Load Rating Guidance Document

Issue Date: 2018

Developed By:

GUIDANCE DOCUMENT APPROVALS

The purpose of this Guidance Document is to provide guidance and direction with regards to the load rating of bridges in South Carolina. Any modifications to this Guidance Document require approval of the SCDOT Bridge Maintenance Office and FHWA. This Guidance Document will be reviewed annually and updated as needed by the State Bridge Maintenance Engineer or designated representative. However, SCDOT reserves the right to make interim updates to the procedures to address lessons learned, evolving approaches, updates to federal, state, local laws, regulations, and policies, provided those updates are reviewed with SCDOT and FHWA oversight.

Recommended By:	_____________________________ Director of Maintenance	__________________ Date
Recommended By:	_____________________________ Director of Preconstruction	__________________ Date
Recommended By:	_____________________________ Chief Engineer for Operations	__________________ Date
Recommended By:	_____________________________ Chief Engineer for Project Delivery	__________________ Date
Recommended By:	_____________________________ Deputy Secretary for Engineering	__________________ Date
Approved:	____________________________ Secretary of Transportation SCDOT	__________________ Date
Approved:	____________________________ SC Division Administrator FHWA	__________________ Date

DISCLAIMER

THE LOAD RATING GUIDANCE DOCUMENT IS PUBLISHED SOLELY TO PROVIDE INFORMATION AND GUIDANCE TO BRIDGE RATING ENGINEERS IN THE STATE OF SOUTH CAROLINA. THIS GUIDANCE DOCUMENT IS ISSUED TO SECURE, SO FAR AS POSSIBLE, UNIFORMITY OF PRACTICE AND PROCEDURE IN COMPLIANCE WITH THE NATIONAL BRIDGE INSPECTION STANDARDS AND THE AASHTO MANUAL FOR BRIDGE EVALUATION. THIS GUIDANCE DOCUMENT IS NOT PURPORTED TO BE A COMPLETE GUIDE IN ALL AREAS OF BRIDGE RATING AND IS NOT A SUBSTITUTE FOR ENGINEERING JUDGMENT.

TABLE OF CONTENTS

Chapter 1 Introduction 1-1
1.1 Purpose 1-1
1.2 Scope 1-1
1.3 Definitions, Abbreviations, and Acronyms 1-1
1.3.1 Definitions 1-1
1.3.2 Abbreviations and Acronyms 1-1
1.4 References 1-2
1.5 Coordination 1-3
1.6 Revisions 1-3
Chapter 2 Results of Parametric Study 2-1
2.1 Purpose of Parametric Study 2-1
2.2 Analysis Parameters 2-1
2.2.1 Live Load 2-1
2.2.2 Structure Types 2-2
2.2.3 Force Effects 2-2
2.2.4 Load Factors / Impact 2-3
2.2.5 Method of Evaluation 2-3
2.3 Results of Parametric Study 2-3
2.3.1 Legal Loads 2-3
2.3.2 Permit Loads 2-4
2.3.3 Emergency Vehicles 2-4
Chapter 3 Load Rating Checking and QA/QC 3-1
3.1 General Requirements 3-1
3.2 Qualifications of Load Rating Personnel 3-1
3.3 Computer Software and Computer Software Verification 3-1
3.4 Checking Procedures 3-1
3.5 QC and QA 3-1
3.5.1 QC Review 3-1
3.5.2 QA Review 3-2
Chapter 4 Load Rating Process 4-1
4.1 General 4-1
4.2 Inspection Data Used for Load Rating 4-1
4.3 Concepts and Load Rating Methodologies 4-1
4.4 New Bridges 4-2
4.5 Existing Bridges 4-2
4.6 Rehabilitated Bridges 4-2

Chapter 5 Data Collection.....5-1
5.1 General.....5-1
5.2 Existing Plans.....5-1
5.3 Inspection Reports.....5-1
5.4 Site Assessments.....5-1
5.5 Other Records.....5-2
Chapter 6 General Requirements.....6-1
6.1 Condition of Bridge Members.....6-1
6.2 Types of Loads to Consider for Ratings.....6-1
6.3 Dead Loads Used to Determine Ratings.....6-1
6.4 Sidewalk Loading or Pedestrian Loading Used to Determine Ratings.....6-1
6.4.1 Sidewalk Loading Using the ASR or LFR Method.....6-1
6.4.2 Pedestrian Loading Using the LRFR Method.....6-1
6.5 Live Loads Used to Determine Ratings.....6-1
6.6 Wind Loads.....6-7
6.7 Impact and Live Load Transverse Distribution.....6-7
6.7.1 Impact.....6-7
6.7.2 Live Load Transverse Distribution.....6-7
6.8 Material Properties for Load Rating.....6-8
6.8.1 Structural Steel (Yield Strengths).....6-9
6.8.2 Steel Rivets.....6-9
6.8.3 Reinforcing Steel.....6-9
6.8.4 Prestressing Steel.....6-9
6.8.5 Concrete.....6-9
6.8.6 Timber.....6-9
6.9 Inventory and Operating Rating Methods.....6-9
6.9.1 ASR and LFR Methods.....6-9
6.9.2 LRFR Method.....6-10
6.9.3 When to Use ASR, LFR, or LRFR.....6-10
6.9.4 When to Use Field Evaluation and Documented Engineering Judgment.....6-10
6.10 Permit Load Analysis.....6-10
6.10.1 Permit Trucks.....6-10
6.11 Load Factors, Condition Factors, and System Factors.....6-11
6.11.1 Load Factors.....6-11
6.11.2 Condition Factors.....6-11
6.11.3 System Factors.....6-11
6.12 Load Testing.....6-12
Chapter 7 Reinforced Concrete Decks.....7-1
7.1 Introduction.....7-1

7.2 Policies and Guidelines ... 7-1
Chapter 8 Timber Decks ... 8-1
8.1 Introduction ... 8-1
8.2 Policies and Guidelines ... 8-1
Chapter 9 Reinforced Concrete Superstructures ... 9-1
9.1 Introduction ... 9-1
9.2 Policies and Guidelines ... 9-1
9.2.1 Software-Specific SCDOT Policy ... 9-1
9.2.2 Reinforced Concrete Slab Bridges ... 9-2
9.2.3 Reinforced Concrete Box Beam Bridges ... 9-3
9.2.4 Reinforced Concrete T-Beam Bridges ... 9-3
9.2.5 ASR or LFR Method ... 9-3
9.2.6 LRFR Method ... 9-3
Chapter 10 Prestressed Concrete Girder Superstructure ... 10-1
10.1 Introduction ... 10-1
10.2 Policies and Guidelines ... 10-1
10.2.1 Software-Specific SCDOT Policy ... 10-1
10.2.2 ASR or LFR Method ... 10-4
10.2.3 LRFR Method ... 10-4
Chapter 11 Steel Superstructures ... 11-1
11.1 Introduction ... 11-1
11.2 Policies and Guidelines ... 11-1
11.2.1 Analysis and Rating ... 11-1
11.2.2 Software-Specific SCDOT Policy ... 11-2
11.2.3 ASR or LFR Method ... 11-3
11.2.4 LRFR Method ... 11-3
Chapter 12 Steel Truss Superstructure ... 12-1
12.1 Introduction ... 12-1
12.2 Policies and Guidelines ... 12-1
12.2.1 Software-Specific SCDOT Policy ... 12-1
Chapter 13 Timber Superstructures ... 13-1
13.1 Introduction ... 13-1
13.2 Policies and Guidelines ... 13-1
Chapter 14 Concrete and Masonry Substructures ... 14-1
14.1 Introduction ... 14-1
14.2 Policies and Guidelines ... 14-1
14.3 Substructure Load Rating Analysis ... 14-1
Chapter 15 Steel Substructures ... 15-1
15.1 Introduction ... 15-1

15.2 Policies and Guidelines 15-1
15.3 Substructure Load Rating Analysis 15-1
Chapter 16 Timber Substructures 16-1
16.1 Introduction 16-1
16.2 Policies and Guidelines 16-1
16.3 Substructure Load Rating Analysis 16-1
Chapter 17 Bridge-Sized Concrete Box Culverts 17-1
17.1 Introduction 17-1
17.2 Policies and Guidelines 17-1
17.2.1 General Guidelines 17-1
17.2.2 Software Specific SCDOT Policy 17-1
Chapter 18 Non-Typical and Complex Bridge Types 18-1
18.1 Introduction 18-1
18.2 Policies and Guidelines 18-1
18.2.1 Software Requirements 18-1
18.2.2 Analysis Documentation 18-1
Chapter 19 Posting of Bridges and Posting Considerations 19-1
19.1 General 19-1
19.2 Posting Considerations 19-1
19.2.1 Methods and Procedures 19-1
19.2.2 Refined Method of Analysis 19-1
19.2.3 Service III Controlling Rating 19-1
19.2.4 Alternative Rating Methods 19-2
19.2.5 Stiffness of Traffic Barrier 19-2
19.3 Options for Restricting Traffic 19-2
19.4 Posting for Legal Truck Loads 19-2
19.5 Posting Documentation 19-3
Chapter 20 Load Rating Documentation 20-1
20.1 Load Rating Deliverables 20-1
20.2 Load Rating Summary 20-1
20.2.1 Load Rating Summary Form Naming Convention 20-1
20.2.2 Load Rating as Part of an Inspection or Independent Rating 20-1

List of Tables

Table 1.3.2. Abbreviations and Acronyms 1-2
Table 6.5-1. Suite of Posting Vehicles 6-2
Table A18.1. SCDOT Non-typical and Complex Bridges 18-3

List of Figures

Figure 6.5-1. Legal Loads (Showing Axle Loads) 6-2
Figure 6.5-2a. AASHTO Short Haul Vehicles (Showing Axle Loads) 6-3
Figure 6.5-2b. South Carolina Short Haul and other Posting Vehicles (Showing Axle Loads) 6-4
Figure 6.5-3. Emergency Vehicles (Showing Axle Loads) 6-5
Figure 6.5-4. Permit Trucks (Showing Axle Loads) 6-6
Figure 6.7.2-1. Examples of Live Load Positioning Using the LRFR Method 6-8
Figure 9.2.1.2-1. Control Options Screenshot from BrR 9-2
Figure 10.2.1.2-1. Control Options Screenshot from BrR 10-3
Figure 10.2.1.2-2. Example Load Case Description Input 10-4
Figure 10.2.1.2-3. Prestressed Concrete Stress Limit Input 10-4
Figure 11.2.2.2-1. Control Options Screenshot from BrR 11-3
Figure 11.2.2.2-2. Example Load Case Description Input 11-3
Figure 13.2-1. Cracked, Broken and Split Timber Stringer Defects 13-2
Figure 13.2-2. Checked, Shaked and Decayed Timber Stringer Defects 13-3
Figure 17.2.1.1-1. Concrete Box Culvert Soil Properties for BrR 17-2
Figure 17.2.1.1-2. Control Options Screenshot from BrR 17-3
Figure 19.4-1. SCDOT Allowable Load Posting Signs 19-3

List of Appendices

Appendix A3.1: QC Review Checklist 3-3
Appendix A3.2: QC Review Tracking Sheet 3-5
Appendix A3.3: QA Review Checklist 3-7
Appendix A3.4: QA Review Tracking Sheet 3-9
Appendix A5.1: Site Assessment Form 5-3
Appendix A5.2: Site Assessment Supplemental Findings Form 5-9
Appendix A.6-1: 1972 AASHTO Table 1.10.1 6-13
Appendix A18.1: SCDOT Non-typical and Complex Bridges 18-2
Appendix A19.1: Bridge Signing/Posting Form 19-4
Appendix A20.1: Bridge Load Rating Summary (LRS) Worksheet Guide 20-3
Appendix A20.2: Bridge Maintenance Office Approval Form 20-13

CHAPTER 1 INTRODUCTION

1.1 PURPOSE

The purpose of this guidance document is to define the South Carolina Department of Transportation's (SCDOT) policies and procedures for load rating and posting of bridges within the State of South Carolina. This guidance document is intended to establish procedures for load rating of bridges, to provide uniformity in the load rating process and ensure that all bridges are load rated as to their safe load carrying capacity. This guidance document presents guidelines and procedures for rating bridges and outlines the documentation required.

1.2 SCOPE

The requirements presented in this guidance document are to be followed by SCDOT bridge staff as well as by consultants performing work for SCDOT in the load rating and posting of structures.

1.3 DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

1.3.1 Definitions

The following terms in this guidance document are used as defined below:

Bridge – A structure, including supports, erected over a depression or an obstruction such as water, a highway, or a railway; having a track or passageway for carrying traffic or other moving loads; and having an opening measured along the centerline of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches or extreme ends of openings for multiple boxes. It may also contain multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening. Any bridge, which does not meet the NBIS definition, does not need to be inspected or load rated.

Controlling Component – The component of a structure with the least live load carrying capacity.

Inventory Level – Generally corresponds to the rating at the design level of reliability for new bridges in the American Association of State Highway and Transportation Officials (AASHTO) Specifications, but reflects the existing bridge and material conditions with regard to deterioration and loss of section.

Inventory Rating – Load ratings based on the Inventory Level, which allow comparison with the capacity for new structures and, therefore, result in a live load that can safely utilize an existing structure for an indefinite period of time.

Live Load Distribution Factor – The fraction of a rating truck or lane load assumed to be carried by a structural component. The AASHTO Standard Specifications for Highway Bridges uses wheel lines whereas the AASHTO LRFD Bridge Design Specifications uses axles.

Load Rating – The determination of the live load capacity of an existing bridge using bridge plans and supplemented by information gathered from a field inspection.

Operating Level – Maximum load level to which a structure may be subjected; generally corresponds to the rating at the Operating Level of reliability in past load rating practice.

Operating Rating – Load ratings based on the Operating Level, which generally describe the maximum permissible live load to which the structure may be subjected. Allowing unlimited numbers of vehicles to use the bridge at Operating Level may shorten the life of the bridge.

Rating Factor – The ratio of the available capacity in excess of dead load to the live load demand.

Redundant – Where multiple load paths exist so that if one element fails, alternate load paths will allow the load to be redistributed.

1.3.2 Abbreviations and Acronyms

The abbreviations and acronyms used in this guidance document are defined in Table 1.3.2.

Table 1.3.2. Abbreviations and Acronyms

Abbreviation	Term
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
ADTT	Average Daily Truck Traffic
ASCE	American Society of Civil Engineers
ASD	Allowable Stress Design
ASR	Allowable Stress Rating
BDM	SCDOT Bridge Design Manual
BMO	SCDOT Bridge Maintenance Office
EDM	SCDOT Engineering Directive Memorandums
EOR	Engineer of Record
FCM	Fracture Critical Members
FHWA	Federal Highway Administration, U.S. Department of Transportation
LFD	Load Factor Design
LFR	Load Factor Rating
LRFD	Load and Resistance Factor Design
LRFR	Load and Resistance Factor Rating
MBE	AASHTO "Manual for Bridge Evaluation"
MUTCD	SCDOT Supplemental Manual on Uniform Traffic Control Devices
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NCHRP	National Cooperative Highway Research Program
NHS	National Highway System
QA	Quality Assurance
QC	Quality Control
RFC Plans	Released for Construction Plans
SCDOT	South Carolina Department of Transportation
SI&A	Structure Inventory and Appraisal

1.4 REFERENCES

The user is encouraged to refer to the following references for additional information when performing a load rating:

AASHTO Publications

Standard Specifications for Highway Bridges, 17th Edition
AASHTO LRFD Bridge Design Specifications, 8th Edition
The Manual for Bridge Evaluation, Latest Edition (MBE)

SCDOT Publications

BDM (2006)
Bridge Design Memorandums
Bridge Inspection Guidance Document
EDM 11 – Procedures for Posting or Changing Weight Limits on Bridges
EDM 18 – Bridge Security and Release of Plans

Commented [RP1]: Once the BIGD is complete and has been saved on the SCDOT website, provide a hotlink to the document.

EDM 35 – Emergency Procurement of Construction and Consultant Services
EDM 44 – Procedures for Removing Closed Bridges from the State System
EDM 68 – NHS Bridge Replacement Project Prioritization Process
EDM 70 – Load Restricted Bridge Replacement Prioritization Process
Supplemental to the Manual on Uniform Traffic Control Devices

FHWA Publications

Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges
Manual on Uniform Traffic Control Devices
Metrics for the Oversight of the National Bridge Inspection Program (2017)
Recommended Framework for a Bridge Inspection QC/QA Program

Other

American Institute of Steel Construction (AISC), 1990, Iron and Steel Beams 1873 to 1952
NCHRP Report 725, Guidelines for Analysis Methods and Construction Engineering of Curved and Skewed Steel Girder Bridges
NCHRP Report 406, Redundancy in Highway Bridge Superstructures
NCHRP Report 458, Redundancy in Highway Bridge Substructures
23 CFR 650 Subpart C, National Bridge Inspection Standards

1.5 COORDINATION

Users should direct questions concerning the applicability or requirements of the referenced documents to the State Bridge Maintenance Engineer or designated representative.

1.6 REVISIONS

Revisions may be the result of changes in SCDOT specifications, FHWA requirements, or AASHTO requirements.

Users are invited to send suggestions for revisions to this guidance document to the State Bridge Maintenance Engineer or designated representative. Suggestions need to be written with identification of the problem, the recommended revision, and the reason for the recommendation.

SCDOT will consider suggestions submitted and changes determined to be acceptable shall be submitted to FHWA for review and approval. Approved policy and editorial revisions to this guidance document will be indicated with a line in the margin of the applicable page.

CHAPTER 2 RESULTS OF PARAMETRIC STUDY

2.1 PURPOSE OF PARAMETRIC STUDY

A parametric study was performed for the SCDOT Bridge Maintenance Office to examine the maximum moments and shears occurring at specific points of interests of a variety of bridge span configurations and from a suite of vehicles including special hauling vehicles, a South Carolina representative school bus, annual Permit Loads, SCDOT Special Permit Loads and AASHTO Legal and SCDOT modified Legal Vehicles, all in comparison to AASHTO LRFD HL-93 Design Loadings. The primary purpose of the study was to summarize which trucks need to be used for load rating of South Carolina bridges in order to be compliant with Federal Highway Administration, Department of Transportation (FHWA) 23CFR 650.307 c.(2) Load Rating and 23 CFR 650.313 (g) Quality Control and Quality Assurance. Another purpose of the study was to compare rating results of the vehicles to the normalized HL-93 Design Loadings.

2.2 ANALYSIS PARAMETERS

The following sections summarize the parameters used to evaluate the live load analysis with respect to Legal and Permit study vehicles compared to the LRFR HL-93 Design Truck + Lane, HL-93 Design Tandem + Lane and the HL-93 Truck Train + Lane, and the LFR HS-20 Design Truck.

2.2.1 Live Load

Live loads were identified from various sources including AASHTO, South Carolina Statutes, and Permit Trucks from adjacent states. In order to bracket maximum load scenarios, various truck configurations were included in the parametric study.

Design Loadings used for the evaluation included the following:

- HL-93 Truck with the Design Lane (.64 kips/ft.) - LRFR
- HL-93 Design Tandem with the Design Lane (.64 kips/ft.) - LRFR
- HL-93 Truck Train (90%) with 90% of Design Lane (.576 kips/ft.) - LRFR
- HS-20 Design Truck - LFR

HS-15 and HS-25 Design Trucks were not included in the study since they are straight ratios from and have the same axle spacings as the HS-20 Design Truck.

Legal Trucks used for evaluation in the study included the following (note that ‘SC’ stands for specific South Carolina Legal Trucks):

- AASHTO Type 3 (Modified to encompass SC State Statute requirements)
- AASHTO Type 3S2 (Modified to encompass SC State Statute requirements)
- AASHTO Type 3-3
- 2-0.75 AASHTO Type 3-3 + .2klf Lane
- SC-SHV1A (65k)
- SC-SHV1B (70k)
- SC-SHV2A (66k)
- SC-SHV2B (80k)
- SC-SHV3A (85k)
- SC-SHV3B (90k)
- SC School Bus
- SC-SU2 (40k)
- SHV-SU4 (Special Hauling Vehicle)
- SHV-SU5 (Special Hauling Vehicle)
- SHV-SU6 (Special Hauling Vehicle)

- SHV-SU7 (Special Hauling Vehicle)

Note that the EV2 (Emergency Vehicle – 57.5k) and EV3 (Emergency Vehicle – 86k) trucks were not included in the study because they must always be run in a rating analysis.

South Carolina standard Permitting Vehicles were included in the evaluation of potential load rating vehicles. Statutes of South Carolina Permit Vehicles as well as the database history for trucks permitted within the state were researched for common truck configurations to evaluate in the study. The study "Permit" Trucks envelope SC State Statutes and neighboring state permit vehicles. The 5-, 6-, and 7-axle "General" Permit Trucks not only encompass the maximum allowable sizes and weights granted by permit and South Carolina Code of Law, but also encompass regulations of Permit Trucks found in Georgia and North Carolina. The 100k and 120k Permit Trucks are conservative for South Carolina and also allow safety for across the border travel from Georgia and North Carolina. The following Permit Trucks were used in the study:

- SC-100k Permit (5 axles)
- SC-120k Permit (6 axles)
- SC-130k (7 axles)
- SC Crane #544726 (160k)
- SC Crane #527568 (177.7k)

2.2.2 Structure Types

The structures investigated were assumed to be typical bridges with uniform stiffness and with girder spacings and span lengths within the range of application for the distribution factors of the AASHTO Standard Specifications for Highway Bridges (LFD) and the AASHTO LRFD Bridge Design Specifications (LRFD). Span lengths utilized ranged from 10 to 200 feet, with span increments of 5 feet for span lengths between 10 to 70 feet and span increments of 10 feet for span lengths from 70 to 200 feet.

