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Project Development Division
Bridge Design Section
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John Bel Edwards, Governor
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MEMORANDUM

TO: ALL BRIDGE DESIGNERS - IN-HOUSE AND CONSULTANTS

FROM: ZHENGZHENG "JENNY" FU, P.E.
BRIDGE DESIGN ENGINEER ADMINISTRATOR

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Date: 2022.09.09 17:32:16 -05'00'

SUBJECT: BRIDGE DESIGN TECHNICAL MEMORANDUM NO. 111 (BDTM.111)
BDEM PART II VOLUME 5 SECTION 6 - REVISED - BRIDGE LOAD RATING

DATE: September 7, 2022

Effectively immediately, the following revision is to be implemented in accordance with Bridge Design and Evaluation Manual, Preface, section titled "Implementation Policy of BDEM and Revisions." This BDTM revises the LADOTD Bridge Design and Evaluation Manual (BDEM), Part II, Volume 5, Section 6 (attached).

Revision summary:

1. Update for Continuous Steel Stringers Load Rating

Section 6, 6A.6.9 – I-Sections in Flexure, 6A.6.9.3 – Non-Composite Sections has been added.

When load rating continuous steel stringers using AASHTOWare Bridge Rating software, the Moment Gradient Modifier, C_b, is calculated in accordance with the *AASHTO LRFD Bridge Design Specifications*. For designing stringers, this method provides a conservative design with regard to determining flexural strength of continuous stringers with a non-composite deck. For load rating, this method may understate the capacity, resulting in the requirement for bridge load posting or member strengthening.

LADOTD Bridge Design Section and LTRC performed research to compare and evaluate other specifications and codes and recommend using AISC Commentary C-F1-5 for continuous stringers C_b calculation.

The following (3) documents are available on the Bridge Design website under the Bridge Load Rating link in the "Continuous Stringer Load Rating" folder:

- LTRC Final Report 650: Load Rating of Existing Continuous Stringers on Louisiana's Bridges dated October 2021.
- LADOTD Stringer Load rating per AISC C_b: AISC C_b Excel file.
- Stringer Load Rating - Sample

Implement the above research report to assist in the improvement of continuous stringer load rating. The above Excel file has been developed to calculate the C_b for continuous stringer rating.

2. Other Revisions

- Section 6A.1.1 – "General" is revised by adding Emergency Vehicles EV2 and EV3 to the As-Designed Load Rating Table for bridges with HL-93 Inventory Rating < 1.0. These rating vehicles are required by BDTM.90.
- Section 6A.1.1 – "General" is revised by adding language to clarify the requirements for As-Designed Load Ratings, As-Built Load Ratings, and Present Condition Load Ratings.
- Section 6A.4.1 – "Introduction" is revised by removing Service II Limit State for rating steel members for Legal rating loads. This modification was made under BDTM.90.
- Section 6 was updated to coordinate with the Manual for Bridge Evaluation, Third Edition.

This technical memorandum is posted on the LA DOTD Website under *Inside La DOTD* > *Divisions - Engineering* > *Bridge Design* > *Technical Memoranda – BDTMs.*
Please contact Kelly Kemp (kelly.kemp@la.gov or 225-379-1809) if you have questions or comments.

ZZF/df
Attachment

c: Christopher P. Knotts (Chief Engineer)
Chad Winchester (Deputy Chief Engineer)
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David Smith (Project Development Division Chief)
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District Administrators and ADAs of Engineering and Operations
District Bridge Engineers and Area Engineers

SECTION 6 – LOAD RATING

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6.1—SCOPE

The following shall supplement *A6.1*.

Load rating methods shall be in accordance with the latest AASHTO *The Manual for Bridge Evaluation* (MBE) and supplemental requirements of this document. When updating the load rating of any public bridge or performing the load rating of a bridge for the first time the load rating needs to comply with the Load and Resistance Factor Rating (LRFR) method. The only exception granted is for timber bridges, which may be rated by LRFR or Allowable Stress Rating (ASR). Any other load rating method will only be allowed with a prior written approval from the LADOTD Load Rating Engineer.

