

D.6.6 NOMINAL CAPACITY

D.6.6.3 Load Factor Method

D.6.6.3.3 Prestressed Concrete

After the 5th RF equation, add the following heading:

Operating Rating

D.6.7 LOADINGS

D.6.7.2 Evaluation for Shear

Delete the last sentence.

E.6 RATING OF SEGMENTAL CONCRETE BRIDGES

E.6.2 GENERAL RATING REQUIREMENTS

Add the following:

Six features of concrete segmental bridges are to be load rated at the Design Load (Inventory and Operating) Levels. Three of these criteria are at the Service Limit State and three at the Strength Limit State, as follows:

At the Service Limit State:

- Longitudinal Box Girder Flexure
- Transverse Top Slab Flexure
- Principle Web Tension

At the Strength Limit State:

- Longitudinal Box Girder Flexure
- Transverse Top Slab Flexure
- Web Shear

In accordance with AASHTO LRFR Equation 6-1, the general Load Rating Factor, RF, shall be determined according to the formula:

$$RF = \frac{C-(\gamma_{DC})(DC)-(\gamma_{DW})(DW)\pm(\gamma_{EL})(P+EL)-(\gamma_{FR})(FR)-(\gamma_{CR})(TU+CR+SH)-(\gamma_{TG})(TG)}{(\gamma_{L})(LL+IM)}$$

Where:

For Strength Limit States:

C = Capacity = $(\varphi_c \times \varphi_s \times \varphi)\, R_n$.

φ_c = Condition Factor per Article 6.4.2.3.

φ_s = System Factor per Article E.6.4.2.4.

φ = Strength Reduction Factor per LRFD.

R_n = Nominal member resistance as inspected, measured and calculated according to formulae in LRFD with the exception of shear, for which, capacity is calculated according to the AASHTO Guide Specification for Segmental Bridges.

For Service Limit States:

C = f_R = Allowable stress at the Service Limit State (FDOT Table 6-9B).

E.6.8 APPENDIX E6 STEP-BY-STEP SUPPLEMENT (NEW)

Add new supplemental information.

F.6 POSTING AVOIDANCE (NEW)

Add new appendix.

G.6 LOAD RATING SUMMARY FORMS (NEW)

Add new appendix.

8 – NON DESTRUCTIVE LOAD TESTING

8.8 LOAD RATING THROUGH LOAD TESTING

8.8.1 Introduction

Add the following:

FDOT generally uses proof load testing as described in article 8.8.3. If this methodology is not used, then Table 8-1 shall establish the magnitude of the benefit.

9 – SPECIAL TOPICS

9.2 DIRECT SAFETY ASSESSMENT OF BRIDGES

Delete Section 9.2

E.6 RATING OF SEGMENTAL CONCRETE BRIDGES

E.6.8 STEP-BY-STEP SUPPLEMENT (NEW)

E.6.8.1 Load Factors and Load Combinations

Load factors and load combinations for the Strength and Service Limit States shall be made in accordance with FDOT Table 6-1. Load factors for permanent (e.g. dead) loads and transient (e.g. temperature) loads are provided. Note: one-half thermal gradient (0.5TG) is used only for longitudinal Service Inventory conditions.

STRENGTH I and II and SERVICE I and III limit states are used in the context of their definitions as given in FDOT Table 6-1 summarizing:

STRENGTH I - applies to Design Load Rating (Inventory and Operating) and Legal Load Rating.

STRENGTH II - applies only to Permit Loads.

SERVICE I - applies primarily for concrete in compression but is also to prevent yield of tension face reinforcement or prestress under overloads (permits). This limit state is extended to concrete tension in transversely prestressed deck slabs, typical of most segmental bridges.

SERVICE III - applies to concrete in longitudinal tension and principal tension. Load factors for SERVICE III for Design Operating, Legal, and Permit ratings have been selected in conjunction with either higher allowable tensile stress or, in the case of joints in segmental bridges that cannot carry tension, use of the number of striped lanes.
The following is a detailed checklist of the load applications, combinations and circumstances necessary to satisfy FDOT and ***AASHTO LRFR*** ratings.