Simple span, two-span continuous and three-span continuous structures were considered. For the two-span continuous structures, the span arrangement consisted of equal span lengths. For the three-span continuous structures, the interior span had a span length 1.3 x the length of the end spans.

2.2.3 Force Effects

The critical live load force effects of interest (moment and shear) were:

- For simple span structures:
  - Positive moment at midspan
  - Positive end shear
- For two-span continuous structures:
  - Positive moment at 0.4L of first span
  - Negative moment at interior support
  - Positive end shear
  - Negative shear left of interior support
  - Positive shear right of interior support
- For three-span continuous structures:
  - Positive moment at 0.4L of first span
  - Positive moment at 0.5L in center span
  - Negative moment at interior support
  - Positive end shear
  - Negative shear left of interior support
  - Positive shear at right of interior support

2.2.4 Load Factors / Impact

Impact was included in the evaluation of the study vehicles in comparison to LRFR's HL-93 Design Loadings. For LRFR evaluations and comparisons, an impact factor of 33% and the appropriate load factors were applied to all trucks (Permit, Legal and Design), but not to the lanes according to AASHTO LRFD Code. A load factor of 1.75 was applied to the HL-93 Design Loading according to Table 6A.4.2.2-1 of the AASHTO MBE. A load factor of 1.3 (average of load factors) was applied to all Permit Loads according to the 2013 revision to Table 6A.4.5.2a-1 of the AASHTO MBE. A load factor of 1.45 was applied to all Legal Trucks according to the 2013 revision of Table 6A.4.4.3a-1 of the AASHTO MBE. For the LFR comparison (Legal and Permit Trucks compared to HS-20 Design Truck), no impact or load factors were applied due to the comparison being for reference only (unfactored moments and shears).

2.2.5 Method of Evaluation

Influence line ordinates were determined for each of the force effects listed in Section 2.2.3 for the different span configurations described Section 2.2.2. The analysis assumed a prismatic cross-section for the entire structure length. Influence line ordinates obtained at 20th points were found to provide sufficient accuracy for this analysis.

The critical force effects for all structure types and base span lengths were calculated for all study vehicles. LARSA, a structural analysis software, was used to create models for each span arrangement (1-span, 2-span, and 3-span). Each of the trucks chosen were applied to a prismatic section as part of a moving load analysis. Enveloped maximum shear and moment results were exported from LARSA into EXCEL and then evaluated at the predetermined specific points of interest. As a part of the post processing of the LARSA data, the maximum moment and shear values at the points of interest were sub-divided into the four categories of trucks (Legal SU's vs. HL-93 Design Loadings, AASHTO Legal Trucks vs. HL-93 Design Loadings, SC Specific Legal Trucks vs. HL-93 Design Loadings and Permit Trucks vs. HL-93 Design Loadings). Once divided into these categories, the moments and shears were normalized to the HL-93 Design Truck + Lane (1.0) by dividing the force effect of the Legal Trucks, Permit Trucks, HL-93 Design Tandem + Lane and HL-93 Truck Train + Lane force effects by the corresponding HL-93 Design Truck + Lane force effect. The normalized moments and shears for each category were then graphed for each Rating Factor point of interest.

2.3 RESULTS OF PARAMETRIC STUDY

Refer to Section 6.5 of this guidance document for a listing of vehicles that must be considered for a rating analysis. The following provides a general summary of the results of the parametric study:

2.3.1 Legal Loads

For Legal Loads, for the 1-span, 2-span and 3-span bridges studied, the AASHTO LRFD design loads (AASHTO HL-93 Design Truck + Lane, HL-93 Design Tandem + Lane, and HL-93 Truck Train + Lane) envelope the Rating Factor for all Legal Trucks for all span lengths and critical force effects.

If a bridge yields a Rating Factor less than 1.0 for the AASHTO LRFD Design Loads, posting values may be determined considering the following: (Note, the SC-SHV vehicles are not allowed on interstate routes and thus bridges on interstate routes need not be analyzed for SC-SHV vehicles at the legal rating level; use AASHTO Legal SHV vehicles for interstate routes)

- For 2-axle Single Unit Trucks, the SC School Bus typically controls for spans under 30 feet, while the SC-SU2 controls for spans over 30 feet. The study recommends analyzing for both vehicles.

- For 3-axle Single Unit Trucks, generally use the SC-SHV1A (65k) Truck (non-interstate only), although the Modified AASHTO SC Type 3 Truck controls in some isolated cases.
- For 4- or-more axle Single Unit Trucks, generally use the SC-SHV2A (66k) Truck (non-interstate only), although an AASHTO SU4 Truck controls in some isolated cases. Analyze also for all AASHTO Legal SHV vehicles (SU4, SU5, SU6 and SU7).
- For Combination Unit Trucks of 5 or more axles, use the SC-SHV3A (85k) Truck (non-interstate only), the SC-SHV3B (90k) Truck (non-interstate only), the Modified AASHTO SC Type 3S2 and AASHTO Type 3-3 trucks.

2.3.2 Permit Loads

For Permit Loads, the following results were found:

- For 1-span arrangements, the HL-93 Design Truck + Lane load generally controls, although the SC Crane # 527568 (177.7k) controls for spans from 70'-180' for end shear and maximum midspan moment.
- For 2-span arrangements, the HL-93 Design Truck + Lane load generally controls although:
    - The SC Crane # 527568 (177.7k) controls in the 65'-120' span lengths for shear points of interest.
    - The SC Crane # 527568 (177.7k) controls in the 80'-140' span lengths for moment at .4L of Span 1.
    - Either Permit Crane (SC Crane # 544726 (160k) or SC Crane # 527568 (177.7k)) may control at 30'-45' span lengths for maximum moment at interior bent.
- For 3-span arrangements:
    - Permit Cranes (SC Crane # 544726 (160k) or SC Crane # 527568 (177.7k)) control over the HL-93 Design Loading Trucks and Lane at various locations of each of the points of interest.
    - The SC-130k (7 axle) and SC-120k (6 axle) Permit Trucks control over the HL-93 Design Loading Trucks and Lanes for the 25'-40' span lengths for maximum negative moment at interior bents.

2.3.3 Emergency Vehicles

Per the MBE, emergency vehicles (EV) should always be included in the rating analysis.

CHAPTER 3 LOAD RATING CHECKING AND QA/QC

3.1 GENERAL REQUIREMENTS

The goal of SCDOT is to provide a safe transportation system. Load rating results shall be checked for accuracy as part of the Quality Assurance (QA)/Quality Control (QC) process.

3.2 QUALIFICATIONS OF LOAD RATING PERSONNEL

Load ratings and load rating checks shall be performed by individuals qualified to do load rating. At a minimum, the individual performing the load rating or the individual performing the load rating check shall be a professional engineer licensed in the state of South Carolina or shall be under the supervision of a professional engineer licensed in the State of South Carolina and the load rating shall be certified by the professional engineer.

3.3 COMPUTER SOFTWARE AND COMPUTER SOFTWARE VERIFICATION

SCDOT requires the use of AASHTOWare BrR, version 6.8.2 load rating software for all structure types supported by this software. AASHTOWare BrR can be used to load rate steel rolled beam, steel girder, steel floor beam, prestressed concrete girder, concrete slab, concrete girder, timber beam, and steel truss bridges using the ASR, LFR, or LRFR methods. It will also load rate concrete culverts.

If a specialized structure type cannot be load rated using BrR, and an alternative proprietary software or spreadsheet is required to perform the load rating, approval of the alternative software must be obtained from the State Bridge Maintenance Engineer or designated representative. If Microsoft EXCEL and / or PTC Mathcad are required for bridges that cannot be load rated by BrR, pre-approval by SCDOT for use as an alternate software is not required.

The load rater shall provide documentation that alternative load rating software is performing as intended and is accurate. Program documentation shall consist of longhand calculations verifying key portions of the computer analysis or, alternatively, provide documentation of the computer program’s results by means of an independent software analysis program. Refer to Chapter 20 of this guidance document for specific requirements of computer program documentation.

The load rater and checker are responsible for using all software appropriately, interpreting the results appropriately, and performing load rating checks as required.

3.4 CHECKING PROCEDURES

A load rating check shall include confirmation of the assumptions used for the load rating, verification of appropriate equations and calculations for load rating, and a check of arithmetic. Load rating checks may consist of an independent mirror set of load rating calculations. When computer programs are used, the checker should verify all input data, verify that the summary of load capacity information accurately reflects the analysis, and be satisfied with the accuracy and suitability of the computer program. Discrepancies found by the load rating checker shall be documented and resolved with the original generator of the load rating.

3.5 QC AND QA

3.5.1 QC Review

Typically, consultants perform all load ratings for the SCDOT. Consultants shall be responsible for the QC review of all of their load ratings. A QC review of the load rating results must be performed by a professional engineer licensed in the State of South Carolina. The QC review shall include the following:

- Confirmation that a formal load rating check was completed,
- A general overview of the assumptions and methods used for the load rating,

- Confirmation that any structural deterioration has been properly accounted for in developing the rating,
- Confirmation that the results of the load rating / load rating check are properly summarized on the Load Rating Summary Form,
- Documentation of the QC process (complete the "Quality Control Engineer" box on the Load Rating Summary Form).

3.5.1.1 QC Review Checklist

In addition to completing the "Quality Control Engineer" box on the Load Rating Summary Form, consultants shall utilize a standardized checklist to document the QC process for all bridges they have load rated. The standardized QC Review Checklist is included in Appendix A3.1 of this chapter.

3.5.1.2 QC Tracking Spreadsheet

Consultants shall also utilize a standardized tracking spreadsheet to document the process of the final load rating for all assigned bridges. The standardized QC Review Tracking Sheet is included in Appendix A3.2 of this chapter.

3.5.2 QA Review

QA reviews shall be performed on a monthly basis for all load ratings submitted by consultants the previous month. Each month, all bridge database information from the standardized QC Tracking Spreadsheet will be entered into a master QA Tracking Spreadsheet to determine which bridges will be assigned for QA The information will be filtered by various priority categories. The categories, in order of priority, include:

1. Fracture Critical Bridges
2. Scour Critical Bridges
3. Bridges with NBI Condition Ratings of 4 or less for any of the four NBIS Condition Rating items
4. Complex Bridges
5. Bridges on the National Highway System
6. All Remaining Bridges

For each category, QA review shall be performed on 10% of the load ratings submitted the previous month and the actual bridges selected shall be determined by a random number generator. If a bridge falls into more than one category and is randomly selected more than once, in will be replaced in the lowest-priority category. Not less than one bridge shall be reviewed for each category if the sample lot for the category is less than 10 load ratings (unless there are no bridges for that category that month). The standardized QA Review Tracking Sheet is included in Appendix A3.4 of this chapter

Consultants shall not perform QA reviews for their own load ratings; QA reviews shall be performed by a different consultant than the consultant that performed the load rating analysis. The QA reviews shall review the QC Review documentation (QC Review Checklist) and the Load Rating Summary Form to confirm a QC review was completed for the selected load ratings, to confirm each QC comment received a response and was resolved, and to verify consistency in load rating procedures among all consultants involved in the load rating process. The Quality Assurance Engineer shall complete the "Quality Assurance Engineer" box on the Load Rating Summary Form. The Quality Assurance Engineer shall also complete a QA Review Checklist. The standardized QA Review Checklist is included as Appendix A3.3 of this chapter.

APPENDIX A3.1: QC REVIEW CHECKLIST

Load Rating QC Review Checklist

Version: 1.0
Page 1 of 1

SECTION 1: GENERAL BRIDGE DATA						
(8) Asset ID:	(2) District:	(3) County:	(7) Facility Carried:		(6) Feature Crossed:	
	Select District	Select County				
(92A) Fracture Critical?	(113) Scour Critical?	(58, 59, 60 or 62) Lowest of Deck, Superstructure, Substructure or Culvert NBI Condition:		(104) On NHS?	Complex Bridge?	(27) Year Built:
No	No			No	No	

SECTION 2: LOAD RATING QC REVIEW CHECKLIST

For each item in this section, list the QC comments, and describe the process by which these comments were resolved. If there were no QC comments associated with the item, the space may be left blank. The box should only be checked after all QC comments are addressed. If more space is needed to document the process, attach additional sheets to this form.

☐ 1. A formal check of the load rating was completed.

☐ 2. The assumptions used for the load rating were valid.

☐ 3. Structural deterioration (if applicable) was accounted for in the load rating.

☐ 4. The Load Rating Summary (LRS) Form was completed entirely and correctly.

☐ 5. The LRS Form agrees with the results of the load rating / load rating check.

☐ 6. The “Quality Control Engineer” box on the LRS Form was completed.

QUALITY CONTROL ENGINEER	
Name:	
Company:	
Date:	

A link to the latest version of the QC Review Checklist is located here: QC Review Checklist

Commented [RP2]: Add hotlink once form is finalized and the form is saved on SCDOT website

APPENDIX A3.2: QC REVIEW TRACKING SHEET

Version 1.0
OCT2018
Page 1 of 1

QC Review Tracking Sheet

Consultant: (Enter Consultant Name)
Month: (Enter Month of Ratings Completed)

No.	(8) Asset ID	(2) District	(3) County	(7) Facility Carried	(6) Feature Crossed	(27) Year Built	(92A) Fracture Critical?	(113) Scour Critical 3 or U?	(58, 59, 60, 62) Lowest NBI Condition of Deck, Superstructure, Substructure, Culvert	Complex Bridge? (See list)	(104) On NHS?	Site Assessment Performed	Load Rating Performed	Load Rating QC Completed	Signed Load Rating Package Submitted
1	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
2	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
3	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
4	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
5	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
6	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
7	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
8	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
9	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
10	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
11	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
12	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
13	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
14	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
15	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
16	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
17	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
18	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
19	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
20	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
21	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
22	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
23	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
24	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
25	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
26	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
27	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
28	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
29	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
30	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
31	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
32	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
33	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
34	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
35	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
36	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
37	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
38	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
39	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
40	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
41	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
42	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
43	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
44	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
45	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
46	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
47	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
48	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
49	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX
50	XXXX	X	(Name)	(Facility Carried)	(Feature Crossed)	XXXX	(Y/N)	(Y/N)	X	(Y/N)	(Y/N)	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX

A link to the latest version of the QC Review Tracking Sheet is located here: QC Review Tracking Sheet.

Commented [RP3]: Add hotlink once form is finalized and the form is saved on SCDOT website

APPENDIX A3.3: QA REVIEW CHECKLIST

SCDOT

Load Rating QA Review Checklist

Version: 1.0
Page 1 of 1

SECTION 1: GENERAL BRIDGE DATA					
(8) Asset ID:	(2) District:	(3) County:	(7) Facility Carried:	(6) Feature Crossed:	
	Select District	Select County			
(92A) Fracture Critical?	(113) Scour Critical?	(58, 59, 60 or 62) Lowest of Deck, Superstructure, Substructure or Culvert NBI Condition:	(104) On NHS?	Complex Bridge?	(27) Year Built:
No	No		No	No	

SECTION 2: LOAD RATING QA REVIEW CHECKLIST

For each item in this section, list the QA comments, and describe the process by which these comments were resolved. If there were no QA comments associated with the item, the space may be left blank. The box should only be checked after all QA comments are addressed. If more space is needed to document the process, attach additional sheets to this form.

☐ 1. All appropriate Load Rating Package Deliverables have been submitted to SCDOT.

☐ 2. The Load Rating Summary (LRS) Form was completed entirely and correctly.

☐ 3. The Load Rating QC Review Checklist was completed entirely.

☐ 4. If there were QC review comments, the process by which these comments were resolved was documented.

☐ 5. The "Quality Control Engineer" box on the LRS Form was completed.

QUALITY ASSURANCE ENGINEER	
Name:	
Company:	
Date:	

A link to the latest version of the QA Review Checklist is located here: QA Review Checklist

Commented [RP4]: Add hotlink once form is finalized and the form is saved on SCDOT website

APPENDIX A3.4: QA REVIEW TRACKING SHEET

QA Review Tracking Sheet Template.xlsm

SCDOT

Date Printed: 11/21/2018 11:46 AM
Page 1 - of - 1

Fracture Critical

No.	(8) Asset ID	(2) District	(3) County	(7) Facility Carried	(6) Feature Crossed	(27) Year Built	(92A) Fracture Critical?	(113) Scour Critical 3 or U?	(58, 59, 60, 62) Lowest NBI Condition of Deck, Superstructure, Substructure, Culvert	Complex Bridge? (See list)	(104) On NHS?	Site Assessment Performed	Load Rating Performed	Load Rating QC Completed	Signed Load Rating Package Submitted	Random Number for QA Selection	Bridge selected for QA?	QA Review Performed
4	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	94355	Yes	
29	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	94062	Yes	
2	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	90659	Yes	
35	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	87212	Yes	

Scour Critical

No.	(8) Asset ID	(2) District	(3) County	(7) Facility Carried	(6) Feature Crossed	(27) Year Built	(92A) Fracture Critical?	(113) Scour Critical 3 or U?	(58, 59, 60, 62) Lowest NBI Condition of Deck, Superstructure, Substructure, Culvert	Complex Bridge? (See list)	(104) On NHS?	Site Assessment Performed	Load Rating Performed	Load Rating QC Completed	Signed Load Rating Package Submitted	Random Number for QA Selection	Bridge selected for QA?	QA Review Performed
3	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	96355	Yes	
24	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	91674	Yes	
10	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	88325	Yes	

Low NBI Condition

No.	(8) Asset ID	(2) District	(3) County	(7) Facility Carried	(6) Feature Crossed	(27) Year Built	(92A) Fracture Critical?	(113) Scour Critical 3 or U?	(58, 59, 60, 62) Lowest NBI Condition of Deck, Superstructure, Substructure, Culvert	Complex Bridge? (See list)	(104) On NHS?	Site Assessment Performed	Load Rating Performed	Load Rating QC Completed	Signed Load Rating Package Submitted	Random Number for QA Selection	Bridge selected for QA?	QA Review Performed
27	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	97623	Yes	
28	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	96303	Yes	

Complex Structures

No.	(8) Asset ID	(2) District	(3) County	(7) Facility Carried	(6) Feature Crossed	(27) Year Built	(92A) Fracture Critical?	(113) Scour Critical 3 or U?	(58, 59, 60, 62) Lowest NBI Condition of Deck, Superstructure, Substructure, Culvert	Complex Bridge? (See list)	(104) On NHS?	Site Assessment Performed	Load Rating Performed	Load Rating QC Completed	Signed Load Rating Package Submitted	Random Number for QA Selection	Bridge selected for QA?	QA Review Performed
11	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	91758	Yes	
32	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	91154	Yes	
14	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	86504	Yes	

NHS

No.	(8) Asset ID	(2) District	(3) County	(7) Facility Carried	(6) Feature Crossed	(27) Year Built	(92A) Fracture Critical?	(113) Scour Critical 3 or U?	(58, 59, 60, 62) Lowest NBI Condition of Deck, Superstructure, Substructure, Culvert	Complex Bridge? (See list)	(104) On NHS?	Site Assessment Performed	Load Rating Performed	Load Rating QC Completed	Signed Load Rating Package Submitted	Random Number for QA Selection	Bridge selected for QA?	QA Review Performed
47	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	87914	Yes	

Remaining Structures

No.	(8) Asset ID	(2) District	(3) County	(7) Facility Carried	(6) Feature Crossed	(27) Year Built	(92A) Fracture Critical?	(113) Scour Critical 3 or U?	(58, 59, 60, 62) Lowest NBI Condition of Deck, Superstructure, Substructure, Culvert	Complex Bridge? (See list)	(104) On NHS?	Site Assessment Performed	Load Rating Performed	Load Rating QC Completed	Signed Load Rating Package Submitted	Random Number for QA Selection	Bridge selected for QA?	QA Review Performed
21	XXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	91762	Yes	

A blank output summary from the QA Review Tracking Sheet is shown. A link to the latest version of the QA Review Tracking Sheet is located here: QA Review Tracking Sheet.

Commented [RP5]: Add hotlink once form is finalized and the form is saved on SCDOT website

CHAPTER 4 LOAD RATING PROCESS

4.1 GENERAL

The load rating work discussed in this guidance document is covered by the specifications in the current version of the AASHTO Manual for Bridge Evaluation (MBE) and as modified by this guidance document. The load rating and checking must be performed by individuals who are licensed professional engineers or under the supervision of a licensed professional engineer.

4.2 INSPECTION DATA USED FOR LOAD RATING

Refer to the MBE, Section 2 for requirements for Bridge Files and Documentation requirements and Chapter 5 of this guidance document.

4.3 CONCEPTS AND LOAD RATING METHODOLOGIES

The following concepts are to be applied to the load rating process:

1. In general primary load carrying members are required to be load rated.
2. Members of substructures need not be routinely load rated. Substructure elements such as pier caps and columns should be rated in situations where the engineer has reason to believe that their capacity may govern the load capacity of the entire bridge, such as where substructure elements have sustained significant collision or impact damage, where substructure elements have significant deterioration (particularly with lack of redundancy), or where scour, undermining or settlement may affect the footing's bearing capacity or the column's unbraced length.
3. Using engineering judgment, all superstructure spans and live load carrying components of the span shall be load rated for moment, shear, and axial load (where appropriate) until the governing component is established. If the engineer, using engineering judgment, determines that certain components will not control the rating, then a full investigation of the non-controlling elements is not required. However, it is to be noted which components were not rated and the reasons leading to the engineering judgment not to rate the components.
4. For most structures, the governing rating shall be the lesser of the shear capacity or moment capacity of the critical component. For more complex structures, other forces such as axial or principal shear may control the rating.
5. All bridges shall have a load rating which reflects the current configuration and condition of the bridge. A new load rating is required if the bridge has been reconstructed such that the work changes the bridge's roadway width, load carrying capacity, structural or geometric configuration, or generally any change requiring a Professional Engineer to sign and seal plans. Examples of reconstruction would include deck alteration that effectively increase the dead load (deck overlays); addition of new spans; converting pin and hangers to a continuous design; converting simple spans to continuous; substructure modifications including new pile spacing or configurations or cap alterations; modifications to fracture critical elements or fatigue prone details; substructure replacement; replacement of deck; stringer replacement; superstructure replacement; or bridge widening. Some emergency bridge repairs such as girder end repairs, emergency repairs or critical finding repairs may also trigger the need for a new load rating.
6. Existing bridges that are found, during inspections, to have additional substantial member section loss or damage affecting section properties observed as compared to past inspections shall be assessed for possible re-rating. This would include deterioration or damage identified during a Special Inspection or during a Damage inspection resulting from fire, impact by an over-height vehicle, flood, hurricane or other natural or man-made disaster. New load ratings are required unless the current load rating can be determined to be adequate by engineering judgment.