AASHTOWare Bridge Rating (BrR) and Bridge Design (BrD) are the official load rating software to be used for LADOTD load rating. If a bridge is capable of being defined and analyzed in BrDR, it shall be load rated using BrDR. Bridges shall be defined in system superstructure when possible. Prior to performing load rating, the engineer shall verify the current acceptable versions of approved rating software as well as request permission to use software not listed in LADOTD Pre-Approved Software List. An influence line/surface submittal is required for any structure element not load rated using BrDR. The influence line submittal form can be downloaded from the Bridge Design Section website (COMPSTIL2 standard input file).

C6.1

The following shall supplement *AC6.1*

LADOTD Load Rating Engineer shall be the engineer who is in charge of the Bridge Rating Unit within the LADOTD Bridge Design Section as defined in *EDSM IV.4.1.2*.

6.1.1—Assumptions

The following shall supplement *A6.1.1.*

Bridges being investigated for load capacity are to be inspected for condition as per the latest edition of the MBE and National Bridge Inspection Standards (NBIS).

The rating engineer shall review the original design and as-built plans as the first source of information for material strengths and stresses. If the material strengths are not explicitly stated on the design plans, LADOTD construction and material specifications applicable at the time of original bridge construction shall be reviewed, which may require reviewing the ASTM or AASHTO Material Specifications active at the time of original bridge construction.

Continuous prestressed concrete girder bridges shall be modeled and load rated as simple span bridges unless written exemption is approved by LADOTD Load Rating Engineer.

Do not include future wearing surface as dead load in the load rating.

C6.1.1

6.1.4—Bridges with Unknown Structural Components

The following shall supplement *A6.1.4.*

Engineering judgement can be used to establish an approximate load rating.

6.1.5—Component-Specific Evaluation

6.1.5.2—Substructures

The following shall supplement *A6.1.5.2.*

– Pile bents
  - All pile caps
  - All timber elements
  - All metal elements

– Hammerhead bents

– Steel framed bents

6.1.9—Documentation of Load Rating

The following shall supplement *A6.1.9.*

Load rating calculations and documentation shall be incorporated into a comprehensive rating report to facilitate updating the information and calculations in the future. The load rating shall be completely documented in writing including all background information such as structure description, vicinity map, bridge layout plans with details, field inspection reports, material and load test data, all supporting computations, and a clear statement of all assumptions made in calculating the load rating. Sketches shall be provided to document section losses incorporated in the analysis. Inspection reports, testing reports, and articles referenced as part of the load rating shall be documented. When refined methods of analysis or load testing are used, the load rating report shall include live load distribution factors for all rated members determined through such methods. The computer model files and associated documentation shall become part of the bridge load rating records and deliverables. An influence line/surface submittal is required for any member not rated by BrDR. An electronic version of the load rating report including

the BrDR input data file and any computer models used in the analysis shall be submitted to LADOTD.

The following checklists for rating reports and submittals shall be utilized to assist and standardize the review process and rating report preparation.

Load Rating Report:

- Cover sheet including recall number.
- Stamped and signed Bridge Load Rating Summary Sheet including the engineering seal and initials of the Rater, the Checker, and the Reviewer. The electronic copy of Load Rating Summary Sheet can be downloaded from Bridge Design Section website.
- List of all assumptions.
- List of all material values.
- Discussion of current condition of the bridge and any assumption based on that condition.
- The critical rating values.
- Rating output of every rated member.
- Influence line (if applicable).
- Hand calculations, sample calculations.
- All bridge plans in PDF file format.

Submittals:

- Load Rating Report for each bridge (one PDF copy per bridge).
- Rating model for each bridge. Each bridge shall have one AASHTOWare BrDR model. For multi-span bridges, the bridge span numbers shall follow the numbering system in the inspection report (NBI Inventory).
- All submittals shall be in the form of removable storage, such as USB flash drive, large file transfer, ProjectWise, or AssetWise. Email submittals are strictly prohibited for bridge load rating reports and inspection reports.