E.6.8.2 Design Load Rating - Inventory

Transverse:
• Apply HL93 Truck or Tandem (FDOT Table 6-1).
• Do not apply uniform lane load.
• Apply same axle loads in each lane if multiple lane loading apples.
• Apply Dynamic Load Allowance, IM = 1.33 on Truck or Tandem.
• For both Strength and Service Limit States, use number of load lanes per ***LRFD***.
• Apply multi-presence factor: one lane, m =1.20; two lanes, m = 1.00; three, m = 0.85; four or more, m = 0.65. (Maximum value of m = 1.20 is the appropriate AASHTO LRFD / LRFR current criteria to allow for rogue vehicles).
• Place loads in full available width as necessary to create maximum effects.
• Apply pedestrian live load as necessary (counts as one lane for "m").
• Apply no Thermal Gradient transversely.
• Use SERVICE I Limit State with live load factor, γ_L = 1.00 and limit concrete transverse flexural stresses to values in FDOT Table 6-9B. (Note: = 1.00 as AASHTO LRFR).
• For STRENGTH I Limit State use live load factor, γ_L = 1.75.
Longitudinal:
• Apply HL93 Truck or Tandem, including 0.64 kip/ft uniform lane load (FDOT Table 6-1).
• Apply same load in each lane.
• Apply Dynamic Load Allowance, IM = 1.33 on Truck or Tandem only.
• For both Strength and Service Limit States, use number of load lanes per LRFD.

• Apply multi-presence factor: one lane, m =1.2; two lanes, m = 1.00; three, m = 0.85; four or more, m = 0.65. (Maximum value of m = 1.20 is the appropriate AASHTO LRFD / LRFR current criteria for notional loads and rogue vehicles).
• For negative moment regions: apply 90% of the effect of two Design Trucks of 72 kip GVW spaced a minimum of 50 feet apart between the leading axle of one and the trailing axle of the other, plus 90% of uniform lane load.
• Place loads in full available width as necessary to create maximum effects.
• Apply pedestrian live load as necessary (counts as one lane for "m").
• For Thermal Gradient, apply 0.50TG with live load for Service but zero TG for Strength.
• Use SERVICE III Limit State with live load from striped lanes and limit longitudinal tensile stress to values in FDOT Table 6-9B as appropriate.
• For STRENGTH I Limit State use live load factor, γ_L = 1.75.

E.6.8.3 Design Load Rating - Operating

Transverse:
• Apply one HL93 Truck or Tandem per lane (FDOT Table 6-1).
• Do not apply uniform lane load.
• Apply same axle loads in each lane if multiple lane loading apples.
• Apply Dynamic Load Allowance, IM = 1.33 on Truck or Tandem.
• For both Strength and Service Limit States, use number of load lanes per LRFD.
• Apply multi-presence factor: one and two lanes, m =1.0; three, m = 0.85; four or more, m = 0.65. (Maximum limit of 1.0 applies because this is a rating for specific (defined) axle loads, not notional loads or rogue vehicles).
• Place loads in full available width as necessary to create maximum effects.
• Apply pedestrian live load as necessary (counts as one lane for "m").
• Apply no Thermal Gradient transversely.
• Use SERVICE I Limit State with live load factor, γ_L = 1.00 and limit concrete transverse flexural stresses to values in FDOT Table 6-9B
• For STRENGTH I Limit State use live load factor, γ_L = 1.35.
Longitudinal:
• Apply HL93 Truck or Tandem, including 0.64 kip/ft uniform lane load (FDOT Table 6-1).
• Apply same load in each lane.
• Apply Dynamic Load Allowance, IM = 1.33 on Truck or Tandem only.
• For the Strength Limit State, use number of load lanes per LRFD.
• For the Service Limit State use the number of striped lanes.
• Place loads in full available width as necessary to create maximum effects (for example, in shoulders).
• Multi-presence factor: HL93 Design Load (including uniform lane load) one lane, m =1.20; two lanes, m = 1.00; three, m = 0.85; four or more, m = 0.65. (The maximum value of 1.20 for one lane is necessary because the load is a notional load with a uniform lane load component).
• For negative moment regions, apply 90% of the effect of two Design Trucks of 72 kip GVW each spaced a minimum of 50 feet apart between the leading axle of one and the trailing axle of the other, plus 90% of 0.64 kip/LF uniform lane load.
• Apply pedestrian live load as necessary (counts as one lane for "m").
• Apply no Thermal Gradient.
• Use SERVICE III Limit State with live load factor developed from striped lanes and limit concrete longitudinal flexural tensile and principal tensile stresses to values in FDOT Table 6-9B.
• For STRENGTH I Limit State use live load factor, γ_L = 1.35.