Additionally, bridges shall be assessed to determine if re-rating is warranted for the following reasons:

- If the Condition Rating for Deck, Superstructure, Substructure or Culvert NBI items drops to 4, Poor Condition or 3, Serious Condition.
- If the Condition Rating for Deck, Superstructure, Substructure or Culvert NBI items drops 2 points or more below when the original load rating was performed.
- If the existing bridge is found, during inspection, to be supporting an increased dead load, such as a thicker layer of gravel overlay, or if the bridge did not previously have an overlay and has received an overlay of the existing deck since the previous inspection. Note: If the controlling Rating Factor of a bridge is large enough to accommodate an added overlay or increased overlay thickness, sound engineering judgment may be used to determine that a new load rating is not needed. However, the changed condition to reflect the current overlay shall be documented in the bridge file and the rationale for not requiring a new load rating shall be provided.
- If the Program Manager determines a load rating is required.

7. When consultants perform load ratings, they will follow the requirements of this guidance document and the current MBE.

4.4 NEW BRIDGES

FHWA requires that new bridges and bridge replacements designed after October 1, 2010 be designed in accordance with the LRFD Bridge Design Specifications using the appropriate loading. As such, all new bridges shall be load rated by the bridge designer per the Load and Resistance Factor Rating (LRFR) method prior to opening the bridge to the public. Load Rating Submittal Packages shall be delivered with RFC Plans and updated as needed with As-Built Plans if there have been any changes to the bridge that affect the load rating.

4.5 EXISTING BRIDGES

Refer to Chapters 7 through 18 of this guidance document, inclusive, for SCDOT's policies on rating methods to use for the various structural types.

Existing bridges designed by the ASD method shall be load rated using the LFR method, except for timber and masonry bridges, which will be rated using the ASR method. An existing timber or masonry bridge load rated by the ASR method does not have to be reanalyzed as long as the existing rating has been performed considering the current condition and configuration of the bridge.

Bridges designed by the LFD method shall be load rated using the LFR method.

Bridges designed by LRFD method shall be rated using the LRFR method.

4.6 REHABILITATED BRIDGES

If the existing load rating is inaccurate or did not account for deterioration of the bridge as reported in bridge inspection reports, a new load rating shall be performed for the existing bridge in accordance with this guidance document. All bridge widening or rehabilitation projects shall be designed in accordance with the current BDM.

CHAPTER 5 DATA COLLECTION

5.1 GENERAL

The collection of relevant and pertinent existing data about the structure is required to perform the load rating. The available information for a specific bridge may be assembled from many different sources or may rely exclusively on inspection and field measurements when other information does not exist. It is the rating engineer's responsibility to determine the reliability and applicability of all available information used to support the rating.

Security protocols are in place within the SCDOT to limit access to specific information about bridge structures that could be used to compromise the transportation system within the state. Consultants needing information from a Bridge File to perform a load rating will need to first request a ProjectWise account with SCDOT by filling out an account request located at the following site: https://www.scdot.org/business/pdf/design-build/Account_Request_Form.pdf#search=ProjectWise

Once a ProjectWise account is established, send a request to access the Bridge File by contacting the State Bridge Maintenance Engineer or designated representative.

5.2 EXISTING PLANS

Existing plans are used to determine loads, bridge geometry, component cross sections and material properties. Such plans may include as-bid plans, as-built plans, shop drawings, and repair plans. Design plans, also referred to as as-bid plans, are created by the designer and used as a contract document for bidding and constructing the project. Construction record plans, also referred to as as-built plans, are contract design plans that have been modified to reflect changes made during construction. Changes from the as-bid plans during fabrication may not be represented in the as-built plans, but would be documented in the shop drawings. Repair plans that document repairs performed during the life of the structure may also be available. Plans may not exist for some structures, and in these cases, field measurements will be required.

5.3 INSPECTION REPORTS

Prior to performing a load rating, inspection reports must be reviewed to determine if there is deterioration or damage that needs to be accounted for in the rating. Routine Inspection reports would typically contain this information, although Special Inspection reports, Damage Inspection reports, Underwater Inspection reports, etc. may also be available and may provide additional information regarding deterioration or damage. In addition, inspection reports may contain pertinent measurements of members or may note if additional loading is present. Over the life of the structure, undocumented repairs and/or changes during construction or erection may have taken place without the appropriate documentation. These changes may be discovered and documented within the inspection report. Inspection report photos, field notes and measurements can also be used to verify members and measurements in existing plan documents.

Photographs and field measurement of losses should be reported in the inspection report. It is the responsibility of the rating engineer to determine the extent of the losses and their impact on the load carrying capacity of the structure.

5.4 SITE ASSESSMENTS

If existing plans are not available and/or bridge inspection reports do not contain sufficient detail to perform the load rating, an independent Site Assessment may be required to collect the necessary data to perform the load rating, including development of record drawings or sketches documenting visible information to complete the load rating. When existing plans are available, orientation and numbering of bridge elements referenced in the Site Assessment shall be as shown on the existing plans. In the absence of existing plans, numbering and orientation of bridge elements shall be in accordance with Section 5.4.9 of the Bridge Inspection Guidance Document.

Prior to performing a Site Assessment, notify the State Bridge Maintenance Engineer or designated representative to document the additional effort required for the Site Assessment and obtain approval for the added effort.

The template for documenting information affecting the load rating as a result of a Site Assessment is included in Appendix A5.1 to this chapter. Use the Site Assessment Supplemental Findings Form in Appendix A5.2 to document other findings during a Site Assessment that do not directly affect the load rating.

5.5 OTHER RECORDS

Other structure history records may exist that will provide additional information pertinent to the load rating. These records may override specifications or measurements that are reported in the as-bid plans or repair plans. Examples of pertinent records are:

Standard Plans
Correspondence
Photographs
Maintenance History and Repair Records
Field Testing Reports
Material Test Reports
Mill Reports
Historic Rating Analyses and Posting History

APPENDIX A5.1: SITE ASSESSMENT FORM

SCDOT

Site Assessment Form

Version: 1.0
OCT2018
Page 1 of 5

SECTION 1: GENERAL BRIDGE DATA

(420) Asset ID:	(8) Structure Number:	(2) District:	(3) County:	(9) Bridge Location:	Site Assessment Date:

Bridge Coordinates: (16) Latitude:		degrees		minutes		seconds	(17) Longitude:		degrees		minutes		seconds

(7) Facility Carried:	(6) Feature Crossed:	(43, 44) Bridge Description:	
(45) Number of Main Spans:	(46) Number of Approach Spans:	(49) Structure Length:	(52) Structure Width (out-to-out)

SECTION 2: FIELD NOTES

In this section, include information on items that affect the load rating, such as SIP forms, utilities, attached signs, overlays, etc. Include notes about deterioration of members to be rated. Do not include information that does not affect the load rating, such as minor deck cracking and spalling. Do not include site assessment critical findings not related to the supporting members to be rated; these should be reported in a separate form.

SCDOT

Site Assessment Form

Version: 1.0
OCT2018
Page 2 of 5

(420a) Asset ID:	(8) Structure Number:	District:	(3) County:	(9) Bridge Location:	Site Assessment Date:

SECTION 3: ADDITIONAL NOTES

In this section, include information (if necessary) such as field measurements of deteriorated members to be rated that were not recorded during initial site visit, load testing recommendations, etc.

SCDOT

Site Assessment Form

Version: 1.0
OCT2018
Page 3 of 5

(420a) Asset ID:	(8) Structure Number:	District:	(3) County:	(9) Bridge Location:	Site Assessment Date:

SECTION 4: FIELD SKETCHES

In this section, include information such as field measurements, not provided in design plans or as-built plans needed to complete load rating. Attach additional sheets, if necessary.

Site Assessment Form

Version: 1.0
OCT2018
Page 4 of 5

(420a) Asset ID:	(8) Structure Number:	District:	(3) County:	(9) Bridge Location:	Site Assessment Date:

SECTION 5: PHOTOGRAPHS

Include photos of information to assist with the load rating only. Also include photos of any weight restrictions postings. Do not include photos of defects such as minor deck cracking and spalling. Do not include general photos of the bridge that are in typical inspection reports.

Site Assessment Form

Version: 1.0
OCT2018
Page 5 of 5

(420a) Asset ID:	(8) Structure Number:	District:	(3) County:	(9) Bridge Location:	Site Assessment Date:

SECTION 5: PHOTOGRAPHS

Include photos of information to assist with the load rating only. Also include photos of any weight restrictions postings. Do not include photos of defects such as minor deck cracking and spalling. Do not include general photos of the bridge that are in typical inspection reports.

A link to the latest version of the Site Assessment Form is located here: Site Assessment Form.

Commented [RP6]: Add hotlink once form is finalized and the form is saved on SCDOT website

APPENDIX A5.2: SITE ASSESSMENT SUPPLEMENTAL FINDINGS FORM

SCDOT **Site Assessment Supplemental Findings Form**

Version: 1.0
NOV2018
Page 1 of 4

SECTION 1: GENERAL BRIDGE DATA

(8) Asset ID:	(2) District:	(3) County:	(9) Bridge Location:	Site Assessment Date:
	Select District	Select County		

Bridge Coordinates:
(16) Latitude: ___ degrees ___ minutes ___ seconds (17) Longitude: ___ degrees ___ minutes ___ seconds

(7) Facility Carried:	(6) Feature Crossed:	(43, 44) Bridge Description:

(45) Number of Main Spans:	(46) Number of Approach Spans:	(49) Structure Length:	(52) Structure Width (out-to-out)

SECTION 2: APPLICABLE FINDINGS

In this section, please check all categories that apply to the assessment findings. Please confirm that any findings impacting the load rating are reported in the main "Site Assessment Form."

- ☐ **(36) Traffic Safety Features**
- ☐ (36A) Bridge Railings
- ☐ (36B) Transitions
- ☐ (36C) Approach Guardrail
- ☐ (36D) Approach Guardrail Ends

- ☐ **(58) Deck**
- ☐ Bridge Railing / Parapets and/or Median Barriers
- ☐ Curbs
- ☐ Decks and/or Slabs

- ☐ **(59) Superstructure**
- ☐ Girders / Floor Beams / Stringers and/or Beams
- ☐ Truss Members
- ☐ Bearings
- ☐ Expansion Bearings
- ☐ Paint System(s)

- ☐ **(60) Substructure**
- ☐ Abutments and/or Headwalls
- ☐ Bents and/or Piers

- ☐ **(61) Channel and Channel Protection**
- ☐ Fender System

- ☐ **(62) Culverts**

- ☐ **(71) Waterway Adequacy**
- ☐ Waterway and Scour

- ☐ **(72) Approach Roadway Alignment**
- ☐ Roadway Alignment
- ☐ Traffic Signs

- ☐ **Other:** ______________________

Site Assessment Supplemental Findings Form

Version: 1.0
NOV2018
Page 2 of 4

(8) Asset ID:	District:	(3) County:	(9) Bridge Location:	Site Assessment Date:
	Select District	Select County		

SECTION 3: FIELD NOTES

In this section, include information on all site assessment findings. Findings which impact the load rating should also be reported in the main "Site Assessment Form."

SCDOT Site Assessment Supplemental Findings Form

Version: 1.0
NOV2018
Page 4 of 4

(8) Asset ID:	District:	(3) County:	(9) Bridge Location:	Site Assessment Date:
	Select District	Select County		

SECTION 4: PHOTOGRAPHS

Include photos of all site assessment findings. Do not include general photos of the bridge that are in typical inspection reports.

Site Assessment Supplemental Findings Form

Version: 1.0
NOV2018
Page 4 of 4

(8) Asset ID:	District:	(3) County:	(9) Bridge Location:	Site Assessment Date:
	Select District	Select County		

SECTION 4: PHOTOGRAPHS

Include photos of all site assessment findings. Do not include general photos of the bridge that are in typical inspection reports.

A link to the latest version of the Site Assessment Supplemental Findings Form is located here: Site Assessment Supplemental Findings Form.

Commented [RP7]: Add hotlink once form is finalized and the form is saved on SCDOT website

CHAPTER 6 GENERAL REQUIREMENTS

6.1 CONDITION OF BRIDGE MEMBERS

The condition and extent of deterioration and defects of structural components of the bridge shall be considered in the rating computations. This information shall be based on a recent, thorough field investigation.

6.2 TYPES OF LOADS TO CONSIDER FOR RATINGS

In accordance with Sections 6A.2.1 and 6A.2.2 of the MBE, generally only permanent loads and vehicular loads are considered to be of consequence in load ratings. Environmental loads such as wind, ice, temperature, stream flow and earthquake are usually not considered in rating except where unusual conditions warrant their inclusion. Permanent loads include dead loads and locked-in force effects from the construction process.

6.3 DEAD LOADS USED TO DETERMINE RATINGS

The dead load unit weights given in the current AASHTO LRFD Bridge Design Specifications shall be used in the absence of more precise information. However, the 145 pcf weight of normal weight concrete shall be increased by 5 pcf to 150 pcf to account for the weight of reinforcing steel.

6.4 SIDEWALK LOADING OR PEDESTRIAN LOADING USED TO DETERMINE RATINGS

6.4.1 Sidewalk Loading Using the ASR or LFR Method

Per the MBE, Article 6B.6.2.4, “Sidewalk loadings used in calculations for safe load capacity ratings should be probable maximum loads anticipated. Because of site variations, the determination of loading to be used will require engineering judgment, but in no case should it exceed the value given in AASHTO Standard Specifications. The Operating Level should be considered when full truck and sidewalk live loads act simultaneously on the bridge.”

6.4.2 Pedestrian Loading Using the LRFR Method

Per the MBE, Article 6A.2.3.4, “Pedestrian loads on sidewalks need not be considered simultaneously with vehicular loads when load rating a bridge unless the rating engineer has reason to expect that significant pedestrian loading will coincide with the maximum vehicular loading. Pedestrian loads considered simultaneously with vehicular loads in calculations for load ratings shall be the probable maximum loads anticipated, but in no case should the loading exceed the value specified in LRFD Design Article 3.6.1.6.”

6.5 LIVE LOADS USED TO DETERMINE RATINGS

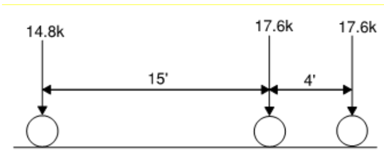
For ASR and LFR load ratings, bridges shall be rated using the Rating Live Load as described by Section 6B.6.2 and Figures 6B.6.2-1 and 6B.6.2-2 of the MBE. For LRFR load ratings, bridges shall be rated using the standard Design Vehicles as described by Section 6A.2.3.1 and appendix C6A of the MBE. In addition, the Legal Trucks shown in Table 6.5-1 shall be analyzed for posting vehicles.

Note that the SCDOT Specialized Hauling Vehicles (SC SHV) can be omitted from Interstate bridge legal level ratings since they are precluded from travelling on Interstates as per the South Carolina Code of Laws Title 56 Chapter 5 Section 4140. Additionally, as per the MBE, Emergency Vehicles (EV’s) should always be included in load rating analyses for bridges. Refer to Figure 6.5-3 for axle configurations of EV vehicles.

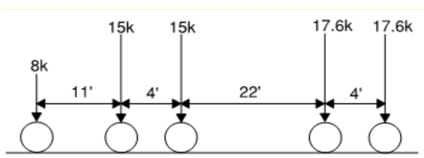
For permit loads, analyze for the permit trucks shown in Figure 6.5-4.

Table 6.5-1. Suite of Posting Vehicles

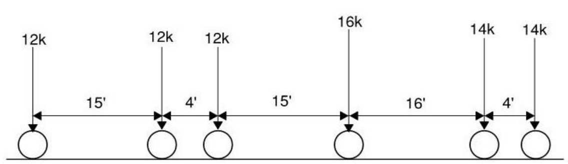
Truck Type	Axle Configuration	Vehicle	Reference Figure
Single Unit	2 Axles	SC-SU2	6.5-2b
		SC Representative School Bus	6.5-2b
	3 Axles	SC SHV1A (65k) - Non-Interstate Only	6.5-2b
		SC- Type 3 (AASHTO modified)	6.5-1
	4 or More Axles	SC SHV2A (66k) - Non- Interstate Only	6.5-2b
		SU4	6.5-2a
		SU5	6.5-2a
		SU6	6.5-2a
		SU7	6.5-2a
Combination Unit	5 or More Axles	SC SHV3A (85k) - Non- Interstate Only	6.5-2b
		SC SHV3B (90k) - Non- Interstate Only	6.5-2b
		SC - Type 3S2 (AASHTO Modified)	6.5-1
		Type 3-3 (AASHTO)	6.5-1
	Dual Trucks	2-0.75 AASHTO Type 3-3 + .2 klf Lane	6.5-1



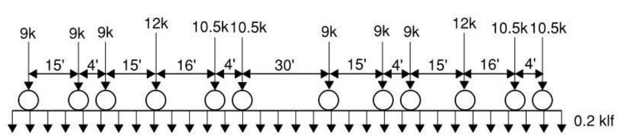
AASHTO SC Type 3



AASHTO SC Type 3S2

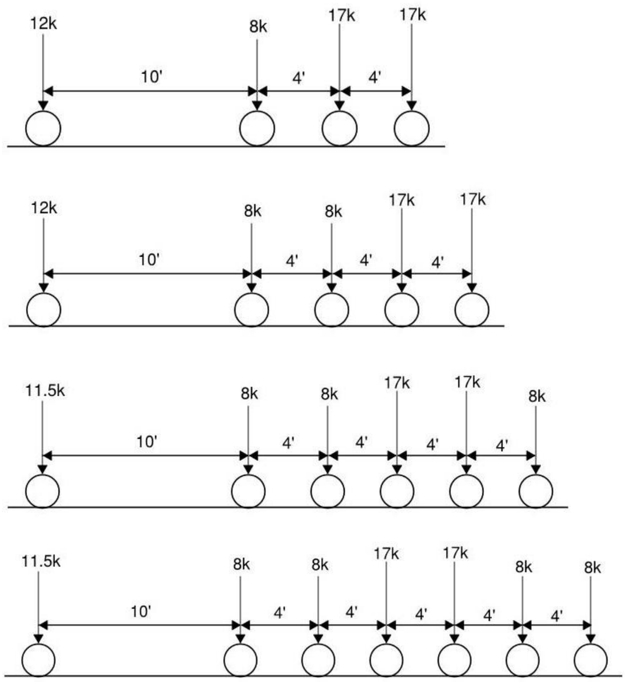


AASHTO Type 3-3



2 – 0.75 AASHTO Type 3-3 + .2 klf Lane (for spans >200')

Figure 6.5-1. Legal Loads (Showing Axle Loads)



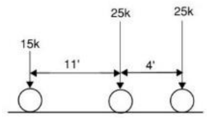
AASHTO SHV – SU4

AASHTO SHV – SU5

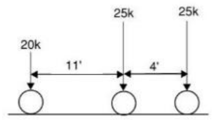
AASHTO SHV – SU6

AASHTO SHV – SU7

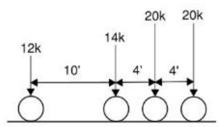
Figure 6.5-2a. AASHTO Short Haul Vehicles (Showing Axle Loads)



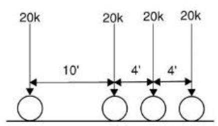
SC-SHV1A (65k)



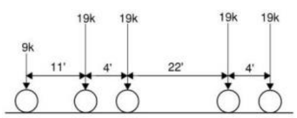
SC-SHV1B (70k)



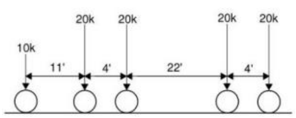
SC-SHV 2A (66k)



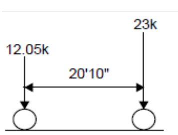
SC-SHV2B (80k)



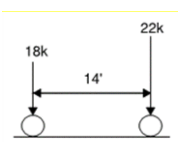
SC-SHV3A (85k)



SC-SHV3B (90k)

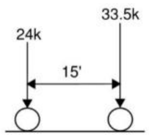


SC Representative School Bus

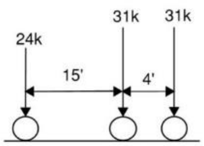


SC-SU2

Figure 6.5-2b. South Carolina Short Haul and other Posting Vehicles (Showing Axle Loads)

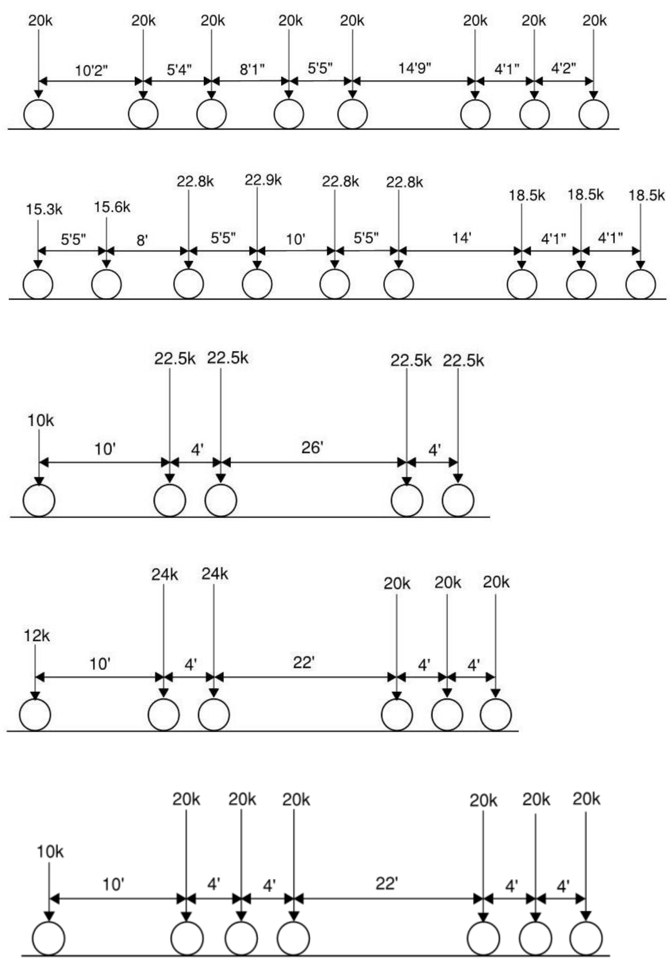


EV2 (57.5k)



EV3 (86k)

Figure 6.5-3. Emergency Vehicles (Showing Axle Loads)



SC Crane #544726 (160k)

SC Crane # 527568 (177.7k)

SC – 100k Permit Truck

SC – 120k Permit Truck

SC – 130k Permit Truck

Figure 6.5-4. Permit Trucks (Showing Axle Loads)

6.6 WIND LOADS

Wind loads are not normally considered in load rating unless special circumstances justify otherwise. However, the effects of wind load on special structures such as movable bridges, long-span bridges, and other high-level bridges should be considered in accordance with applicable standards (AASHTO LRFD Bridge Design Specifications and ASCE 7, Latest Edition)

6.7 IMPACT AND LIVE LOAD TRANSVERSE DISTRIBUTION

6.7.1 Impact

The live load impact used for rating the Design Live Load and the Legal Live Load shall be as specified in the MBE. Section 6, "Part A" shall be used for the determination of the impact when using the LRFR method, and Section 6, "Part B" shall be used for the determination of the impact when using the ASR and LFR methods. SCDOT does not allow the use of the reduced impact allowance (Dynamic Load Allowance) in Table C6A.4.4.3-1 of the MBE unless authorized by the State Bridge Maintenance Engineer or designated representative.