Refer to Section 6A.1.1 for additional requirements on as-designed load rating documentation.

PART A—LOAD AND RESISTANCE FACTOR RATING

6A.1—INTRODUCTION

6A.1.1—General

The following shall supplement *A6A.1.1.*

As-Designed Load Rating:

As-designed load ratings shall be performed by the design engineer and included in contract plans for all new bridges, and for bridges to be rehabilitated in such a way that will alter the existing bridge load rating. In both cases, the as-designed load rating is to reflect the work shown on the plans. As-designed load ratings shall include all load-carrying superstructure and substructure bridge elements.

As-designed load ratings shall include the inventory and the operating ratings for the HL-93, and the inventory rating for the LADV-11. If the inventory rating for the HL-93 is less than 1 (as may be the case for rehabilitated bridges), additional ratings for all legal trucks including SHVs and EVs shall be also provided in accordance with Section 6A.4.1.

The LADV-11 live load model shall be evaluated at the inventory level for all limit states indicated in the "Design" column in the Louisiana LRFR Limit States Table in Section 6A.4.1. For the evaluation of the Service III Limit State for the LADV-11 only, a load factor of 0.9 shall be used.

The following As-Designed Load Rating Table, which shows the most critical as-designed load ratings for each structure, shall be included on the general notes sheet as appropriate.

As-Designed Load Rating Table				
Structure No.		Recall No.		
Vehicle	GVW(KIPS)	Superstructure	Substructure	Notes
HL-93 INV[1]				
HL-93 OPR[1]				
LADV-11 INV[1]				
LA TYPE 3	41.0			
LA TYPE 3-S2	73.0			
TYPE 3-3	80.0			
LA TYPE 6	80.0			
LA TYPE 8	88.0			
SU4	54.0			
SU5	62.0			
SU6	69.5			
SU7	77.5			
Lane- MBE Figure D6A-4				
Lane- MBE Figure D6A-5				
EV2	57.5			
EV3	86.0			
[1] If RF for HL-93 INV $\geq$ 1, only HL-93 OPR and LADV-11 INV RFs are required.				

The as-designed load rating report shall be prepared in accordance with Section 6.1.9. The report shall be sent by the LADOTD Bridge Task Manager to the LADOTD Load Rating Engineer within thirty days after 100% Final Plans are completed. If a consultant performs the as-designed load rating, the as-designed load rating report shall be submitted to the LADOTD Bridge Task Manager, who will in turn submit them to the LADOTD Load Rating Engineer.

If the bridge is open to traffic during any phase of rehabilitation, the contractor performing the rehabilitation is responsible for performing a load rating report for each bridge in accordance with Section 6.1.9 of this document. The load rating shall include construction loads and traffic loads anticipated during the construction period. The contractor shall provide the load rating report to the LADOTD Load Rating Engineer before commencing construction.

As-Built Load Rating:

As-built load ratings shall be performed by the design engineer, and are required for new bridges and repaired or rehabilitated bridges where an as-designed rating was performed. As-built load ratings shall address all changes to the bridge made during construction, and shall include all load-carrying bridge components identified in the as-designed rating.

The as-built load rating report shall be prepared in accordance with Section 6.1.9. The report shall be sent by the LADOTD Bridge Task Manager to the LADOTD Load Rating Engineer within thirty days after construction Final Acceptance. If a consultant performs the as-built load rating, the as-built load rating report shall be submitted to the LADOTD Bridge Task Manager, who will send it to the LADOTD Load Rating Engineer.

In the case where no changes to the bridge are made during construction, an as-built load rating report is not required, and the LADOTD Bridge Task Manager is to notify the LADOTD Load Rating Engineer by letter confirming that the as-designed load rating values are to be taken as as-built load rating values.