E.6.8.4 Legal Load Rating

Longitudinal:
• Apply FDOT Legal Load Trucks SU4, C5 and ST5 (FDOT Table 6-1).
• Apply same truck load in each lane using only one truck per lane (i.e. do not mix Trucks).
• Apply no uniform lane load.
• Apply Dynamic Load Allowance, IM = 1.33 on Legal, HL93 Truck or Tandem.
• For the Strength Limit State, use number of load lanes per LRFD.
• For Service Limit States, use number of striped lanes.
• Place loads in full available width as necessary to create maximum effects (i.e., in shoulders).
• Use multi-presence factor: one and two lanes, m = 1.00; three, m = 0.85; four or more, m = 0.65.
• Apply no pedestrian live load (unless very specifically necessary for the site - in which case it counts as one lane for establishing "m").
• Apply no Thermal Gradient.
• Use SERVICE III Limit State with live load factor developed from striped lanes and limit concrete longitudinal flexural tensile and principal tensile stresses to values in FDOT Table 6-9B.
• For STRENGTH I Limit State, use live load factor, γ_L = 1.35.
• Negative moments load ratings may be limited by ***AASHTO LRFR*** 6.4.4.2.1. If the value of the Rating Factor for the AASHTO Limiting Critical Load is less than 1.00, then the basic rating factor for all FDOT Legal Loads shall be reduced by multiplying by this value. See Appendix B.6.2(c) for load model.

E.6.8.5 Permit Load Rating

Longitudinal, annual "blanket" permits:
• Apply ONE Permit Vehicle (FL120) in all lanes (FDOT Table 6-1).
• For spans over 200 feet, apply a uniform lane load of 0.20 kip / LF in the lane with the permit vehicle. This uniform lane load should be applied beyond the footprint of the vehicle to create the maximum effects. However, for convenience, it may be applied coincident with the vehicle.
• For the Strength Limit State, use number of load lanes per ***LRFD***.
• For Service Limit States, use a reduced load factor or see FDOT Table 6-1.
• Place loads in full available width as necessary to create maximum effects (for example, in shoulders).
• Use multi-presence factor: one and two lanes, m = 1.00; three, m = 0.85; four or more, m = 0.65.
• Dynamic Load Allowance, IM = 1.33 on Permit Trucks.
• Apply no pedestrian live load (unless very specifically necessary for the site - in which case it counts as one lane for establishing "m").
• Apply no Thermal Gradient.
• Use SERVICE III Limit State with live load developed from striped lanes and limit concrete longitudinal flexural tensile and principal tensile stresses to values in FDOT Table 6-9B as appropriate.
• For STRENGTH II Limit State, use live load factor, γ_L = 1.35.
• Reduced Dynamic Load Allowance (IM) or live load factor (γ_L) may be considered only to avoid restrictions.

E.6.8.6 Capacity – Strength Limit State

The capacity of a section in transverse and longitudinal flexure may be determined using any of the relevant formulae or methods in the ***LRFD*** Specifications, or ***AASHTO Guide Specification***

for Segmental Bridges dated 1999, including more rigorous analysis techniques involving strain compatibility. The latter should be used in particular where the capacity depends upon a combination of both internal (bonded) and external (unbonded) tendons.

For Load Rating, the capacity should be determined based upon actual rather than specified or assumed material strengths and characteristics. Concrete strength should be found from records or verified by suitable tests. If no data is available, the specified design strength may be assumed, appropriately increased for maturity. All new designs will assume the plan specified concrete properties. Post construction will include updated concrete properties.

In particular, for shear or combined shear with torsion, the capacity at the Strength Limit State for segmental bridges should be calculated according to the ***AASHTO Guide Specification for Segmental Bridges***. The "Modified Compression Field Theory" of ***LRFD*** may be used as an alternative, but only for structures with continuously bonded reinforcement (e.g. large boxes cast-in-place in cantilever or on falsework).