For live load impact applied to Permit Loads, see Section 6.10 of this guidance document.

6.7.2 Live Load Transverse Distribution

The transverse live load distribution used for rating shall be as specified in the MBE, Section 6, "Part A" for the LRFR method and Section 6, "Part B" for the ASR and LFR methods.

Sections 6A.3.2 and 6A.3.3 of the MBE refer to "refined" and "approximate" methods of analysis for transverse live load distribution. When a refined method of analysis is used for the transverse distribution of live load, the truck and lane load shall be positioned to maximize the force effect being analyzed. Positioning of the truck and uniform lane load within a design lane or adjacent lane is illustrated in Figure 6.7.2-1 for roadway widths greater than 24 feet when using the LRFR method. The live load positioning in this figure also pertains to application of the HS20-44 vehicle, with the exception that the truck and lane would be rated separately. Positioning of truck and uniform lane loads for roadway widths less than 24 feet shall be as directed in the MBE.

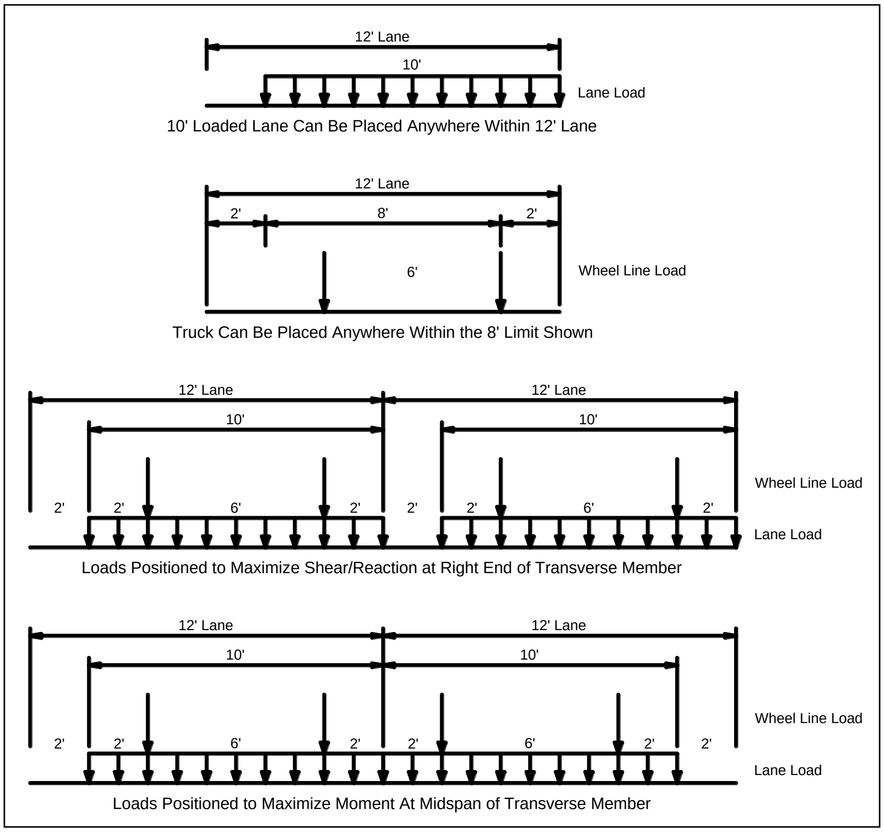


Figure 6.7.2-1. Examples of Live Load Positioning Using the LRFR Method

6.8 MATERIAL PROPERTIES FOR LOAD RATING

The material properties used for the ratings of all structures shall be based on the material grade or design stresses specified in the plans or information in the SCDOT Standard Specifications for Construction for the year the bridge was built. In the absence of information in the standard specifications, information in the plans, or if the plans do not specify the material grades or design stresses, then the load rater must use other means to determine the appropriate material properties based on the information available. Typically, this information is based on the year the bridge was constructed and/or designed and can be found in the MBE, Section 6. Also, if the edition of the AASHTO bridge design specification used for design of the bridge is noted in the plans, this reference can provide useful information that could be used in determining the material properties or in helping to verify the material properties obtained from another source.

The following values should be used by the load rater for the materials noted below unless otherwise shown in the design plans, or known by other means.

6.8.1 Structural Steel (Yield Strengths)

When the yield strengths of steel are unknown or cannot be determined from other sources, yield strengths shall be taken from MBE Table 6A.6.2.1-1 or from the "date built" column of MBE Tables 6B 5.2.1-1 to 6B 5.2-1-4.

For unknown yield strength of steel bridges built after 2006, the yield strength of steel shall be assumed to be 50 ksi. For all weathering steel bridges, regardless of age, the yield strength shall be assumed to be 50 ksi.

6.8.2 Steel Rivets

For values for steel rivets, refer to the MBE, Table 6A.6.12.5.1-1.

6.8.3 Reinforcing Steel

When the yield strengths of reinforcing steel are unknown or cannot be determined from other sources, yield strengths shall be taken from MBE Table 6A.5.2.2-1, except unknown yield strength for reinforcing steel used in bridges constructed after the year 2000 shall be assumed to have a yield strength of 60.0 ksi

6.8.4 Prestressing Steel

Where the tensile strength of the prestressing strand is unknown, the values specified in the MBE, Table 6A.5.2.3-1, based on the date of construction may be used. For bridges built before 2006, Stress-relieved strands should be assumed when strand type is unknown. For bridges built after 2006, low relaxation strand should be assumed when strand type is unknown.

6.8.5 Concrete

For reinforced concrete components where the minimum compressive strength of the concrete is unknown or cannot be determined by other means, f'c for reinforced concrete components for bridges built before the year 2006 may be taken as given in Table 6A.5.2.1-1 of the MBE considering the date of construction. For bridges built after 2006, the minimum compressive strength may be assumed to be 4.0 ksi in accordance with the SCDOT BDM.

For prestressed concrete components where the minimum compressive strength of the concrete is unknown, the minimum compressive strength, f'c, shall be assumed to be 3.125 ksi (2.5 ksi x 1.25%) for bridges built before the year 2000. For bridges built after 2000, the minimum compressive strength shall be assumed to be 5.0 ksi.

6.8.6 Timber

The values for timber are as follows:

Prior to Year 1972 – See Table 1.10.1 of the 1972 AASHTO Interims. For reference purposes, a copy of the 1972 AASHTO Table 1.10.1 is provided in Appendix A6.1.

Year 1972 to October 2010 – Refer to the latest edition of the AASHTO Standard Specifications for Highway Bridges.

After October 2010 – Refer to the current edition of the AASHTO LRFD Bridge Design Specifications, Table 8.4.1.1.4-1, for stress limits.

6.9 INVENTORY AND OPERATING RATING METHODS

6.9.1 ASR and LFR Methods

The HS20-44 live load (truck and lane load) shall be used as the Rating Live Load (see Section 6.5). The truck and lane load shall be rated at the Inventory and Operating Levels.

The structure shall also be rated for the AASHTO Legal Loads and the AASHTO or SCDOT Special Hauling Vehicles and Emergency Vehicles described in Section 6.5 at the Operating Level.

For spans over 200 feet in length, the Legal Loads shall be rated according to the MBE, Article 6B.7.2.

All bridges are required to be rated for permit loads as described in Section 6.5 and shall be performed at the Operating Level.

All ratings shall be expressed in terms of rating factors for all vehicle types rounded to the nearest two decimal places.

6.9.2 LRFR Method

The HL-93 vehicle shall be used as the Design Live Load (see Section 6.5) and shall be rated at the Inventory and Operating Levels.

Although the MBE does not require load ratings of legal loads if the HL-93 Inventory Rating Factor is greater than 1.0, the structure shall also be rated for the Legal Vehicles at the Operating Level as described in Section 6.5.

All bridges are required to be rated for permit vehicles at the Operating level as described in Section 6.5.

All ratings shall be expressed in terms of rating factors for all vehicle types rounded to the nearest two decimal places.

6.9.3 When to Use ASR, LFR, or LRFR

Bridges designed by ASD will be rated using LFR, except for timber and masonry bridges, which will be rated using ASR.

Bridges designed by ultimate strength will be rated using LFR.

Bridges designed by LRFD will be rated with LRFR.

6.9.4 When to Use Field Evaluation and Documented Engineering Judgment

Field evaluation and documented engineering judgment can be used in Operating and Inventory Ratings when the following criteria are satisfied:

- Plans are not available for reinforced/prestressed concrete structures.
- Severe deterioration is found in superstructure (includes reinforced/prestressed concrete, steel, and timber superstructures) or substructures. To use this method, the superstructure/substructure condition rating shall not be higher than three.

Documentation of engineering judgment must include rating calculations for the critical locations. These calculations are a baseline that should be used to explain how engineering judgment was used to determine the load ratings. All reasonable efforts should be taken to base the Inventory and Operating Ratings on calculated values.

6.10 PERMIT LOAD ANALYSIS

6.10.1 Permit Trucks

Rating of Permit Loads is required for bridges.

All Permit Loads are to be analyzed for the permit load mixed with other traffic on the roadway cross section. Full impact shall be assumed for the permit vehicle. If the resulting rating factor is below 1.0, a reduced impact factor may be considered with appropriate speed reductions upon approval of the State Bridge Maintenance Engineer or designated representative.

6.11 LOAD FACTORS, CONDITION FACTORS, AND SYSTEM FACTORS

6.11.1 Load Factors

6.11.1.1 ASR and LFR Methods

There are no load factors associated with the ASR method. For the LFR method, the load factors specified in the MBE should be used.

6.11.1.2 LRFR Method

For the LRFR method, the load factors shown in the MBE shall be used.

The ADTT used to select the live load factors shall be taken from the Structure Inventory and Appraisal (SI&A) Sheet. The value should be obtained using the following equation:

ADTT = ADT*(% Truck/100)
Where ADT is Item 29 and % Truck is Item 109 on the SI&A Sheet

If the bridge is one directional, the calculated value is for one direction. However, if the bridge is two directional, it should be assumed that 55 percent of the total traffic is one directional, unless known otherwise. The 55 percent assumption is taken from the AASHTO LRFD Bridge Design Specifications, Article C3.6.1.4.2. The calculated ADTT needs to be converted to a single lane value by use of the appropriate factor from the AASHTO LRFD Bridge Design Specifications, Table 3.6.1.4.2-1.

If the ADTT is unknown, the most conservative value in the table should be used. Linear interpolation is permitted for determining the appropriate load factor.

Per Article 6A.4.5.4.2c of the MBE, the load factors as given in Table 6A.4.5.4.2a-1 shall be increased when using a refined analysis.

6.11.2 Condition Factors

6.11.2.1 ASR and LFR Methods

Not applicable.

6.11.2.2 LRFR Method

The condition factor provides a reduction to account for the increased uncertainty in the resistance of deteriorated members and the likely increased future deterioration of these members during the period between inspection cycles.

The condition factor for new bridges shall be taken as 1.0. Other Condition Factors are presented in the MBE, Table 6A.4.2.3-1.

Note that the Condition Factor is not a means to account for actual losses or deterioration. The actual losses and/or deterioration need to be accounted for in the rating prior to applying the Condition Factor. The use of the Condition Factor is optional based on the engineer’s judgment.

6.11.3 System Factors

6.11.3.1 ASR and LFR Methods

Not applicable.

6.11.3.2 LRFR Method

System factors that correspond to the load factor modifiers in the AASHTO LRFD Bridge Design Specifications should be used for bridges designed by the LRFD method (that is $\varphi_s=1/(\eta_D*\eta_R)$. The system factors listed in Table 6A.4.2.4-1 of the MBE are more conservative than the LRFD design values and may be used at the discretion of the rating engineer until they are modified in the AASHTO LRFD

Bridge Design Specifications. A rating factor slightly less than 1.0 for a new bridge caused by this practice is considered acceptable with the concurrence of the State Bridge Maintenance Engineer or designated representative. However, when rating non-redundant superstructures for legal loads using the generalized factors in Article 6A.4.4.2.3 of the MBE, Table 6A.4.2.4-1 of the MBE shall be used to maintain an adequate level of system safety.

6.12 LOAD TESTING

Load testing on a case-by case basis may be considered when certain conditions exist that make conventional methods of analysis less reliable and is subject to approval by the State Bridge Maintenance Engineer or designated representative. Specific situations that may lead to load testing are as follows:

1. Deterioration is difficult to quantify.
2. Conventional analysis methods are difficult to apply to a unique structural configuration.
3. There is a public need to allow larger vehicles to cross a bridge than the conventional analysis will allow.

APPENDIX A.6-1: 1972 AASHTO TABLE 1.10.1

Table 1.10.1 Allowable Unit Stresses for Structural Lumber — Visually Graded
(The allowable unit stresses below are for normal loading conditions. See other provisions of Article 1.10.1 for adjustments of these tabulated allowable unit stresses)

Note: This represents only a partial listing of available species and grades. For a complete listing see the Supplement to 1971 Edition of "National Design Specification for Stress Grade Lumber and its Fastenings", NFPA

Species and commercial grade	Size classification	Allowable unit stress in pounds per square inch [1]						Modulus of elasticity "E"	Grading rules agency
		Extreme fiber in bending "F_b"		Tension parallel to grain "F_t"	Horizontal shear "F_v"	Compression perpendicular to grain "$F_{c\perp}$"	Compression parallel to grain "F_c"		
		Engineered uses (single)	Repetitive-member uses						
CALIFORNIA REDWOOD (Surfaced dry, Used at 19% max. m.c.)									Redwood Inspection Service
Clear Heart Structural	4" and less thick any width	2300	—	1550	145	425	2150	1,400,000	
Clear Structural		2300	—	1550	145	425	2150	1,400,000	
Select Structural	4" and less thick and wide	2050	—	1200	100	425	1500	1,400,000	
No. 1		1700	—	1000	100	425	1250	1,400,000	
No. 2		1400	—	800	80	425	1000	1,300,000	
No. 3		800	—	450	80	425	600	1,100,000	
Select Structural	4" and less thick 6" to 12" wide	1750	—	1200	100	425	1450	1,400,000	
No. 1		1500	—	1000	100	425	1250	1,400,000	
No. 2		1200	—	800	80	425	1000	1,300,000	
No. 3		700	—	450	80	425	600	1,100,000	
DOUGLAS FIR-LARCH (Surfaced dry or surfaced green. Used at 19% max. m.c.)									West Coast Lumber Inspection Bureau and Western Wood Products Association (see footnotes 2 through 9)
Dense Select Structural	2" to 4" thick 2" to 4" wide	2450	—	1400	95	455	1850	1,900,000	
Select Structural		2100	—	1200	95	385	1600	1,800,000	
Dense No. 1		2050	—	1200	95	455	1450	1,900,000	
No. 1		1750	—	1050	95	385	1250	1,800,000	
Dense No. 2		1700	—	1000	95	455	1150	1,700,000	
No. 2		1450	—	850	95	385	1000	1,700,000	
No. 3		800	—	475	95	385	600	1,500,000	
Dense Select Structural	2" to 4" thick 6" and wider	2100	—	1400	95	455	1650	1,900,000	
Select Structural		1800	—	1200	95	385	1400	1,800,000	
Dense No. 1		1800	—	1200	95	455	1450	1,900,000	
No. 1		1500	—	1000	95	385	1250	1,800,000	
Dense No. 2		1450	—	950	95	455	1250	1,700,000	
No. 2		1250	—	825	95	385	1050	1,700,000	
No. 3		750	—	475	95	385	675	1,500,000	

33

Table No. 1.10.1 (cont'd)

Species and commercial grade	Size classification	Allowable unit stress in pounds per square inch [1]: Extreme fiber in bending "F_b": Engineered uses (single)	Extreme fiber in bending "F_b": Repetitive-member uses	Tension parallel to grain "F_t"	Horizontal shear "F_v"	Compression perpendicular to grain "$F_{c\perp}$"	Compression parallel to grain "F_c"	Modulus of elasticity "E"	Grading rules agency
Dense Select Structural	Beams and Stringers	1900	— —	1100	85	455	1300	1,700,000	West Coast Lumber Inspection Bureau (see footnotes 2 through 9)
Select Structural		1600	— —	950	85	385	1100	1,600,000	
Dense No. 1		1550	— —	775	85	455	1100	1,700,000	
No. 1		1350	— —	675	85	385	925	1,600,000	
Dense Select Structural	Posts and Timbers	1750	— —	1150	85	455	1400	1,700,000	
Select Structural		1500	— —	1000	85	385	1200	1,600,000	
Dense No. 1		1400	— —	950	85	455	1200	1,700,000	
No. 1		1200	— —	825	85	385	1000	1,600,000	
Select Dex	Decking	1750	2000	— —	— —	385	— —	1,800,000	
Commercial Dex		1450	1650	— —	— —	385	— —	1,800,000	
Dense Select Structural	Beams and Stringers	1900	— —	1250	85	455	1300	1,700,000	Western Wood Products Association (see footnotes 2 through 11)
Select Structural		1600	— —	1050	85	385	1100	1,600,000	
Dense No. 1		1550	— —	1050	85	455	1100	1,700,000	
No. 1		1350	— —	900	85	385	925	1,600,000	
Dense Select Structural	Post and Timbers	1750	— —	1150	85	455	1350	1,700,000	
Select Structural		1500	— —	1000	85	385	1150	1,600,000	
Dense No. 1		1400	— —	950	85	455	1200	1,700,000	
No. 1		1200	— —	825	85	385	1000	1,600,000	
Selected Decking	Decking	— —	2000	— —	— —			1,800,000	
Commercial Decking		— —	1650	— —	— —			1,700,000	
Selected Decking	Decking	— —	2150	— —	— —	(Stresses apply at 15% moisture content)		1,900,000	
Commercial Decking		— —	1800					1,700,000	
EASTERN HEMLOCK – TAMARACK (Surfaced dry or surfaced green. Used at 19% max. m.c.)									Northeastern Lumber Manufacturer Association or Northern Hardwood and Pine Manufacturers Association (see footnotes 2 through 9)
Select Structural	2" to 4" thick 2" to 4" wide	1800	— —	1050	85	365	1350	1,300,000	
No. 1		1500	— —	900	85	365	1050	1,300,000	
No. 2		1250	— —	725	85	365	850	1,100,000	
No. 3		700	— —	400	85	365	525	1,000,000	
Select Structural	2" to 4" thick 6" and wider	1550	— —	1050	85	365	1200	1,300,000	
No. 1		1300	— —	875	85	365	1050	1,300,000	
No. 2		1050	— —	700	85	365	900	1,100,000	
No. 3		625	— —	400	85	365	575	1,000,000	

34

Table No. 1.10.1 (cont'd)