Existing Bridges Present Condition Load Rating:

Present condition load ratings are required for existing bridges and shall be performed by the LA DOTD Load Rating Engineer, who shall review the

bridge inspection file to determine if a new analysis is required per LADOTD's *Engineering Directives & Standards Manual (EDSM) No. I.1.1.15*. The validity of the existing load rating shall be questioned when condition changes have occurred since the last load rating. The condition changes include, but are not limited to, the following:

- The primary member inspection condition rating has changed.
- Dead load has changed due to bridge alterations including, but not limited to, resurfacing, addition or removal of overlay, deck replacement, bridge widening, bridge railing retrofits, and/or addition of utilities.
- Section properties have changed due to deterioration, damage, rehabilitation, re-decking or other alterations.
- Damage due to vehicular, vessel, or railroad collision.
- Cracking of primary members.
- Section losses at critical connections.

Soil and foundation capacities determination for load ratings shall use actual soil borings and/or CPTs when available. Otherwise, the Louisiana Signal Foundation Design Zones map posted on the LADOTD Traffic Service Section website shall be used to determine the soil strength zones. The following presumptive soil strengths shall be used.

Zone	Shear Strength (psf)
1	500
2	1000
3	2000
4	250

The use of different soil strength values may be allowed when justifications are approved by the LADOTD Load Rating Engineer.

Present condition load ratings are required as part of bridge evaluation performed in order to determine the scope of repair or rehabilitation projects. See BDEM Part I Section 6.

6A.4—LOAD-RATING PROCEDURES

6A.4.1—Introduction

The following shall supplement *A6A.4.1.*

Live loads to be used in bridge load ratings are selected based upon the purpose and intended use of the rating results. Live load models outlined below shall be evaluated for the Strength, Service and Fatigue limit states in accordance with the Louisiana LRFR Limit States Table at the end of this section:

1) Design load rating is a first-level rating performed for all bridges using the HL-93 loading at the Inventory (design) and Operating levels. Additionally, an LAVD-11 (inventory) rating is required for all new bridges. If the HL-93 Inventory RF>1.0, no legal load rating is required for substructure rating.

2a) Legal load rating includes the LA Type 3, LA Type 3-S2, AASHTO Type 3-3, LA Type 6, and LA Type 8 vehicles given in Figure: Rating Trucks for Louisiana State Legal Loads in Section 6A.4.4.2.1a. Lane-Type legal load models in Figure *D6A-4* and Figure *D6A-5* of *MBE Appendix D6A* are also included.

2b) SHV

2c) Emergency Vehicles

Louisiana Limit States Table

Bridge Type	Limit State	Design	Legal/SHV/EV	Permits
		HL-93 LADV-11	LA Type 3 LA Type 3-S2 Type 3-3 LA Type 6 LA Type 8 Lane Loads SU4, SU5 SU6, SU7, EV2, EV3	
Steel	Strength I	●	●	
	Strength II			●
	Service II	●		
	Fatigue			
Reinforced Concrete	Strength I	●	●	
	Strength II			●
	Service I			●
Prestressed Concrete (non-segmental)	Strength I	●	●	
	Strength II			●
	Service III	●		
	Service I			●
Wood	Strength I	●	●	●

6A.4.2.3—Condition Factor: φ_c

C6A.4.2.3

The following shall supplement *AC6A.4.2.3.*

LADOTD policy is to set the condition factor equal to the values presented in MBE. The Condition Factor ϕ_c does not account for accurate section loss, but is used in addition to section loss. For instance, a concrete member may receive a low condition rating due to heavy cracking and spalling or due to the deterioration of the concrete matrix. Such deterioration of concrete components may not necessarily reduce their calculated flexural resistance, but it is appropriate to apply the reduced condition factor in the LRFR load rating analysis. If there are also losses in the reinforcing steel of this member, they should be measured and accounted for in the load rating. It is appropriate to also apply the reduced condition factor in the LRFR load rating analysis, even when the as-inspected section properties are used in the load rating as this reduction by itself does not fully account for the impaired resistance of the concrete component.

6A.4.3—Design Load Rating

6A.4.3.1—Purpose

C6A.4.3.1

The following shall supplement *A6A.4.3.1.*

HL-93 Inventory shall be used as the screening level for Louisiana legal loads.