E.6.8.7 Allowable Stress Limits – Service Limit State

Allowable stresses for the Service Limit State are given in FDOT Table 6-9B. The intent is to ensure a minimum level of durability for FDOT bridges that avoids the development or propagation of cracks or the potential breach of corrosion protection afforded to post-tensioning tendons. Also, these are recommended for the purpose of designing new bridges.

E.6.8.7.1 Longitudinal Tension in Joints

Type "A" Joints with Minimum Bonded Reinforcement

The Service level tensile stress is limited to $3\sqrt{f'c}$ or $6\sqrt{f'c}$ (psi) for cast-in-place joints with continuous longitudinal mild steel reinforcing for Design Inventory Rating. (Reference: ***AASHTO Guide Specification for Segmental Bridges*** and ***LRFD*** Table 5.9.4.2.2-1). Reduced reliability at Design Operating, Legal and Permit conditions is attained by using the number of striped lanes and by allowing an increase in tensile stress to $7.5\sqrt{f'c}$ (psi) (FDOT Table 6-9B).

Type "A" Epoxy Joints with Discontinuous Reinforcement

The Service level tensile stress is limited to zero tension for epoxy joints for Design Inventory, Design Operating, Legal, and Permit ratings. (Reference: ***AASHTO Guide Specification for Segmental Bridges*** and ***LRFD*** Table 5.9.4.2.2-1). Reduced reliability is attained by using the number of striped lanes.

Type "B" Dry Joints

Early precast segmental bridges with external tendons and non-epoxy filled, Type-B (dry) joints were designed to zero longitudinal tensile stress. In 1989, a requirement for 200 psi residual compression was introduced with the first edition of the AASHTO Guide Specification for Segmental Bridges. This was subsequently revised in 1998 to 100 psi compression. Service Level Design Inventory Ratings shall be based on a residual compression of 100 psi for dry joints. For Design Operating, Legal, and Permit Ratings, the limit is zero tension. (Reference: ***AASHTO Guide Specification for Segmental Bridges*** and ***LRFD*** Table 5.9.4.2.2-1). Reduced reliability is attained by using the number of striped lanes.

E.6.8.7.2 Transverse Tensile Stress

For a transversely prestressed deck slab, the allowable flexural stresses for concrete tension are provided in FDOT Table 6-9B: namely, for Inventory $3\sqrt{f'c}$ or $6\sqrt{f'c}$ (psi) and for Operating $6\sqrt{f'c}$ (psi).

E.6.8.7.3 Principal Tensile Stress – Service Limit State

A check of the principal tensile stress has been introduced to verify the adequacy of webs for longitudinal shear at service. This is to be applied to both for the design of new bridges and Load Rating. The verification, made at the neutral axis, is the recommended minimum prescribed procedure, as follows:

Sections should be considered only at locations greater than "H/2" from the edge of the bearing surface or face of diaphragm, where classical beam theory applies: i.e. away from discontinuity regions. In general, verification at the elevation of the neutral axis may be made without regard to any local transverse flexural stress in the web itself given that in most large, well proportioned boxes the maximum web shear force and local web flexure are mutually exclusive load cases. This is a convenient simplification. However, should the neutral axis lie in a part of the web locally thickened by fillets, then the check should be made at the most critical elevation, taking into account any coexistent longitudinal flexural stress. Also, if the neutral axis (or critical elevation) lies within 1 duct diameter of the top or bottom of an internal, grouted duct, the web width for calculating stresses should be reduced by half the duct diameter.

Calculate principle tension without the effect of thermal gradient.

Classical beam theory and Mohr's circle for stress should be used to determine shear and principal tensile stresses. At the Service Limit State, the shear stress and Principal Tensile Stress should be determined at the neutral axis (or critical elevation) under the long-term residual axial force, maximum shear and/or maximum shear force combined with shear from torsion in the highest loaded web, using a live load factor, $\gamma L = 1.00$. The live load should then be increased in magnitude so the shear stress in the highest loaded web increases until the Principal Tensile Stress reaches its allowable maximum value (FDOT Table 6-9B).

The Service Limit State Rating Factor is the ratio between the live load shear stress required to induce the maximum Principal Tensile Stress to that induced by a live load factor of 1.00.