Species and commercial grade	Size classification	Allowable unit stress in pounds per square inch [1]: Extreme fiber in bending "F_b": Engineered uses (single)	Extreme fiber in bending "F_b": Repetitive-member uses	Tension parallel to grain "F_t"	Horizontal shear "F_v"	Compression perpendicular to grain "$F_{c\perp}$"	Compression parallel to grain "F_c"	Modulus of elasticity "E"	Grading rules agency
Select Structural	Beams and Stringers	1400	––	925	80	365	950	1,200,000	
No. 1		1150	––	775	80	365	800	1,200,000	
Select Structural	Posts and Timbers	1300	––	875	80	365	1000	1,200,000	
No. 1		1050	––	700	80	365	875	1,200,000	
Select	Decking	1500	1700	––	––	––	––	1,300,000	NeLMA
Commercial		1250	1450	––	––	––	––	1,100,000	
EASTERN SPRUCE (Surfaced dry or surfaced green. Used at 19% max. m.c.)									
Select Structural	2" to 4" thick 2" to 4" wide	1500	––	875	65	255	1150	1,400,000	Northeastern Lumber Manufacturer Association or Northern Hardwood and Pine Manufacturers Association
No. 1		1300	––	750	65	255	900	1,400,000	
No. 2		1050	––	625	65	255	700	1,200,000	
No. 3		575	––	325	65	255	425	1,100,000	
Select Structural	2" to 4" thick 6" and wider	1300	––	875	65	255	1000	1,400,000	
No. 1		1100	––	750	65	255	900	1,400,000	
No. 2		900	––	600	65	255	750	1,200,000	
No. 3		525	––	325	65	255	475	1,100,000	
Select	Decking	1250	1450					1,400,000	
Commercial		1050	1200					1,200,000	
ENGELMANN SPRUCE (Engelmann Spruce - Lodgepole Pine) (Surfaced dry or surfaced green. Used at 19% max. m.c.)									
Selected Decking	Decking	––	1300					1,200,000	Western Wood Products Association
Commercial Decking		––	1100					1,100,000	
Selected Decking	Decking	––	1400	(Stresses apply at 15% moisture content)				1,300,000	
Commercial Decking		––	1150					1,200,000	
HEM-FIR (Surfaced dry or surfaced green. Used at 19% max. m.c.)									
Select Structural	2" to 4" thick 2" to 4" wide	1650	––	975	75	245	1300	1,500,000	West Coast Lumber Inspection Bureau and Western Wood Products Association (see footnotes 2 through 9)
No. 1		1400	––	825	75	245	1000	1,500,000	
No. 2		1150	––	675	75	245	800	1,400,000	
No. 3		625	––	375	75	245	500	1,200,000	
Select Structural	2" to 4" thick 6" and wider	1400	––	950	75	245	1150	1,500,000	
No. 1		1200	––	800	75	245	1000	1,500,000	
No. 2		1000	––	650	75	245	850	1,400,000	
No. 3		575	––	375	75	245	550	1,200,000	

35

Table No. 1.10.1 (cont'd)

Species and commercial grade	Size classification	Allowable unit stress in pounds per square inch: Extreme fiber in bending "F_b" – Engineered uses (single)	Extreme fiber in bending "F_b" – Repetitive-member uses	Tension parallel to grain "F_t"	Horizontal shear "F_v"	Compression perpendicular to grain "$F_{c\perp}$"	Compression parallel to grain "F_c"	Modulus of elasticity "E"	Grading rules agency
Select Structural No. 1	Beams and Stringers	1250 1000	-- --	750 525	70 70	245 245	900 750	1,400,000 1,400,000	West Coast Lumber Inspection Bur. (see footnotes 2 through 9)
Select Structural No. 1	Posts and Timbers	1200 975	-- --	800 650	70 70	245 245	950 850	1,400,000 1,400,000	
Select Dex Commercial Dex	Decking	1400 1150	1600 1300	-- --	-- --	245 245	-- --	1,500,000 1,400,000	
Select Structural No. 1	Beams and Stringers	1250 1050	-- --	850 700	70 70	245 245	900 775	1,400,000 1,400,000	Western Wood Products Association (see footnotes 2 through 11)
Select Structural No. 1	Posts and Timbers	1200 975	-- --	800 650	70 70	245 245	950 850	1,400,000 1,400,000	
Selected Decking Commercial Decking	Decking	-- --	1600 1300					1,500,000 1,400,000	
Selected Decking Commercial Decking	Decking	-- --	1750 1450			(Stresses apply at 15% moisture content)		1,600,000 1,500,000	
IDAHO WHITE PINE (Surfaced dry or surfaced green. Used at 19% max. m.c.)									
Selected Decking Commercial Decking	Decking	-- --	1400 1150					1,400,000 1,300,000	Western Wood Products Association
Selected Decking Commercial Decking	Decking	-- --	1500 1250			(Stresses apply at 15% moisture content)		1,500,000 1,300,000	
LODGEPOLE PINE (Surfaced dry or surfaced green. Used at 19% max. m.c.)									
Selected Decking Commercial Decking	Decking	-- --	1450 1200					1,300,000 1,200,000	Western Wood Products Association
Selected Decking Commercial Decking	Decking	-- --	1550 1300			(Stresses apply at 15% moisture content)		1,400,000 1,200,000	
NORTHERN PINE (Surfaced dry or surfaced green. Used at 19% max. m.c.)									
Select Structural No. 1 No. 2 No. 3	2" to 4" thick 6" and wider	1400 1200 950 575	1600 1400 1100 650	950 800 650 375	70 70 70 70	280 280 280 280	1100 975 825 525	1,400,000 1,400,000 1,300,000 1,100,000	Northeastern Lumber Manufacturers Association and Northern Hardwood and Pine Manufacturers Association
Select Structural No. 1	Beams and Stringers	1250 1050	-- --	850 700	65 65	280 280	800 725	1,300,000 1,300,000	

36

Table No. 1.10.1 (cont'd)

Species and commercial grade	Size classification	Allowable unit stress in pounds per square inch: Extreme fiber in bending "F_b": Engineered uses (single)	Extreme fiber in bending "F_b": Repetitive-member uses	Tension parallel to grain "F_t"	Horizontal shear "F_v"	Compression perpendicular to grain "$F_{c\perp}$"	Compression parallel to grain "F_c"	Modulus of elasticity "E"	Grading rules agency
Select Structural	Posts and Timbers	1150	—	800	65	280	900	1,300,000	(see footnotes 2 through 9)
No. 1		950	—	650	65	280	800	1,300,000	
Select	Decking	1350	1550					1,400,000	NeLMA
Commercial		1150	1300					1,300,000	
PONDEROSA PINE – SUGAR PINE (Ponderosa Pine - Lodgepole Pine) (Surfaced dry or surfaced green. Used at 19% max. m.c.)									
Selected Decking	Decking	—	1350					1,200,000	Western Wood Products Association
Commercial Decking		—	1150					1,100,000	
Selected Decking	Decking	—	1450	(Stresses apply at 15% moisture content)				1,300,000	
Commercial Decking		—	1250					1,100,000	
RED PINE (Surfaced dry or surfaced green. Used at 19% max. m.c.)									
Select Structural	2" to 4" thick 6" and wider	1200	1350	800	70	280	900	1,300,000	National Lumber Grades Author. (A Canadian agency. See footnotes 2 through 8 and 12)
No. 1		1100	1150	675	70	280	825	1,300,000	
No. 2		825	950	550	70	280	675	1,200,000	
No. 3		500	550	325	70	280	425	1,000,000	
Select Structural	Beams and Stringers	1050	—	625	65	280	725	1,100,000	
No. 1 Structural		875	—	450	65	280	600	1,100,000	
Select Structural	Posts and Timbers	1000	—	675	65	280	775	1,100,000	
No. 1 Structural		800	—	550	65	280	675	1,100,000	
Select	Wall and Roof Plank	1150	1350			280		1,300,000	
Commercial		975	1100			280		1,300,000	
SITKA SPRUCE (Surfaced dry or surfaced green. Used at 19% max. m.c.)									West Coast Lumber Inspection Bur.
Select Dex	Decking	1300	1500	—	—	280	—	1,500,000	
Commercial Dex		1100	1250	—	—	280	—	1,300,000	
SOUTHERN PINE (Surfaced dry. Used at 19% max. m.c.)									
Selected Structural	2" to 4" thick 2" to 4" wide	2100	—	1250	90	405	1600	1,800,000	Southern Pine Inspection Bureau
Dense Select Structural		2450	—	1450	90	475	1850	1,900,000	
No. 1		1750	—	1000	90	405	1250	1,800,000	
No. 1 Dense		2050	—	1200	90	475	1450	1,900,000	
No. 2		1250	—	725	75	345	850	1,400,000	
No. 2 Medium Grain		1450	—	850	90	405	1000	1,600,000	

37

Table No. 1.10.1 (cont'd)

Species and commercial grade	Size classification	Allowable unit stress in pounds per square inch: Extreme fiber in bending "F_b" – Engineered uses (single)	Extreme fiber in bending "F_b" – Repetitive-member uses	Tension parallel to grain "F_t"	Horizontal shear "F_v"	Compression perpendicular to grain "$F_{c\perp}$"	Compression parallel to grain "F_c"	Modulus of elasticity "E"	Grading rules agency
No. 2 Dense	2" to 4" thick 2" to 4" wide	1700	—	1000	90	475	1150	1,700,000	Southern Pine Inspection Bureau
No. 3		825	—	475	75	345	600	1,400,000	
No. 3 Dense		950	—	550	90	475	700	1,500,000	
Select Structural	2" to 4" thick 6" and wider	1800	—	1200	90	405	1400	1,800,000	
Dense Select Structural		2100	—	1400	90	475	1650	1,900,000	
No. 1		1500	—	1000	90	405	1250	1,800,000	
No. 1 Dense		1800	—	1200	90	475	1450	1,900,000	
No. 2		1050	—	700	75	345	900	1,400,000	
No. 2 Medium grain		1250	—	825	90	405	1050	1,600,000	
No. 2 Dense		1450	—	975	90	475	1250	1,700,000	
No. 3		725	—	475	75	345	650	1,400,000	
No. 3 Dense		850	—	575	90	475	750	1,500,000	
Dense Std. Factory	2" to 4" thick 2" to 4" wide	2000	—	1200	90	475	1450	1,900,000	
No. 1 Factory		1400	—	825	90	405	1000	1,600,000	
No. 1 Dense Factory		1650	—	975	90	475	1150	1,700,000	
No. 2 Factory		1400	—	825	90	405	1000	1,600,000	
No. 2 Dense Factory		1650	—	975	90	475	1150	1,700,000	
Dense Std. Factory	2" to 4" thick 6" and wider	1750	—	1200	90	475	1450	1,900,000	
No. 1 Factory		1250	—	825	90	405	1050	1,600,000	
No. 1 Dense Factory		1450	—	975	90	475	1250	1,700,000	
No. 2 Factory		1250	—	825	90	405	1050	1,600,000	
No. 2 Dense Factory		1450	—	975	90	475	1250	1,700,000	
Dense Structural 86	2" to 4" thick	2750	—	1850	150	475	2050	1,900,000	
Dense Structural 72		2300	—	1550	125	475	1700	1,900,000	
WESTERN CEDARS (Surfaced dry or surfaced green. Used at 19% max. m.c.)									
Select Dex	Decking	1200	1400	—	—	295	—	1,100,000	West Coast Lumber Inspection Bur.
Commercial Dex		1050	1200	—	—	295	—	1,000,000	
Selected Decking	Decking	—	1400					1,100,000	Western Wood Products Association
Commercial Decking		—	1200					1,000,000	
Selected Decking	Decking	—	1500	(Stresses apply at 15% moisture content)				1,100,000	
Commercial Decking		—	1250					1,000,000	

38

FOOTNOTES FOR TABLE 1.10.1

[1]The allowable unit stresses shown are for selected species and commercial grades. For stresses for other species and commercial grades not shown, the designer is referred to the grading rules of the appropriate grading rules agency.

[2]The recommended design values shown in Table 1.10.1 are applicable to lumber that will be used under dry conditions such as in most covered structures. For 2″ to 4″ thick lumber the DRY surfaced size should be used. In calculating design values, the natural gain in strength and stiffness that occurs as lumber dries has been taken into consideration as well as the reduction in size that occurs when unseasoned lumber shrinks. The gain in load carrying capacity due to increased strength and stiffness resulting from drying more than offsets the design effect of size reductions due to shrinkage. For 5″ and thicker lumber, the surfaced sizes also may be used because design values have been adjusted to compensate for any loss in size by shrinkage which may occur.

[3]Values for "F_b", "F_t", and "F_c" for the grades of Construction and Standard apply only to 4″ widths.

[4]The values in Table 1.10.1 are based on edgewise use. For dimension 2″ to 4″ in thickness, when used flatwise, the recommended design values for fiber stress in bending may be multiplied by the following factors:

Width	Thickness 2″	3″	4″
2″ to 4″	1.10	1.04	1.00
6″ and wider	1.22	1.16	1.11

[5]When 2″ to 4″ thick lumber is manufactured at a maximum moisture content of 15 percent and used in a condition where the moisture content does not exceed 15 percent, the design values shown in Table 1.10.1 may be multiplied by the following factors:

Extreme fiber in bending "F_b"	Tension parallel to grain "F_t"	Horizontal shear "F_v"	Compression perpendicular to grain "$F_{c\perp}$"	Compression parallel to grain "F_c"	Modulus of Elasticity "E"
1.08	1.08	1.05	1.00	1.17	1.05

[6]When 2″ to 4″ thick lumber is designed for use where the moisture content will exceed 19 percent for an extended period of time, the values shown in Table 1.10.1 should be multiplied by the following factors:

Extreme fiber in bending "F_b"	Tension parallel to grain "F_t"	Horizontal shear "F_v"	Compression perpendicular to grain "$F_{c\perp}$"	Compression parallel to grain "F_c"	Modulus of Elasticity "E"
0.86	0.84	0.97	0.67	0.70	0.97

[7]When lumber 5″ and thicker is designed for use where the moisture content will exceed 19 percent for an extended period of time, the values shown in Table 1.10.1 should be multiplied by the following factors:

Extreme fiber in bending "F_b"	Tension parallel to grain "F_t"	Horizontal shear "F_v"	Compression perpendicular to grain "$F_{c\perp}$"	Compression parallel to grain "F_c"	Modulus of Elasticity "E"
1.00	1.00	1.00	0.67	0.91	1.00

39

[8]The tabulated horizontal shear values shown herein are based on the conservative assumption of the most severe checks, shakes or splits possible, as if a plane were split full length. When lumber 4" and thinner is manufactured unseasoned the tabulated values should be multiplied by a factor of 0.92.

Specific horizontal shear values for any grade and species of lumber may be established by use of the following tables when the length of split or check is known:

When length of split is:	Multiply tabulated "F_v" value by: (Nominal 2" Lumber)
No split	2.00
1/2 x wide face	1.67
3/4 x wide face	1.50
1 x wide face	1.33
1-1/2 x wide face or more	1.00

When length of split on wide face is:	Multiply tabulated "F_v" value by: (3" and Thicker Lumber)
No split	2.00
1/2 x narrow face	1.67
1 x narrow face	1.33
1-1/2 x narrow face or more	1.00

[9]Stress rated boards of nominal 1", 1-1/4" and 1-1/2" thickness, 2" and wider, are permited the recommended design values shown for Select Structural, No. 1, No. 2 and No. 3 grades as shown in 2" to 4" thick, 2" to 4" wide and 2" to 4" thick, 6" and wider categories when graded in accordance with those grade requirements.

[10]For species combinations shown in parentheses, the lowest design values for any species in the combination are tabulated.

[11]When "MC15" Decking is used where the moisture content will exceed 15 percent for an extended period of time, the design values tabulated to apply at 15 percent moisture content should be multiplied by the following factors: Extreme Fiber in Bending "F_b" - 0.79; Modulus of Elasticity "E" - 0.92.

[12]National Lumber Grades Authority is the Canadian rules-writing agency responsible for preparation, maintenance and dissemination of a uniform softwood lumber grading rule for all Canadian species.

Insert new Table 1.10.1A.

40

Table 1.10.1A. Allowable Unit Stresses for Structural Glued Laminated Timber, Members Stressed Principally in Bending, Loaded Perpendicular to the Wide Face of the Laminations[1 2 3] (Stresses shown below are for normal conditions of loading. See other provisions of Article 1.10.1 for adjustments of these tabulated allowable unit stresses.)

(1) Douglas Fir and Western Larch

		Allowable unit stresses					
					Compression ⊥ to Grain		
Combination Symbol	Number of Laminations	Extreme Fiber in Bending F_b[4 5]	Tension Parallel to Grain F_t	Compression Parallel to Grain F_c	Tension Face $F_{c\perp}$	Compression Face $F_{c\perp}$	Horizontal Shear F_v
DRY CONDITIONS OF USE E = 1,800,000 psi							
22F	4-10	2200	1600	1500	410	410	165
	4-10	2200	1600	1500	450	385	165
	11-20	2200	1600	1500	450	385	165
	21-30	2200	1600	1500	450	385	165
	31-40	2200	1600	1500	450	385	165
	41 or more	2200	1600	1500	450	385	165
24F	4-10	2400	1600	1500	450	385	165
	11-20	2400	1600	1500	450	385	165
	21-25	2400	1600	1500	450	385	165
	26-35	2400	1600	1500	450	385	165
	36-40	2400	1600	1500	450	385	165
	41 or more	2400	1600	1500	450	385	165
Note:	The 26F combination may not be readily available and the designer should check on availability prior to specifying. The 22F and 24F combinations are generally available from all laminators.						
26F	4-8	2600	1600	1500	450	410	165
	9-20	2600	1600	1500	450	410	165
	21-25	2600	1600	1500	450	410	165
	26-30	2600	1600	1500	450	410	165
	31-34	2600	1600	1500	450	410	165
	35-40	2600	1600	1500	450	410	165
	41 or more	2600	1600	1500	450	410	165
WET CONDITIONS OF USE E = 1,600,000 psi							
22F	4-10	1600	1300	1100	275	275	145
	4-10	1600	1300	1100	305	260	145
	11-20	1600	1300	1100	305	260	145
	21-30	1600	1300	1100	305	260	145
	31-40	1600	1300	1100	305	260	145
	41 or more	1600	1300	1100	305	260	145
24F	4-10	1800	1300	1100	305	260	145
	11-20	1800	1300	1100	305	260	145
	21-25	1800	1300	1100	305	260	145
	26-35	1800	1300	1100	305	260	145
	36-40	1800	1300	1100	305	260	145
	41 or more	1800	1300	1100	305	260	145
Note:	The 26F combination may not be readily available and the designer should check on availability prior to specifying. The 22F and 24F combinations are generally available from all laminators.						
26F	4-8	2000	1300	1100	305	275	145
	9-20	2000	1300	1100	305	275	145
	21-25	2000	1300	1100	305	275	145
	26-30	2000	1300	1100	305	275	145
	31-34	2000	1300	1100	305	275	145
	35-40	2000	1300	1100	305	275	145
	41 or more	2000	1300	1100	305	275	145

Table No. 1.10.1A (cont'd)

(2) Southern Pine

Combination Symbol		Number of Laminations	Allowable Unit Stresses: Extreme Fiber in Bending F_b [4 5 6]	Tension Parallel to Grain F_t	Compression Parallel to Grain F_c	Compression Perpendicular to Grain F_c	Horizontal Shear F_v
DRY CONDITIONS OF USE E = 1,800,000 psi							
18F	1	4 or more	1800	1600	1500	385	200
	2	12 or more	1800	1600	1500	385	200
20F	1	10 or more[9]	2000	1600	1500	385	200
	2	10 or more	2000	1600	1500	385	200
22F	1	6 or more[9]	2200	1600	1500	450	200
	2	14 or more	2200	1600	1500	385	200
	3	18 or more	2200	1600	1500	385	200
24F	1	4 or more	2400	1600	1500	385	200
	2	12 or more	2400	1600	1500	450	200
	3	9 or more	2400	1600	1500	385	200
Note: The 26F combination may not be readily available and the designer should check on availability prior to specifying. Other combinations listed are generally available from all laminators.							
26F	1	9 or more[7 8]	2600	1600	1500	385	200
	2	14 or more	2600	1600	1500	450	200
	3	13 or more	2600	1600	1500	450	200
WET CONDITIONS OF USE E = 1,600,000 psi							
18F	1	4 or more	1400	1300	1100	260	175
	2	12 or more	1400	1300	1100	260	175
20F	1	10 or more[9]	1600	1300	1100	260	175
	2	10 or more	1600	1300	1100	260	175
22F	1	6 or more[9]	1800	1300	1100	300	175
	2	14 or more	1800	1300	1100	260	175
	3	18 or more	1700	1300	1100	260	175
24F	1	4 or more	1900	1300	1100	260	175
	2	12 or more	2000	1300	1100	300	175
	3	9 or more	1900	1300	1100	260	175
Note: The 26F combination may not be readily available and the designer should check on availability prior to specifying. Other combinations listed are generally available from all laminators.							
26F	1	9 or more[7 8]	2000	1300	1100	260	175
	2	14 or more	2000	1300	1100	300	175
	3	13 or more	2100	1300	1100	300	175

42

FOOTNOTES FOR TABLE 1.10.1A

[1]The tabulated stresses in this table are primarily applicable to members stressed in bending due to a load applied perpendicular to the wide face of the laminations. For combinations and stresses applicable to members loaded primarily axially or parallel to the wide face of the laminations, see Table 1.10.1B.

[2]The tabulated bending stresses are applicable to members 12 inches or less in depth. For members greater than 12 inches in depth, the requirements of Article 1.10.2 on Size Factor apply.

[3]The tabulated combinations are applicable to arches, compression members, tension members and also bending members less than 16-1/4 inches in depth. For bending members 16-1/4 inches or more in depth, footnotes 4 and 5 apply.