The LADV-11 shall be rated at inventory level only. The results of the LADV-11 Inventory rating shall be used as the screening level for Louisiana permit loads.

The following shall supplement *AC6A.4.3.1.*

The design-load (HL-93 and LADV-11) ratings assess the performance of existing bridges utilizing the LRFD HL-93 design loading and design standards with dimensions and properties for the bridge in its present as-inspected condition. It is a measure of the performance of existing bridges to new bridge design standards contained in the LRFD Specifications. The design-load rating produces Inventory and Operating level rating factors for the HL-93 loading.

6A.4.4—Legal Load Rating

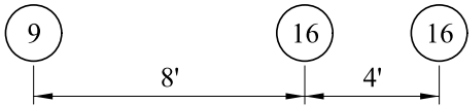
6A.4.4.2—Live Loads and Load Factors

6A.4.4.2.1—Live Loads

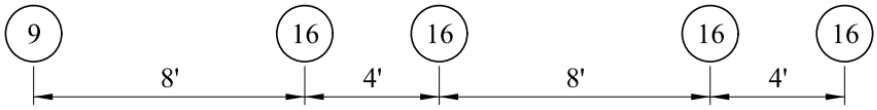
6A.4.4.2.1a—Routine Commercial Traffic

The following shall supplement *A6A.4.4.2.1a.*

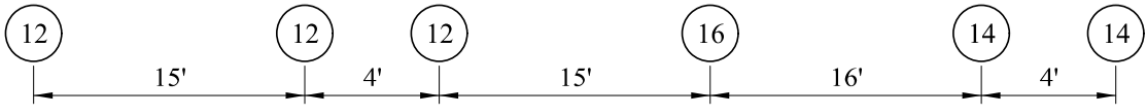
The live load to be used in the LRFR rating for posting considerations for routine commercial traffic should be any of the State legal loads LA Type 3, LA Type 3-S2, AASHTO Type 3-3, LA Type 6, and LA Type 8 given in Figure: Rating Trucks for Louisiana State Legal Loads. They are sufficiently representative of routine commercial truck configurations in use in Louisiana and are to be used as vehicle models for load rating and for bridge posting purposes.



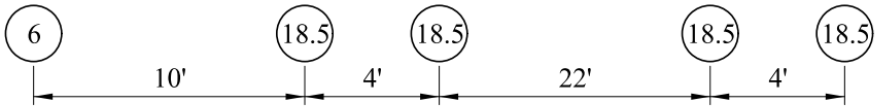
LA Type 3 GVW = 41 kips



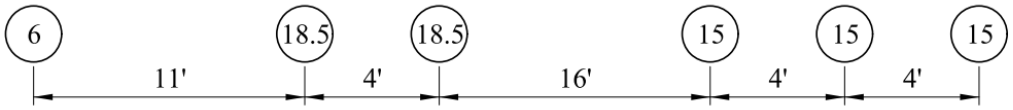
LA Type 3-S2 GVW = 73 kips



AASHTO Type 3-3 GVW = 80 kips



LA Type 6 GVW = 80 kips



LA Type 8 GVW = 88 kips

Rating Trucks for Louisiana State Legal Loads

6A.4.4.2.2—Live Load Factors

C6A.4.4.2.2

The following shall supplement *AC6A.4.4.2.2.*

In cases where site traffic conditions are unavailable from the bridge file, the LADOTD Transportation Planning and Safety Section should be contacted for current ADTT information for the route carried by the bridge or routes with a similar functional classification.

ADTT may also be estimated from Average Daily Traffic (ADT) data for the site.

6A.4.4.3—Dynamic Load Allowance: *IM*

The following shall supplement *A6A.4.4.3*.

For all load ratings, the dynamic load allowance (IM) shall be 33%. For legal load ratings, a reduced IM may be allowed on a case by case basis. The appropriateness for a reduced factor needs to be established by LADOTD and will only be allowed when requested by LADOTD.