E.6.8.8 Local Details

Local Details (i.e. diaphragms, anchorage zones, blisters, deviation saddles, etc.) in concrete segmental bridges are discussed in Chapter 4 of Volume 10A ***Load Rating Post-tensioned Concrete Segmental Bridges***. If a detail shows signs of distress (cracks), a structural evaluation should be performed for the Strength Limit State. The influence of anchorage zones shall be checked for principal tension in accordance with ***Structure Design Guidelines Section*** 4.5.11, Principal Tensile Stresses.

F.6 POSTING AVOIDANCE (NEW)

The following methods of posting avoidance are presented in an approximate hierarchy judged to return the greatest benefit for the least cost or effort for Florida bridges. This hierarchy is not absolute and may change depending on the particular bridge being load rated.

Under no circumstance shall a posting avoidance technique be used when load rating a newly designed bridge or when calculating permit capacity.

Posting avoidance techniques require either a Variance or an Exception. A Variance must be approved by the FDOT District Structures Engineer with concurrence of the District Structures and Facilities Engineer with a copy sent to the State Structures Design Engineer. An Exception requires the approval of the State Structures Design Engineer and may require notification of the Federal Highway Administration. For bridges where the owner is a local government, concurrence from the bridge owner is required before variance or exceptions are processed by FDOT.

F.6.1 DYNAMIC LOAD ALLOWANCE (IM) FOR IMPROVED SURFACE CONDITIONS (VARIANCE)

Using field observations and engineering judgment for spans greater than 40 feet, the Dynamic Load Allowance may be reduced if the following conditions exist:

- Where the bridge approach and the bridge have a smooth transition and where there are minor surface imperfections or depressions, the Dynamic Load Allowance (IM) may be reduced to 20%.
- Where there is a smooth riding surface on the bridge and where the transitions from the bridge approaches to the bridge deck across the expansion joints are smooth, the Dynamic Load Allowance (IM) may be reduced to 10%. (An example of this would be a deck slab finished by grinding and grooving to remove irregularities with no bumps or steps at expansion joints).

F.6.2 APPROXIMATE AND REFINED METHODS OF ANALYSES (VARIANCE)

When using an approximate method of structural analysis (code defined live load distribution ***LRFD*** 4.6.2), a rating factor as low as 0.95 can be rounded up to 1.0.

Refined methods of structural analyses (e.g. using finite elements) may be performed in order to establish an enhanced live load distribution and improved load rating. For fully continuous structures, a more sophisticated analysis of this type does not eliminate the need for a time-dependent construction analysis to determine overall longitudinal effects from permanent loads (e.g. BD 2 analysis).

F.6.3 SHEAR CAPACITY BY AASHTO LRFD FOR SEGMENTAL BOX GIRDER BRIDGES (VARIANCE)

When calculated in accordance with the ***AASHTO LRFD*** 5.8.6, the shear capacity, at the strength limit state, is based upon an assumed crack angle of 45 degrees, and may lead to an unsatisfactory load rating. The assumed angle of crack may be reconsidered and the capacity recalculated according to the procedure in this Appendix B of "Volume 10 A ***Load Rating Post-Tensioned Concrete Segmental Bridges***" (Dated Oct. 8, 2004).

F.6.4 EXISTING BRIDGE INVENTORY BEFORE JANUARY 2005 (VARIANCE)

If the bridge load carrying capacity as determined by Service III Limit State is causing unusual hardship and the current bridge inspection is showing no signs of either shear or flexural cracking, the capacity established for load posting and overweight vehicle permitting can be established using Strength Limit State.

F.6.5 SHEAR CAPACITY – SEGMENTAL CONCRETE BRIDGES (BOX GIRDER) - CRACK ANGLE AND PRINCIPAL TENSION (VARIANCE)

To calculate a crack angle more exactly than the assumed 45 degree angle use the specifications, use the procedure found in Appendix B of "Volume 10 A ***Load Rating Post-Tensioned Concrete Segmental Bridges***" (dated Oct. 8, 2004) found on the Structures Design Office internet web site.