[4]The grading restrictions as contained in AITC 301-22, 301-24 and 301-26 tension lamination requirements shall be followed for the outermost tension laminations representing 5% of the total depth of glued laminated bending members 16-1/4 inches or more in depth. For all conditions of use, AITC 301-22 is applicable to combination 22F, AITC 301-24 is applicable to combination 24F and AITC 301-26 is applicable to combination 26F. See Appendix "A" of AITC 203-70 for details of these tension lamination requirements.

[5]In addition to other requirements, the tension laminations as described in AITC 301-22, 301-24 and 301-26 are required to be dense.

[6]The next inner 5% of the outermost tension laminations are to be No. 1 Dense for the same conditions as indicated by footnote number 4.

[7]For fewer than nine (9) laminations, add one No. 1 lamination to each outer zone.

[8]For combination 26F(1), six or fewer laminations, the allowable unit stresses for tension parallel to grain and compression parallel to grain can be increased to 1800 psi and 1600 psi respectively for the dry condition of use and to 1500 psi and 1200 psi respectively for the wet condition of use.

[9]Where fewer laminations are required, a combination with a higher allowable unit stress can be selected.

43

Insert new Table 1.10.1B.

Table 1.10.1B

Allowable Unit Stresses for Structural Glued Laminated Timber, Members Stressed Principally in Axial Tension or Axial Compression, or a combination of Axial Loading Plus Bending Parallel to or Perpendicular to the Wide Face of the Laminations.[1] (Stresses shown below are for normal conditions of loading. See other provisions of Article 1.10.1 for adjustments of these tabulated allowable unit stresses.)

Combination Symbol	Number of Laminations	Tension Parallel to Grain F_t	Compression Parallel to Grain F_c	Extreme Fiber in Bending F When Loaded: Parallel to Wide Face[3]	Extreme Fiber in Bending F When Loaded: Perpendicular to Wide Face[2,4]	Compression Perpendicular to Grain[3] $F_{c\perp}$	Horizontal Shear F_v When Loaded: Parallel to Wide Face[3]	Horizontal Shear F_v When Loaded: Perpendicular to Wide Face[4]
(1) Douglas Fir and Western Larch		DRY CONDITIONS OF USE E = 1,800,000 psi						
1	All	1200	1500	900	1200	385	145	165
2	All	1800	1800	1500	1800	385	145	165
3	All	2200	2100	1900	2200	450	145	165
4	All	2400	2000	2100	2400	410	145	165
5	All	2600	2200	2300	2600	450	145	165
		WET CONDITIONS OF USE E = 1,600,000 psi						
1	All	950	1100	750	950	260	120	145
2	All	1400	1300	1100	1400	260	120	145
3	All	1800	1500	1450	1800	305	120	145
4	All	1900	1450	1500	1900	275	120	145
5	All	2000	1600	1600	2000	305	120	145
(2) Southern Pine		DRY CONDITIONS OF USE E = 1,800,000 psi						
1	All	1600	1400	950	1100	385	165	200
2	All	2200	1900	1700	1800	385	165	200
3	All	2600	2200	2000	2100	450	165	200
4	All	2400	2100	1950	2400	385	165	200
5	All	2600	2200	2300	2600	450	165	200
		WET CONDITIONS OF USE E = 1,600,000 psi						
1	All	1300	1000	750	850	260	145	175
2	All	1800	1400	1350	1450	260	145	175
3	All	2100	1600	1600	1700	300	145	175
4	All	1900	1500	1550	1950	260	145	175
5	All	2100	1600	1850	2100	300	145	175

FOOTNOTES FOR TABLE 1.10.1B

[1] The tabulated stresses in this table are primarily applicable to members loaded axially or parallel to the wide face of the laminations. For combinations and stresses applicable to members stressed principally in bending due to a load applied perpendicular to the wide face of the laminations, see Table 1.10.1A.

[2] It is not intended that these combinations be used for deep bending members, but if bending members 16-1/4 inches or deeper are used, the applicable AITC tension lamination requirements must be followed.

[3] The tabulated stresses are applicable to members containing three (3) or more laminations.

[4] The tabulated stresses are applicable to members containing four (4) or more laminations.

44

CHAPTER 7 REINFORCED CONCRETE DECKS

7.1 INTRODUCTION

This section covers the rating of reinforced concrete decks. A reinforced concrete deck supported by stringers, girders, or floor beams should be rated when inspection results highlight deterioration of the bridge deck that can make the load carrying capacity of the deck questionable.

7.2 POLICIES AND GUIDELINES

When design plans are available, the applicable concrete strength and reinforcing steel yield strength should be used for the load rating analysis. If plans or material information is not available, the values used should be as shown in Section 6.8 this guidance document for the reinforcing steel and for the concrete strength.

Concrete decks shall be rated according to a punching shear analysis based on the remaining thickness of sound concrete. The deck should be assumed to be unreinforced, unless the spacing, size and condition of the deck reinforcing steel can be field verified. While the use of ground penetrating radar could provide the spacing of reinforcing steel, it is not effective for determining the size of reinforcing bars. Based on engineering judgment, the load rater may assume the presence of temperature and shrinkage reinforcing steel, as defined by the AASHTO design code applicable at the time of the bridge design, as a maximum amount of reinforcing steel present when the reinforcing steel size, strength and spacing is unknown.

Wheel loads used for deck load rating shall be the maximum wheel load for the rating vehicles.

CHAPTER 8 TIMBER DECKS

8.1 INTRODUCTION

This section covers the rating of timber decks. Timber decks shall be rated for bending and horizontal shear capacity.

8.2 POLICIES AND GUIDELINES

The ASR method shall be used for timber decks built before October 2010 as there is no LFR method for this type of material. Unless plans show material properties or the material properties are otherwise known, refer to Section 6.8.6 or of this guidance document for material properties.

The LRFR method shall be used for timber bridges built after October 2010. Refer to the AASHTO LRFD Bridge Design Specifications, Table 8.4.1.1.4-1, for stress limits.

Wheel loads used for deck load rating shall be the maximum wheel load for the rating vehicles.

CHAPTER 9 REINFORCED CONCRETE SUPERSTRUCTURES

9.1 INTRODUCTION

This section covers the rating of reinforced concrete girders and longitudinally reinforced concrete slabs. This section does not cover prestressed concrete members. All reinforced concrete girders and reinforced concrete slab bridges shall be rated.

9.2 POLICIES AND GUIDELINES

When design plans are available, the applicable concrete strength and reinforcing steel strength should be used. If material information is not available, the values used should be as shown in Section 6.8 of this guidance document.

9.2.1 Software-Specific SCDOT Policy

9.2.1.1 Supplemental Calculations

Provide supplemental calculations to calculate these items:

- Parapet and railing loads if BrR is not capable of calculating within the program
- Diaphragm weights
- Haunch load
- Deck effective width if BrR is not capable of calculating within the program
- Sign loads (if applicable)
- Utility loads (if applicable)
- Any other loads not calculated internally by BrR

9.2.1.2 BrR Input

SCDOT Policies specific to BrR are as follows:

1. Use Girder Superstructure when inputting into BrR. Link members when girders are of similar geometry and condition state. Members may need to be unlinked at a future time if the condition state for a particular girder changes.
2. Girder property input method should be schedule-based whenever possible.
3. Load Case Distribution: Add Default Load Case Descriptions (DC1, DC2, DW). Add load cases for additional loads not covered in Structure Typical Section.
4. Input diaphragms and loads into Structure Framing Plan Details. Do not input end diaphragms if they are not contributing to loads on girders.
5. For Control Options in BrR, see the screenshot in Figure 9.2.1.2-1.

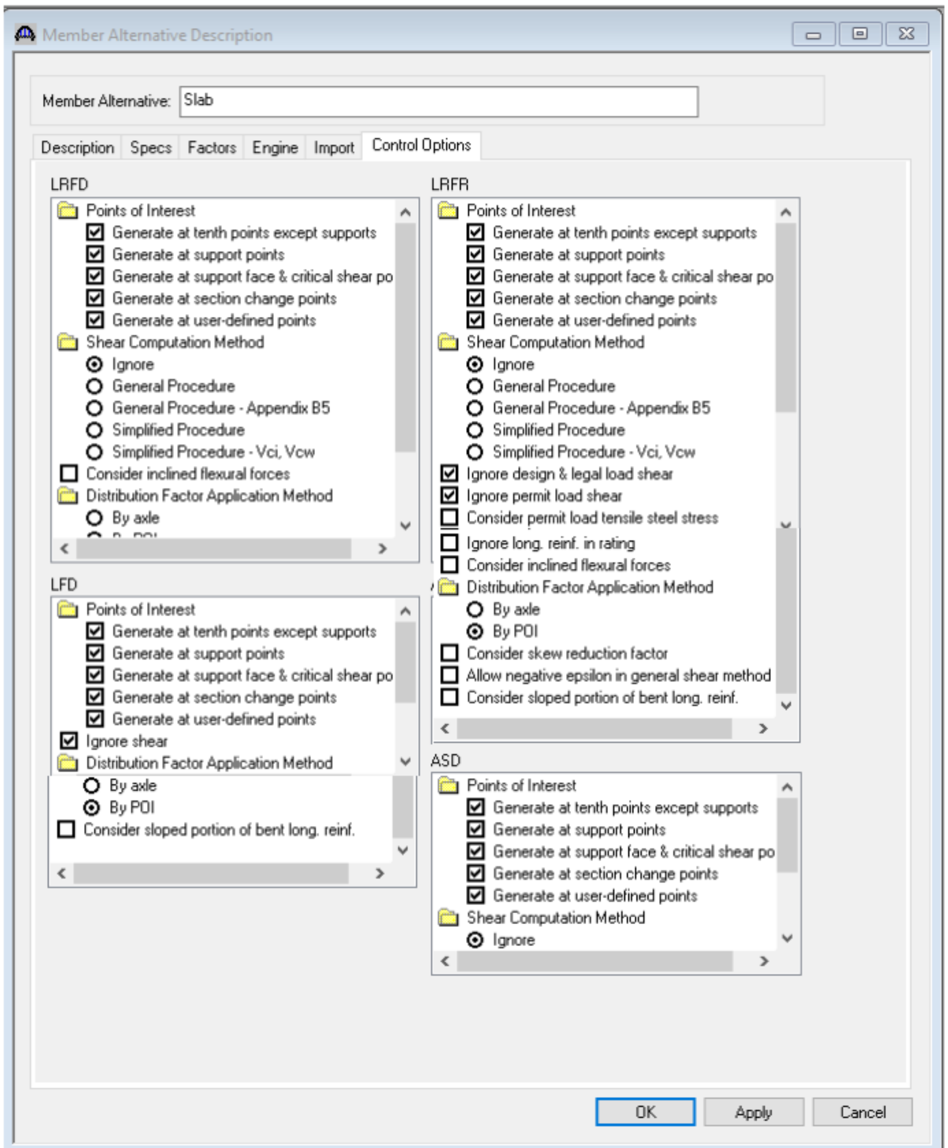


Figure 9.2.1.2-1. Control Options Screenshot from BrR

9.2.2 Reinforced Concrete Slab Bridges

Enter the full slab section width for reinforced concrete slab bridges. The edge girder section is not typically load rated.

9.2.3 Reinforced Concrete Box Beam Bridges

The lane live load distribution factor should be calculated from AASHTO LRFD Bridge Design Specifications Articles 4.6.2.2.2 and 4.6.2.2.3 for an interior girder, multiplied by the number of girders (webs).

All longitudinal reinforcement in the entire bridge, as specified in the bridge plans, shall be used in the bridge analysis model for load capacity ratings.

Negative moment ratings should be determined at the face of the supports. Shear ratings should be determined at a distance "D" from the face of supports where "D" is the effective depth of the section where shear is considered.

9.2.4 Reinforced Concrete T-Beam Bridges

The slab limits for the longitudinal reinforcement in reinforced concrete T-beam bridges shall be contained within the tributary width of the slab for each beam.

Negative moment ratings should be determined at the face of the supports. Shear ratings should be determined at a distance "D" from the face of supports where "D" is the effective depth of the section where shear is considered.

9.2.5 ASR or LFR Method

No exceptions to the MBE should be made.

9.2.6 LRFR Method

No exceptions to the MBE should be made.

CHAPTER 10 PRESTRESSED CONCRETE GIRDER SUPERSTRUCTURE

10.1 INTRODUCTION

This section covers the rating of prestressed concrete girders. All prestressed concrete bridges are to be rated.

10.2 POLICIES AND GUIDELINES

When design plans are available, the applicable concrete strength and prestressing steel strength should be used. If material information is not available, refer to the Section 6.8 of this guidance document, for the appropriate year of construction.

Use the following:

1. Do not use elastic shortening applied to a transformed beam section because the transformed section already accounts for the elastic shortening effect.
2. The dead loads applied to the girder during construction should be applied to the transformed section.
3. Do not use 2n for calculating the stress due to long-term superimposed dead loads. Use “n” for all dead load cases.
4. Design Memorandum DM08/90 dated September 12, 1990 designated the top ¼” of a bridge deck as sacrificial. Design Memorandum DM0196 dated February 14, 1996 increased the top clear cover for bridge decks from 2” to 2 ½”. As per the current SCDOT BDM, the top 2 ½” concrete cover for bridge decks includes ¼” that is sacrificial. The weight of the sacrificial layer shall be included for dead load calculations, but shall not be considered to provide a structural contribution for load rating analysis. When considering effective depths for decks, consider the top 2” as effective for bridges designed before September 12, 1990, the top 1 ¾” as effective for bridges designed between September 12, 1990 and February 14, 1996, and the top 2 ¼” as effective for bridges designed after February 14, 1996 unless otherwise noted on as-built drawings or observed during a field investigation.
5. Multi-span composite prestressed concrete girder bridges may have been designed for one of two conditions:

    - Simple span for both dead load and live load
    - Simple span for dead load and continuous for live load.

    Where a continuity diaphragm exits at interior supports, load rating for prestressed girders shall consider the more critical condition of a fully effective connection at the continuity diaphragm (fully continuous) or complete loss of continuity (simple span).

10.2.1 Software-Specific SCDOT Policy

10.2.1.1 Supplemental Calculations

Provide supplemental calculations to calculate these items:

- Parapet & Railing loads if BrR is not capable of calculating within the program.
- Diaphragm weights
- Haunch Load
- Deck effective width if BrR is not capable of calculating within the program
- Sign Loads (if applicable)
- Utility Loads (if applicable)

- Any other load not calculated internally by BrR

10.2.1.2 BrR Input

SCDOT policies specific to BrR are as follows:

1. Input material properties per as built plans. If material properties are not shown, refer to Section 6.8 of this guidance document for the appropriate year of construction.
2. If available, input actual strand pattern as shown in as-built plans.
3. Use Girder System Superstructure when inputting into BrR. Link members when girders are of similar geometry and condition state. Girder members may need to be unlinked at a future time if the condition state for a particular girder changes.
4. Use an average humidity of 70%.
5. Load Case Description: Add Default Load Case Descriptions (DC1, DC2, DW). Add load cases for additional loads not covered in Structure Typical Section.
6. Input diaphragms and loads into Structure Framing Plan Details. Do not input end diaphragms if they are not contributing to loads on girders.
7. Stress Limits: use default values calculated by BrR, except use 3*√(f`c) psi (0.0949*√(f'c) ksi) for the final allowable tension for LFR. Use the final allowable tension per the SCDOT Bridge Design Manual Memo DM0108 for LRFR based on the location of the bridge.
8. Prestress Properties: Input loss method as "AASHTO Approximate." Input Jacking Stress ratio based on strand type.
9. For Control Options in BrR, see the screenshot in Figure 10.2.1.2-1. For an example Load Case Description input, see Figure 10.2.1.2-2. For Prestressed Concrete Stress Limit input, see figure 10.2.1.2-3.
10. Member Loads: Input miscellaneous member loads not covered in Structure Typical Section input (i.e. haunch weight, sign loads, utility loads).
11. Strand Layout: Input strands using "Strands in rows" unless strand locations are unknown, in which case the prestress force and the center of gravity of the strands should be used. Note: Force entered should be initial force.
12. Define deck profile if girder is structurally composite with deck. (Note that the BrR calculated effective flange width computed from the typical section will potentially produce an incorrect effective flange width if using a narrow top flange section)
13. Do not define the haunch for prestressed girder bridges. Include haunch as a member load, but structural properties should not be used.
14. Do not input deck reinforcement for simple span bridges.
15. Prestressed Girder Shear Reinforcement Ranges: Input shear stirrups and check box "Extends into Deck" if deck and girder are structurally composite.

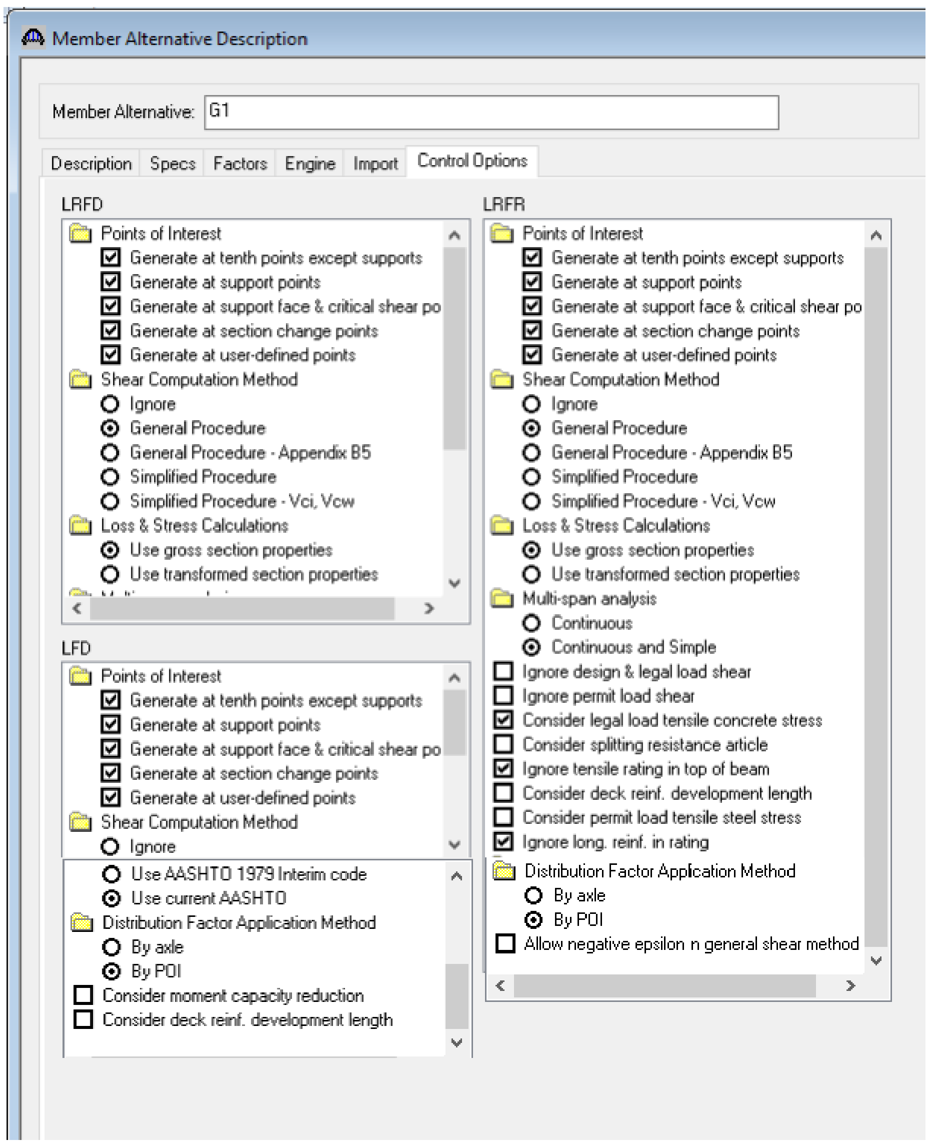
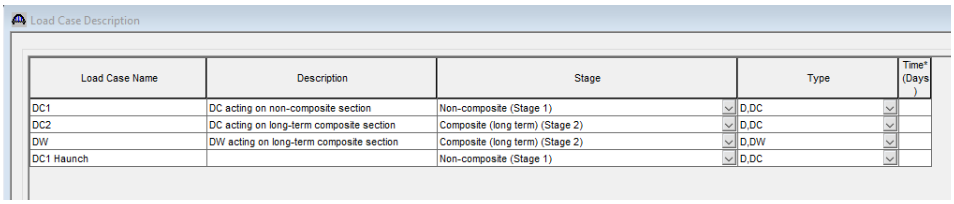


Figure 10.2.1.2-1. Control Options Screenshot from BrR


Load Case Description

Load Case Name	Description	Stage	Type	Time* (Days)
DC1	DC acting on non-composite section	Non-composite (Stage 1)	D,DC	
DC2	DC acting on long-term composite section	Composite (long term) (Stage 2)	D,DC	
DW	DW acting on long-term composite section	Composite (long term) (Stage 2)	D,DW	
DC1 Haunch		Non-composite (Stage 1)	D,DC	

Figure 10.2.1.2-2. Example Load Case Description Input

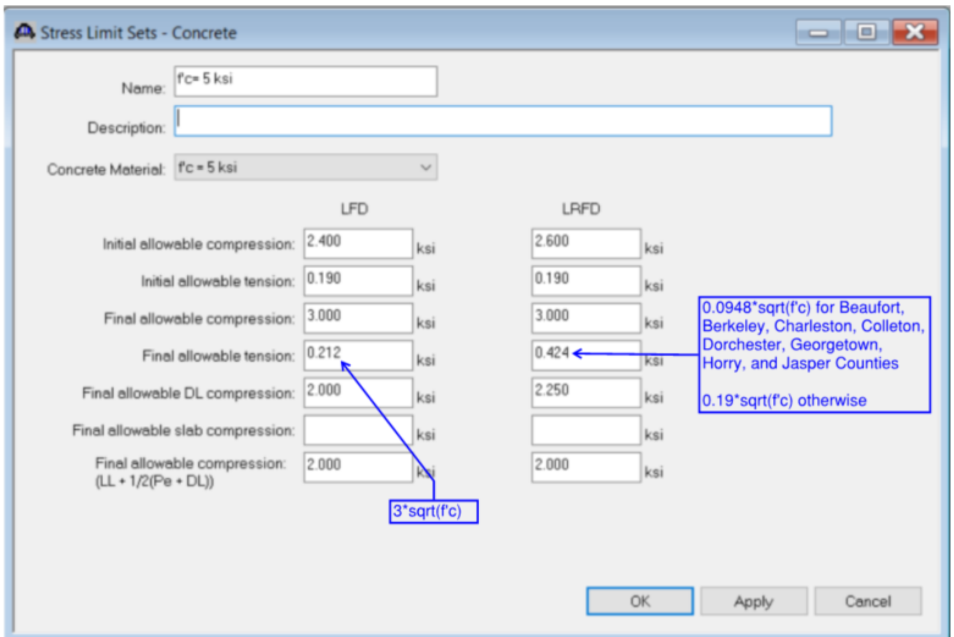


Figure 10.2.1.2-3. Prestressed Concrete Stress Limit Input

10.2.2 ASR or LFR Method

No exceptions to the MBE should be made other than noted above.