6A.4.5—Permit Load Rating

6A.4.5.5—Dynamic Load Allowance: *IM*

The following shall supplement *A6A.4.5.5.*

For all load ratings, the dynamic load allowance (IM) shall be 33%. For permit load ratings, a reduced IM may be allowed on a case by case basis. The appropriateness for a reduced factor needs to be established by LADOTD and will only be allowed when requested by LADOTD.

6A.5.8—Evaluation for Shear

The following shall supplement *A6A.5.8.*

Include shear capacity for design loads, legal loads, and permit loads when load rating existing reinforced and prestressed concrete bridge members, with the exception of concrete slab bridges (COSLAB, COPCSS, CCOVSL, COVSLB).

6A.6.9—I-Sections in Flexure

6A.6.9.3—Non-Composite Sections

The following shall supplement *A6A.6.9.3*

The moment gradient modifier (C_b) equation (AASHTO 6.10.8.2.3-7) for lateral-torsional buckling resistance is conservative for load rating continuous stringers. For existing non-composite I-section stringers subject to reverse curvature bending, the C_b values of AISC Specification for Structural Steel Building 2016 in the Commentary C-F1-5 may be considered optional. See LTRC Final Report 650: Load Rating of Existing Continuous

Stringers on Louisiana's Bridges dated October 2021.

$$C_b = 3.0 - \frac{2}{3}\left(\frac{M_1}{M_0}\right) - \frac{8}{3}\left[\frac{M_{CL}}{(M_0+M_1)^*}\right]$$

AISC C-F1-5

Where

M_0 = moment at the end of the unbraced length that gives the largest compressive stress in the bottom flange, kip-in

M_1 = moment at the other end of the unbraced length, kip-in

M_{CL} = moment at the middle of the unbraced length, kip-in

$(M_0+M_1)^*$= M_0 if M_1 is positive

Bottom flange unbraced length is to be taken as the floor beam spacing when determining stringer flexural strength regardless of whether or not the floor beam contains devices that laterally restrain the bottom flange, such as bolts, bearings, or other devices.

6A.8—POSTING OF BRIDGES

6A.8.1—General

The following shall supplement *A6A.8.1.*

Strength limit state is to be used for checking the ultimate capacity of structural members and is the primary limit state utilized by LADOTD for determining posting needs. Service and Fatigue limit states are utilized to limit stresses, deformations, and cracking under regular service conditions. In LRFR, Service and Fatigue limit states are checked in the sense that a posting or permit decision does not have to be dictated by the result. These serviceability checks provide valuable information for the engineer to use in the decision making process.

If legal load Rating Factors fall below 0.3, and the remaining live load capacity is greater than 3.0 ton, the bridge may be posted at the remaining live load capacity.

C6A.8.1

The following shall supplement *AC6A.8.1.*

National Bridge Inspection Standards (NBIS), 23 CFR 650 requires the rating of all structures defined as highway bridges located on public roads as to its safe loading capacity. The bridge rating needs to be in accordance with the MBE. As a result of the bridge load rating, if a bridge is shown as not capable of carrying statutory loads, it is to be posted for a lesser load limit. The decision to load post or restrict a bridge will be made by the bridge owner, based on LADOTD's load-posting practice. When the maximum unrestricted legal loads exceed that which is allowed under the legal rating, the bridge shall be posted in accordance with this document, applicable EDSMs, or State law.

REFERENCES

Bridge Gross Weight Formula, U.S. Department of Transportation and FHWA Publication.

LADOTD *Engineering Directives and Standard Manual (EDSM) I.1.1.8 Establishment of Uniform, Regulatory Truck Weight limit for Structurally Deficient Highway Bridges Located on Public Roads*

LADOTD *Engineering Directives and Standard Manual (EDSM) I.1.1.15 Louisiana Bridge Load Rating Standards*

LADOTD *Engineering Directives and Standard Manual (EDSM) IV.4.1.2 for Louisiana Bridge Inspection and Load Rating Standards*

LADOTD *Regulations for Trucks, Vehicles and Loads,* Latest Edition.