F.6.6 STIFFNESS OF TRAFFIC BARRIER (EXCEPTION)

Barrier stiffness should be considered and appropriately included if necessary. Inclusion of the barriers acting compositely with the deck slab and beams should improve longitudinal load ratings. When barriers are considered in this manner, the difference in the modulus of elasticity of the lower strength barrier concrete relative to that of the deck slab and to that of the beams should be taken into account. The presence of joints in a barrier reduces the overall effective section at the joint to that of the deck slab plus beam. This may result in a local concentration of longitudinal stress that should be appropriately considered.

Nevertheless, load ratings should benefit from reasonable consideration of barrier stiffness.

F.6.7 CONCRETE BOX GIRDER - LONGITUDINAL TENSION IN EPOXY JOINTS (EXCEPTION)

The ***AASHTO Guide Specification for Segmental Bridges*** and ***LRFD*** limit longitudinal tensile stresses to zero at epoxied match-cast joints under Service level conditions. The ability of the epoxy joint to accept tension is not considered. However, in properly prepared epoxy joints the bond usually exceeds the tensile strength of the concrete. Consequently, for posting avoidance, tensile stresses may be accepted as a function of the location and quality of the epoxy joint:

- For top fiber stresses on the roadway surface – no tension is permitted for all load rating calculations.
- For bottom fiber stresses –

(a) Allow 200 psi tension at good quality epoxy joints (i.e. no leaks and fully sealed).
(b) No tension allowed for poor quality epoxy joints (i.e. leaky or not filled, gaps).

F.6.8 CONCRETE BOX GIRDER - TRANSVERSE TENSILE STRESS LIMIT IN TOP SLAB (EXCEPTION)

For Legal and Permit loads, the permissible tensile stress in a transversely post-tensioned slab is set at $6.0\sqrt{f'c}$, regardless of the environment (FDOT Table 6-9B). For posting avoidance, up to $7.5\sqrt{f'c}$ may be allowed providing that:

a) There is sufficient bonded reinforcement to carry the calculated tensile force in the concrete computed on the assumption of an uncracked section at a stress of $0.5f_y$, and,

b) It is verified by field inspection that there are no cracks in the bridge deck as a consequence of routine or historically heavy vehicular traffic.

F.6.9 CONCRETE BOX GIRDER - PRINCIPAL TENSILE STRESS (EXCEPTION)

If the load rating based upon the limiting principal tensile stress at the neutral axis of the basic beam or composite section is not satisfactory, the rating factor with regard to principal tension may be taken as 1.00 providing that:

a) There is no visible evidence of any representative cracking in the webs.

b) The capacity is satisfactory under the required Strength Limit State.

However, if during field inspection, cracks are discovered at or near a critical section where, by calculation, the principal tensile stress is found to be less than the allowable, then further study is recommended to determine the origin of the cracks and their significance to normal use of the structure. If possible, a check should be made of construction records to determine if there was any change of construction, temporary loads or support reactions that may have induced a significant but temporary local affect.

F.6.10 REDUCED STRUCTURAL (DC) DEAD LOAD (EXCEPTION)

A lower dead load factor may be considered in accordance with the following criteria. Under no circumstance should this load factor be less than 1.10. For the self weight determined by:

a) Design Plan or Shop Drawing dimensions and assumed average density for concrete, reinforcement and embedded items: $\gamma_{DC} = 1.25$.

b) As-built dimensions, deck slab thickness and build-up using concrete density determined from construction records, adjusted for weight of embedded reinforcing: $\gamma_{DC} = 1.15$.

c) Actual beam weights measured during construction: $\gamma_{DC} = 1.10$.

Cases (b) and (c) may only be used providing that neither additional structural component (DC) nor superimposed dead loads (DW) has been added whose weight cannot be accurately ascertained.

In using either (a) or (b) above, and when it is known that the original design was based on an assumed density for normal concrete and that a check or investigation can verify that a bridge has been constructed with Florida Limerock, then the unit weight may be reduced to 138 lbs per cubic foot for the concrete plus an allowance for the weight of steel.

F.6.11 REDUCED SUPERIMPOSED (DW) DEAD LOAD (EXCEPTION)

The load factor for superimposed dead loads including wearing surface and utilities is normally $\gamma_{DW} = 1.50$. A lower factor may be considered if weights are determined from an accurate survey. Under no circumstance should this be taken less than $\gamma_{DW} = 1.25$.