10.2.3 LRFR Method

No exceptions to the MBE should be made other than noted above.

CHAPTER 11 STEEL SUPERSTRUCTURES

11.1 INTRODUCTION

This section covers the rating of steel girders. All steel girder and rolled beam bridges shall be rated.

11.2 POLICIES AND GUIDELINES

The plastic capacity of a girder can be used for determining the load capacity. All required checks must be satisfied in the AASHTO specifications before the plastic capacity is allowed.

Girders with shear studs or anchors are considered to be composite with the deck in positive bending regions. Do not consider composite action in negative moment regions.

11.2.1 Analysis and Rating

11.2.1.1 Special Considerations

The following items shall be considered:

1. 3D or grid analysis shall not incorporate top flange or bottom flange lateral bracing members (for example, wind bracing in the plane of the flanges) unless permitted by SCDOT. If lateral bracing members are incorporated into the analysis, they shall be treated as primary members and rated accordingly.
2. Top flanges of “Through Girder” bridges shall be considered unbraced unless it can be shown otherwise by acceptable analysis methods and permitted by SCDOT.
3. In-span hinges shall be rated for bending, shear, and bearing.
4. Bolted splices in fracture critical girders shall be rated.
5. Cross members resisting primary loads shall be rated (e.g. floor beams or cross frames supporting a substringer).
6. As per the SCDOT BDM, the top 2 ½” concrete cover for bridge decks includes ¼” that is considered sacrificial. The weight of the sacrificial layer shall be included for dead load calculations, but shall not be considered to provide a structural contribution for load rating analysis.
7. Fatigue rating is not typically performed.
8. For I-sections in flexure, if plans are not available for the bridge and it is unknown whether the concrete deck is connected to the steel section with shear connectors, the determination of whether composite action may be considered shall be in accordance with MBE Section 6A.6.9.

11.2.1.2 Tangent Girders

Analysis and rating of tangent girders should be performed as follows:

The engineer is responsible for selecting the appropriate analysis method for the bridge being rated. Some analysis methods available include:

- Line girder
- Grid
- 3D analysis

Rate for bending and shear at controlling locations.

11.2.1.3 Curved Girders

Analysis and rating of curved girders should be performed as follows; refer to NCHRP Report 725, Guidelines for Analysis Methods and Construction Engineering of Curved and Skewed Steel Girder Bridges:

Use one of the following analysis methods:

- Line girder utilizing the V-Load method
- Grid
- 3D analysis

Rate curved girders as follows:

- Rate for bending and shear at controlling locations.
- Incorporate lateral flange bending effects.
- For rating curved girder bridges with a degree of curvature less than or equal to 3 degrees, the girders may be analyzed as tangent girders. The span length used in the analysis should be the length along the curve of the girders. However, the rating engineer should refer to ASSHTO LRFD Bridge Design Specification, Articles 4.6.1.2.4b and c, for additional information, and should consider these articles when the bridge has unusual geometry or other factors that may require a more refined analysis.

11.2.1.4 Pin and Hangers

Pin and hanger connections for steel girders shall be load rated.

11.2.2 Software-Specific SCDOT Policy

11.2.2.1 Supplemental Calculations

Provide supplemental calculations to calculate these items:

- Parapet & Railing loads if BrR is not capable of calculating within the program
- Cross frame/diaphragm weights
- Sign Loads (if applicable)
- Utility Loads (if applicable)
- Any other load not calculated internally by BrR

11.2.2.2 BrR Input

SCDOT policies specific to BrR are as follows:

1. Input material properties per as built plans. If material properties are not shown, refer to Section 6.8 of this guidance document for the appropriate year of construction.
2. Input rolled shapes into Steel Beam Shape window. Plate girders are defined in the Member Alternative Description.
3. Use Girder System Superstructure when inputting into BrR. Link members when girders are of similar geometry and condition state. Girder members may need to be unlinked at a future time if the condition state for a particular girder changes.
4. Load Case Description: Add Default Load Case Descriptions (DC1, DC2, DW). Add load cases for additional loads not covered in Structure Typical Section.
5. Input diaphragms and loads into Structure Framing Plan Details. Do not input end diaphragms if they are not contributing to loads on girders.
6. Member Alternative Description: Add 5% for additional self-load.
7. For Control Options in BrR, see Figure 11.2.2.2-1. For an example Load Case Description input, see Figure 11.2.2.2-2.
8. Member Loads: Input miscellaneous member loads not covered in Structure Typical Section input (i.e. haunch weight, sign loads, utility loads)
9. Do not input deck reinforcement for simple span bridges.
10. Define deck profile if girder is structurally composite with deck.
11. Input shear connectors as composite if deck is composite with girders.
12. Note: Web stiffener weight is not calculated in BrR. The weight should be included as a separate member load if stiffener weight is not included in diaphragm weight calculation.

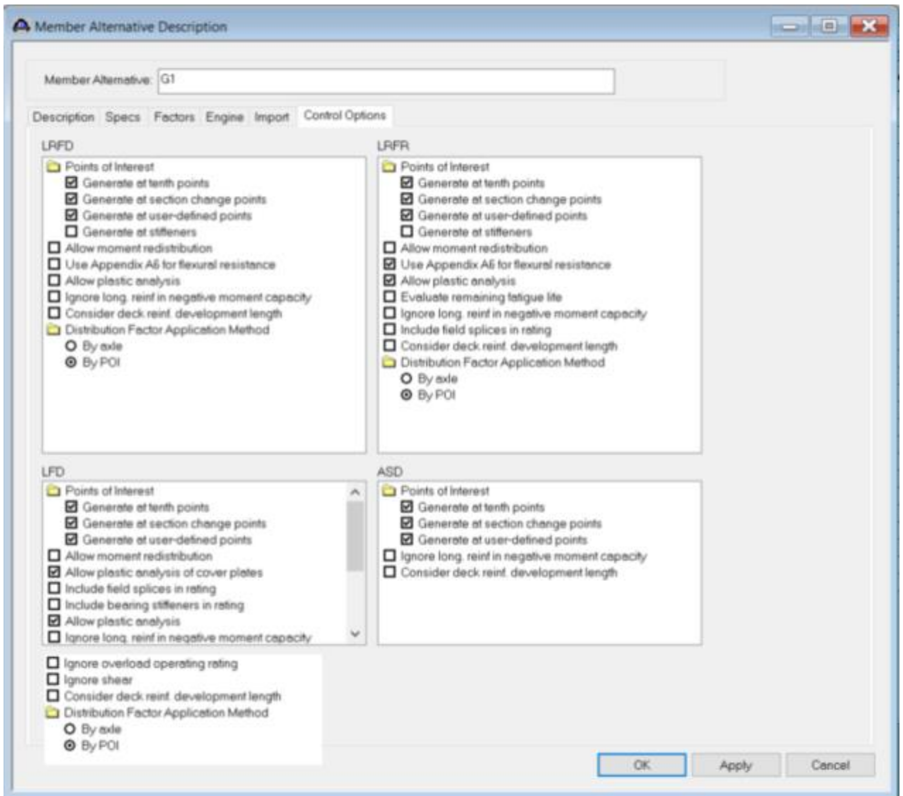


Figure 11.2.2.2-1. Control Options Screenshot from BrR

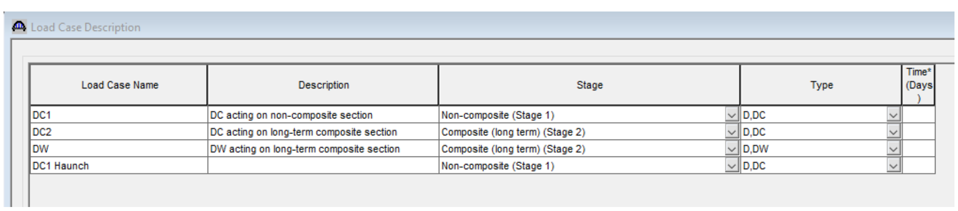


Figure 11.2.2.2-2. Example Load Case Description Input

11.2.3 ASR or LFR Method

No exceptions to the MBE should be made other than noted above.

11.2.4 LRFR Method

No exceptions to the MBE should be made other than noted above.

CHAPTER 12 STEEL TRUSS SUPERSTRUCTURE

12.1 INTRODUCTION

This section pertains to the rating of steel truss superstructures. All steel trusses shall be rated.

12.2 POLICIES AND GUIDELINES

Use the following guidelines:

1. Truss Members – A rating is required for all primary truss members carrying live load. Typically, a rating is not required for a zero-force member, portal bracing or sway bracing, although cross frames of a deck truss supporting stringers would be required to be load rated.
2. Interior Floor Beams – A rating is required for the critical interior floor beam and its connections. To determine the critical floor beam, more than one interior floor beam may require investigation due to variations in cross-sectional size, grade of material, loads, or any other determining factor.
3. End Floor Beams – A rating is required for an end floor beam and its connections when its cross-sectional size is different from that used for the interior floor beams or when member deterioration or loading could result in a lower rating factor than an interior floor beam.
4. Interior Stringers – A rating is required for the critical interior stringer and its connections. To determine the critical stringer, more than one interior stringer may require analysis due to variations in cross-sectional size, grade of material, span length, loads, or any other determining factor.
5. Exterior Stringers – A rating is required for an exterior stringer and its connections when its cross-sectional size is different from that used for the interior stringers or when member deterioration or loading could result in a lower rating factor than an interior stringer.
6. Gussets – A rating is required for all gussets carrying live load. Gusset load rating should follow the provisions in the MBE, which are based on the findings from NCHRP Project 12-84 (Ocel, 2013). FHWA-IF-09-014, dated February 2009, provided initial guidance for gusset plate load rating prior to the adoption of the 2014 Interim Revisions to the MBE 2nd Edition, and now is considered obsolete. However, the rater may find the FHWA publication as a valuable reference to gain basic understanding of gusset load rating. The FHWA publication presents a table of factored shear resistance for rivets; however, the user is cautioned that this table is not in agreement with the values in the 3rd Edition of the MBE. Therefore, the rater should use the values noted in the latest edition of the MBE unless other information proves otherwise. Note that many SCDOT steel truss bridges may not have plans or shop drawings for existing gusset plates and therefore may require field measurements documented during a Site Assessment in order to complete the load rating.
7. Main Chord Splices – A rating is required for all splices present in the truss members.
8. Main Chord Pins – A rating is required for all pin hanger connections and pin bearing connections present in the truss.
9. Others – A rating or strength evaluation is required for any components or details not covered above exhibiting deterioration, that are critical in transferring loads, either subject to live load effects or not.

12.2.1 Software-Specific SCDOT Policy

12.2.1.1 Supplemental Calculations

Provide supplemental calculations to calculate these items:

- Parapet & Railing loads if BrR is not capable of calculating within the program
- Diaphragm weights

- Deck effective width for floor beam and stingers (if composite) if BrR is not capable of calculating within the program
- Sign Loads (if applicable)
- Utility Loads (if applicable)
- Any other load not calculated internally by BrR
- Effective area reduction for rivets or bolts for all truss members
- Section properties for Nondetailed Section
- Additional weight of truss members not calculated by BrR including; splice plates, lacing, rivets, batten plates, etc.
- Additional weights of panel point loads including gusset plates
- Truss live load distribution factor for single and multi-lane. Use lever rule for truss members
- Member capacity calculation for Override Capacity

12.2.1.2 BrR Input

SCDOT policies specific to BrR are as follows:

1. Input material properties per as built plans. If material properties are not shown, refer to Section 6.8 of this guidance document for the appropriate year of construction.
2. Use Truss System Superstructure when inputting into BrR. Link trusses that are similar.
3. Load Case Description: Add Default Load Case Descriptions (DC1, DC2, DW). Add load cases for additional loads not covered in Structure Typical Section.
4. Input diaphragms and loads into Structure Framing Plan Details.
5. Create a different Superstructure Definition for timber stringers or reinforced concrete decks that span between floor beams.
6. Use the control options for steel girders (see Chapter 11) to define points of interest and Distribution Factor Application Methods for steel stringers and floor beams of trusses.

CHAPTER 13 TIMBER SUPERSTRUCTURES

13.1 INTRODUCTION

This section pertains to the rating of timber superstructures. All timber bridges shall be rated.

13.2 POLICIES AND GUIDELINES

The ASR method shall be used for load rating timber bridges.

Use the following:

1. Impact shall not be applied to timber structures.
2. Horizontal shear can often control the ratings and should always be checked.
3. Vertical shear does not typically control the rating, but should be checked.
4. Bending and shear stresses can be affected by imperfections in the members and should be accounted for in the rating calculations as follows.
    - A cracked stringer shall be defined as a complete separation of the wood across the grain, with the separation not extending more than one-fourth of the depth of the stringer. Shear and bending strength shall be determined based on the section remaining (i.e. according to the effective uncracked section depth). Shear increase factors shall not be applied. See Figure 13.2-1.
    - A broken stringer shall be defined as a complete separation of the wood across the grain, with the separation extending more than one-fourth the depth of the stringer. All broken stringers shall be assumed to be ineffective and have no contribution to capacity. Live load distribution factors shall be computed based on the maximum average of the stringer spacing on either side assuming the broken stringer is not effective. See Figure 13.2-1.
    - A split shall be defined as a complete separation of the wood fibers parallel to the grain direction. Splits extending less than ¾ the length of the stringer shall not be considered to affect the member capacity and may be ignored. Splits extending more than ¾ the length of the stringer shall be considered to affect the member capacity and shall be analyzed using the section remaining. The section remaining for the load rating shall be the side of the split with the larger depth. Shear increase factors shall not be applied. See Figure 13.2-1.
    - A check shall be defined as a separation of the wood fibers parallel to the grain direction resulting from stresses set up in the wood during seasoning, and usually extends across the annual growth rings. Checks in stringers may be on one or both sides of the stringer. Checks need not be considered to affect member capacity and may be ignored. See Figure 13.2-2.
    - A shake shall be defined as a separation of the wood fibers parallel to the grain direction which occurs between annual growth rings as a result of growth in the tree. Shakes shall not be considered to affect member capacity and may be ignored. See Figure 13.2-2.
    - Shear and bending strength shall be rated based on section remaining in the event of decay to the member. See Figure 13.2-2.
    - A knot shall be defined as a separation of the wood fibers due to an inner-grown limb and associated grain deviation. Knots located in high tensile stress areas (the portion of a stringer below the neutral axis located in the middle half of a simple span) affect member bending capacity and bending capacity will be determined based on the section remaining (i.e. exclude the knot from the effective depth). Treat stringer cracks or broken stringers that initiate from a knot in a high tensile area as noted above.

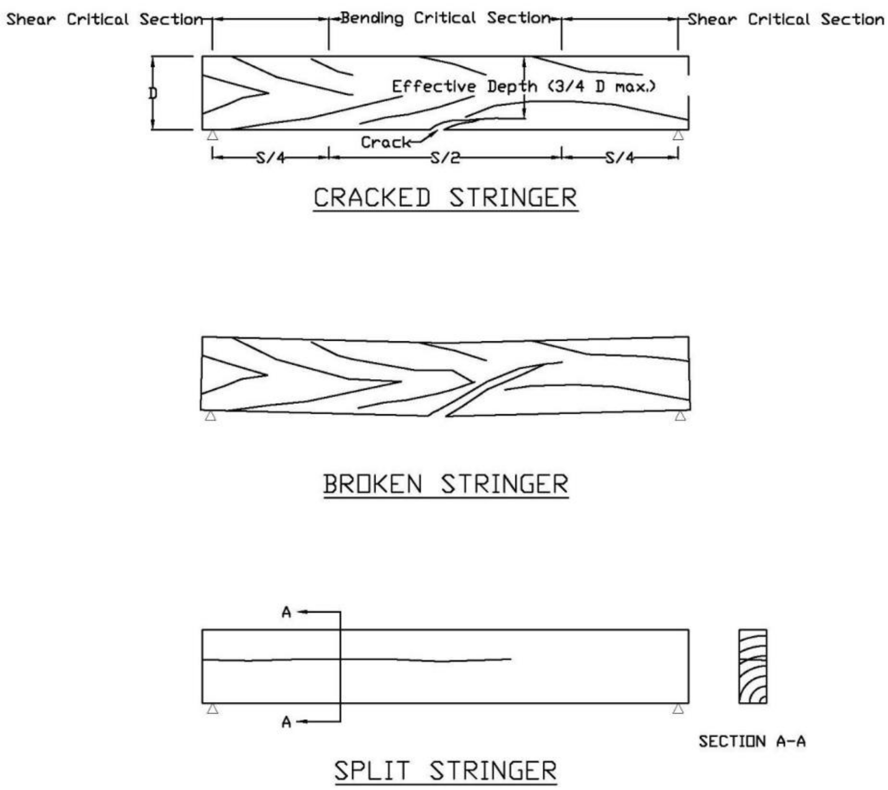


Figure 13.2-1. Cracked, Broken and Split Timber Stringer Defects

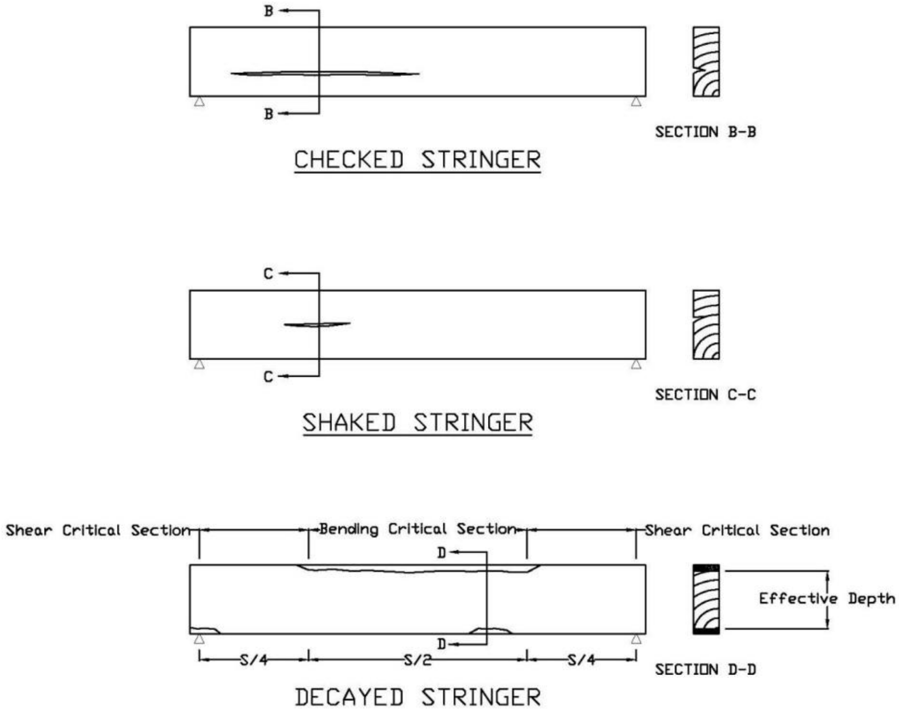


Figure 13.2-2. Checked, Shaked and Decayed Timber Stringer Defects

CHAPTER 14 CONCRETE AND MASONRY SUBSTRUCTURES

14.1 INTRODUCTION

This section pertains to the rating of concrete and masonry substructures.

14.2 POLICIES AND GUIDELINES

Use the following criteria to determine when the substructure should be rated:

1. Substructures shall be rated when there is deterioration, tipping, or damage present that is determined to be detrimental to the substructure's load carrying capabilities. Examples of distress that could trigger a load rating of substructure components include: a high degree of corrosion or section loss, changes in column / concrete pile end conditions due to deterioration, changes to concrete pile unbraced length due to scour, or columns / concrete piles with impact damage.
2. Piles should be rated if a significant amount of soil has been lost by scour or other means around the pile that could cause a buckling issue, if there is significant pile deterioration (corrosion of steel pile, decay of timber piles or deterioration of concrete piles) that could affect their load carrying capability, or if loss of soil around the piles would preclude adequate geotechnical support of the piles for piles deriving their load in friction.
3. Pier caps shall be rated if there is deterioration or other structural issues present that would have an effect on the capacity of the cap.

14.3 SUBSTRUCTURE LOAD RATING ANALYSIS

BrR does not contain modules for load rating of bridge substructures. In lieu of using BrR, spreadsheets or other proprietary software, subject to approval by the State Bridge Maintenance Engineer or designated representative, may be used for load rating of concrete or masonry substructures. Load rating assumptions, supplemental calculations, hand calculations, spreadsheet output and /or the executable input file for approved proprietary software shall be submitted as part of the load rating documentation.

CHAPTER 15 STEEL SUBSTRUCTURES

15.1 INTRODUCTION

This section pertains to the rating of steel substructures.

15.2 POLICIES AND GUIDELINES

Use the following criteria to determine when the substructure should be rated:

1. Substructures shall be rated when there is deterioration, tipping, or damage present that is determined to be detrimental to the substructure's load carrying capabilities. Examples of distress that could trigger a load rating of substructure components include: a high degree of corrosion or section loss, changes in steel pile end conditions due to deterioration, changes to steel pile unbraced length due to scour, or columns / steel piles with impact damage.
2. Piles should be rated if a significant amount of soil has been lost by scour or other means around the pile that could cause a buckling issue, if there is significant pile deterioration or corrosion that could affect their load carrying capability, or if loss of soil around the piles would preclude adequate geotechnical support of the piles for piles deriving their load in friction.
3. Pier caps shall be rated if there is deterioration, corrosion, broken welds or other structural issues present that would have an effect on the capacity of the cap.
4. Integral steel pier caps (if applicable) shall be load rated.
5. Steel pier caps classified as Fracture Critical Members shall be load rated.

15.3 SUBSTRUCTURE LOAD RATING ANALYSIS

BrR does not contain modules for load rating of bridge substructures. In lieu of using BrR, spreadsheets or other proprietary software, subject to approval by the State Bridge Maintenance Engineer or designated representative, may be used for load rating of steel substructures. Load rating assumptions, supplemental calculations, hand calculations, spreadsheet output and /or the executable input file for approved proprietary software shall be submitted as part of the load rating documentation.

CHAPTER 16 TIMBER SUBSTRUCTURES

16.1 INTRODUCTION

This section pertains to the rating of timber substructures.

16.2 POLICIES AND GUIDELINES

The ASR method shall be used for load rating timber substructures.

Use the following criteria to determine when the substructure should be rated:

1. As a general rule, timber substructures shall be load rated if they are given a condition rating of 5 or less based on the latest inspection report or at the discretion of the load rating engineer.
2. Substructures shall be rated when there is deterioration, tipping, or damage present that is determined to be detrimental to the substructure's load carrying capabilities. Examples of distress that could trigger a load rating of substructure components include: a high degree of rot or section loss, changes in timber pile end conditions due to deterioration, changes to timber pile unbraced length due to scour, or timber piles with impact damage.
3. Piles should be rated if a significant amount of soil has been lost by scour or other means around the pile that could cause a buckling issue, if there is significant pile deterioration (decay or brooming of timber piles) that could affect their load carrying capability, or if loss of soil around the piles would preclude adequate geotechnical support of the piles for piles deriving their load in friction.
4. Pier caps shall be rated if there is deterioration or other structural issues present that would have an effect on the capacity of the cap. Consideration shall also be given to the structural geometry present and its impact on the load rating. For example, load rating of timber bent caps may govern when the pile spacing is excessive or when there is loss of support by individual timber piles due to rot or decay that would increase the effective span of the timber bent cap.

16.3 SUBSTRUCTURE LOAD RATING ANALYSIS

BrR does not contain modules for load rating of bridge substructures. In lieu of using BrR, spreadsheets or other proprietary software, subject to approval by the State Bridge Maintenance Engineer or designated representative, may be used for load rating of timber substructures. Load rating assumptions, supplemental calculations, hand calculations, spreadsheet output and /or the executable input file for approved proprietary software shall be submitted as part of the load rating documentation.

CHAPTER 17 BRIDGE-SIZED CONCRETE BOX CULVERTS

17.1 INTRODUCTION

This section pertains to the rating of bridge-sized concrete box culverts (that is, a length of 20 feet or greater between inside faces of outside walls measured along the centerline of the roadway).

17.2 POLICIES AND GUIDELINES

When design plans are available, the applicable concrete strength and reinforcing steel strength should be used. If material information is not available, the values used should be as shown in Section 6.8 of this guidance document.

17.2.1 General Guidelines

1. If a culvert is single-span and does not have fill greater than 8 feet or is multiple-span and does not have fill greater than distance between faces of end walls, report results per standard operating procedures.
2. If a culvert is single-span and has fill greater than 8 feet or is multiple-span and has fill greater than distance between faces of end walls and BrR returns a rating factor of 99.9, the large rating factor is due to the fact that the live load is distributed throughout the large fill and the structure sees only dead load. Report the rating factor of 99.9 and document the reasoning for it in the Load Rating Summary Form.
3. If a culvert is single-span and has fill greater than 8 feet or is multiple-span and has fill greater than distance between faces of end walls and BrR returns a rating factor of 0.00, dead load demands are exceeding calculated capacities. However, per MBE 6.1.4, if little to no deterioration is noted in past inspection reports and the culvert has been in service for any period of time, the typical frequency of inspections (i.e. 24 months) shall be maintained, and the culvert shall be monitored for further deterioration. Increase the culvert reinforcing steel in BrR in 20% increments to overcome dead load effects and increase the capacity until the rating is not 0.00. This increase shall be documented in the Load Rating Summary Form. If the culvert has been in service for less than 10 years and is showing signs of significant deterioration, the load rating shall be coordinated with the State Bridge Maintenance Engineer or designated representative.

17.2.2 Software Specific SCDOT Policy

17.2.2.1 Supplemental Calculations

Provide supplemental calculations to calculate these items:

- Parapet and railing loads if BrR is not capable of calculating within the program
- Calculation of fill heights, if required
- Live load surcharge heights
- Any other load not calculated internally by BrR

17.2.2.2 BrR Input

SCDOT Policies specific to BrR are as follows:

1. If required, input bent truss bars as straight bars and with fully developed ends as appropriate. Do not include the sloped portion of bent truss bars.
2. Some culverts may require analysis of maximum and minimum fill heights.
3. On skewed culverts, do not rate edge beams.
4. For LFR ratings, if the maximum and minimum fill fall in different impact zones but are within 6” +/- of each other, run only the upper limit of the larger impact zone.
    a. Example: Max. fill = 14”, Min. Fill = 9” => Use 12” fill with 30% impact
    b. Example: Max. fill = 3’-1”, Min. fill = 2’-10” => Use 3’-0” fill with 10% impact
5. Use a subgrade modulus of 200 pounds per cubic inch.

6. Input soil properties per Figure 17.2.1.1-1.
7. For Control Options in BrR, see the screenshot in Figure 17.2.1.2-2.

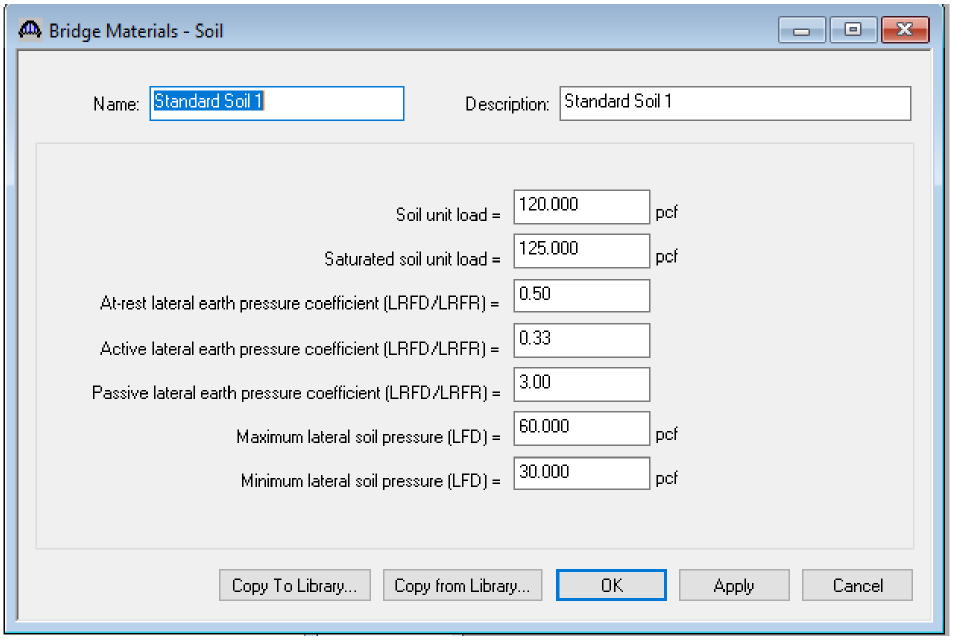


Figure 17.2.1.1-1. Concrete Box Culvert Soil Properties for BrR

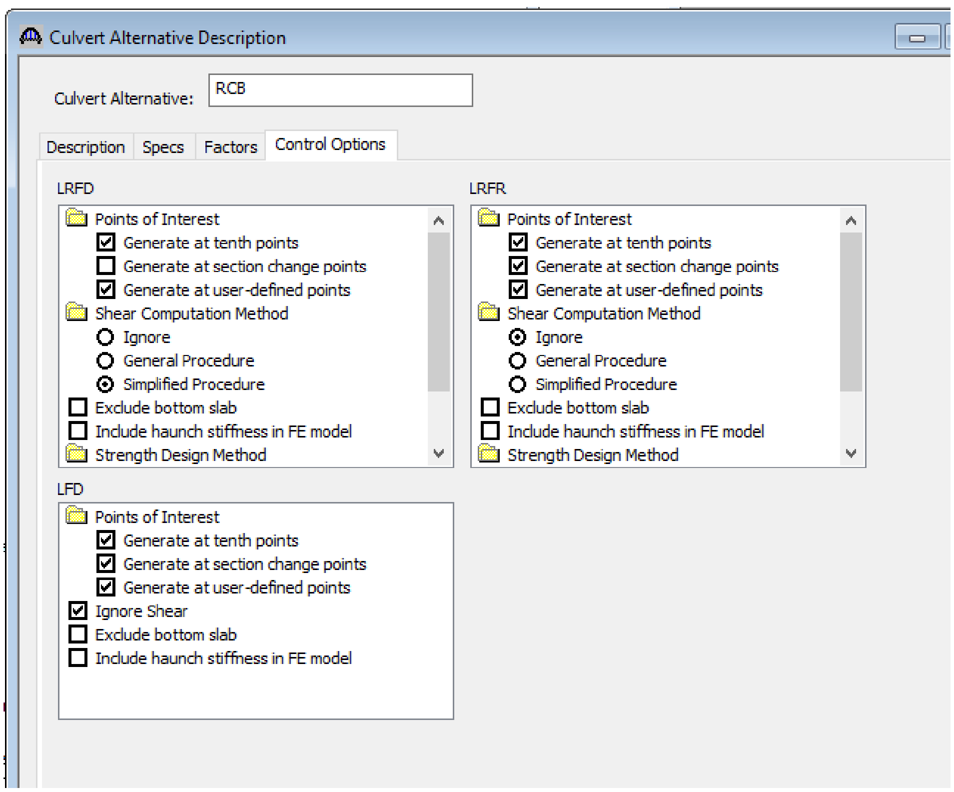


Figure 17.2.1.1-2. Control Options Screenshot from BrR

CHAPTER 18 NON-TYPICAL AND COMPLEX BRIDGE TYPES

18.1 INTRODUCTION

This section pertains to non-typical and complex bridge types that are not covered in other sections of this guidance document, such as steel arch bridges, concrete arch bridges, cable stayed bridges, suspension bridges, segmental concrete bridges and complex or cantilevered steel truss bridges. A listing of SCDOT bridges considered non-typical and / or complex is included in Appendix A18.1.

18.2 POLICIES AND GUIDELINES

18.2.1 Software Requirements

SCDOT currently has separate contracts for inspection and load rating of complex bridges and it is recognized that these complex bridges, by their nature, may require advanced analysis methods or specific software in order to load rate the structures. As noted in Section 3.3 of this Guidance Document, the use of proprietary software other than AASHTOWare BrR requires approval of the State Bridge Maintenance Engineer or designated representative.

In the load rating of these complex structures, the use of BrR software shall be used to the greatest extent possible for non-complex components that would be supported by BrR. These might include but are not limited to:

- Non-complex approach units for a complex bridge such as conventional prestressed concrete beam approach spans or conventional steel girder approach spans.
- Stringers of a complex span
- Field splices for steel stringers
- Floor beams of a complex span

18.2.2 Analysis Documentation

Commented [RP8]: Outstanding question remains of how ratings for non-typical and complex bridges using non-BrR software will be used with Hexagon and OSOW routing permits

In addition to the load rating documentation requirements outlined in Chapter 20 of this Guidance Document, the load rating of non-typical or complex bridges should include a summary document to describe the load rating methodology and software used in the analysis of the complex bridge. The summary document shall include:

- A general description of the analysis methodologies
- A listing of key assumptions
- A matrix listing the software used, the release versions of software and what bridge components were analyzed by each software
- Documentation of SCDOT approval for use of software other than BrR. (See Bridge Maintenance Office Approvals Form in Appendix A20.2.)

APPENDIX A18.1: SCDOT NON-TYPICAL AND COMPLEX BRIDGES

Table A18.1. SCDOT Non-typical and Complex Bridges

Asset ID	Facility Carried (NBI 007)	Features Intersected (NBI 006)	County (NBI 003)	Location (NBI 009)	District (NBI 02)	Structure Material, Main (NBI 43B)	Structure Type, Main (NBI 43)
228	US 17 SB	Ashley River	Charleston	In Charleston	6	Steel	Movable - Bascule
686	S-26-20	ICWW	Horry	City of Cherry Grove	5	Steel	Movable - Swing
687	S-26-616	ICWW	Horry	10.5 miles S. of Conway	5	Steel	Movable - Swing
925	US 21	Harbor River	Beaufort	12.5 miles SE of Beaufort	6	Steel	Movable - Swing
1303	SC 703	ICWW	Charleston	Between Sullivans Island /Mt. Pleasant	6	Steel	Movable - Swing
2303	SC 171	Wappoo Creek	Charleston	1 mile S. of US17 James	6	Steel	Movable - Bascule
3186	US 21 Bus.	Beaufort River	Beaufort	In town of Beaufort	6	Steel	Movable - Swing
3607	US 17 NB	Ashley River	Charleston	In Charleston	6	Steel	Movable - Bascule
8235	I-526 EBL - Wando	Wando River	Charleston	Near Charleston	6	Prestressed Concrete Continuous	Segmental Box Girder
8238	I-526 WBL - Wando	Wando River	Charleston	Near Charleston	6	Prestressed Concrete Continuous	Segmental Box Girder
9824	US 17	Cooper River and Town	Charleston	2 miles W. of Mt. Pleasant	6	Steel Continuous	Stayed Girder
9973	L-834	ICWW	Horry	Myrtle Beach	5	Steel Continuous	Movable - Swing

CHAPTER 19 POSTING OF BRIDGES AND POSTING CONSIDERATIONS

19.1 GENERAL

In accordance with Sections 6A.8.2 and 6B.7.2 of the MBE, when the maximum legal load under state law exceeds the safe load capacity of a bridge, restrictive posting shall be required. Refer to Appendix A6A of the MBE for a typical flow chart showing the rating and posting process. Before weight limit posting is recommended, posting avoidance options should be discussed with the State Bridge Maintenance Engineer or designated representative as these options may require additional analysis.

Posting bridges for load limits is important to ensure the safety of the travelling public. Posting informs the public of the load limits of a bridge and alerts drivers not to cross the bridge if their vehicle exceeds the capacity posted. As such, appropriate weight posting is critical for public safety and the preservation of the bridge assets.

Load posting a bridge can create a hardship on the motoring public, emergency responders, industry and agricultural operations in the vicinity of the bridge. In making load posting decisions, factors to be considered might include the criticality of the bridge, the character of traffic, the likelihood of overweight vehicles, the enforceability of weight posting, detour length, impacts to commerce and alternatives to load posting, such as strengthening or replacement.

19.2 POSTING CONSIDERATIONS

When a load posting is determined to have detrimental impact to commerce or emergency response, consideration of posting avoidance measures may be appropriate to minimize impacts. Posting avoidance is the application of engineering principles to a load rating by modifying the MBE-defined procedures through the use of variances and, when appropriate, exceptions. The methods of posting avoidance in this section are presented in an approximate hierarchy to provide the greatest benefit for the least cost. This hierarchy is not absolute and may change depending on the particular bridge being rated. Posting avoidance techniques may be used as follows:

- Posting avoidance techniques are to be used to avoid weight limit posting, when appropriate, to extend the useful life of a bridge until strengthening or replacement of the bridge is planned and executed.

19.2.1 Methods and Procedures

Load posting shall follow the general guidance in Sections 6A.8 and 6B.7 of the MBE supplemented by further considerations as noted in the following subsections, as warranted.

19.2.2 Refined Method of Analysis

If justified as necessary in terms of cost/benefit and impact, with thorough consideration of management and operational use of the load rating analyses and results, refined methods of analysis may be performed in order to establish a more accurate live load distribution. Examples of refined methods include finite element analysis and/or performing a load test on a structure.

19.2.3 Service III Controlling Rating

This requirement applies to bridges rated by the LRFR method. For prestressed concrete bridges, the Service III limit state shall be considered in the legal load rating analysis. If the Service III limit state yields a controlling rating factor lower than 1.0, the Service III limit state may be waived upon approval by the State Bridge Maintenance Engineer or designated representative if the current bridge inspection is showing no signs of either shear or flexural distress. However, waiving the Service III limit state will not be approved where salt is prevalent (coastal and mountainous regions).

For post-tensioned concrete segmental bridges, both the Service I and Service III limit states are mandatory for legal load rating in accordance with Section 6A.5.11.5.1 of the MBE.

19.2.4 Alternative Rating Methods

If a LRFR load rating analysis results in a controlling rating factor below 1.0, with approval of the State Bridge Maintenance Engineer or designated representative, the load rater could investigate the use of other load rating methods (ASR or LFR) to minimize load posting effects. Note that regardless of the alternative rating methods used for load posting, the LRFR or LFR values are to be reported in the National Bridge Inventory.

19.2.5 Stiffness of Traffic Barrier

As general guidance, stiffness of the traffic barriers should not be considered in the load rating analysis. If justified appropriate and absolutely necessary for a particular bridge of concern, the contribution of the traffic barriers to global stiffness of the structure may be considered after exercising sound holistic judgment based on commonly accepted engineering principles.

When barriers are considered, the physical condition of the barriers, a general opinion of the condition of the interface between the barriers and the bridge superstructure, and the condition of the joints as they affect the longitudinal continuity of the barriers shall be field verified. If a decision is made to consider the stiffness of the traffic barriers in the load rating analysis, the barriers and the interfacial connection (reinforcing steel) shall be rated. When the barrier concrete uses a lower concrete strength than the bridge deck, 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 analysis assumptions shall be fully documented on the Load Rating Summary Form and the inspectors should be alerted to verify the conditions of the barriers, connections and barrier joints when performing subsequent inspections. The State Bridge Maintenance Engineer or designated representative shall be notified immediately if discrepancies found during the field inspection invalidate the previous analysis assumptions.

19.3 OPTIONS FOR RESTRICTING TRAFFIC

The following options may be used for restricting traffic:

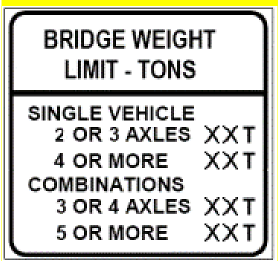
- Post the bridge for the governing one-lane or two-lane maximum gross vehicle weights, depending on deck geometry, travel lane configuration, etc..
- Restrict traffic to one lane down the center of the bridge roadway. Traffic signals and temporary traffic barriers may be needed.

19.4 POSTING FOR LEGAL TRUCK LOADS

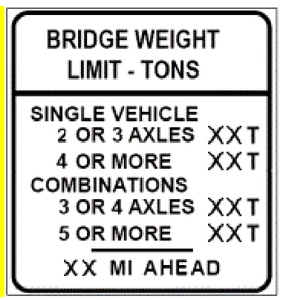
SCDOT uses the following:

1. Posting signs should limit all vehicles as efficiently as possible. Posting for a single gross weight limit, maximum axle weight limit, or both, are the most enforceable means of restricting vehicles.
2. Allowable SCDOT load posting signs are shown in Figure 19.4-1.
3. The minimum load posting value for gross weight is 3 tons. Bridges not capable of carrying a minimum gross legal load weight of 3 tons shall be closed.
4. SCDOT's policy for determination of the posting loads is using AASHTO legal loads and South Carolina legal loads (whichever governs and depending on whether the bridge is located on the interstate system or not) and in accordance with the MBE. Refer to Chapters 2 and 6 of this Guidance Document for legal loads and legal / posting load rating procedures.
5. The Operating capacity shall be used as the limit for posting for load ratings. Limits below the Operating capacity can be used at the SCDOT's discretion.

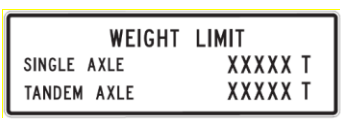
6. Sign R12-SC100 is the primary load posting sign to be used. In addition, for bridges that require additional axle restrictions to account for any potential shear failures that could occur from an individual axle loading, sign R12-SC6 shall be placed below the R12-SC100 or R12-SC101 sign (See Item #7).
7. Advance sign (R12-SC101) is to be used at the nearest intersection on each side of the bridge along with detour signs to direct trucks through the approved detour.
8. If the decision is made to post the bridge, the necessary public and private officials shall be notified prior to placement of any weight limit signs. This shall include notifying local school districts, and both fire and law enforcement agencies, as well as businesses that may be affected. Also, the South Carolina Department of Transportation's Oversize/Overweight Permits Office shall be notified. The detour route, along with the new weight limits, should be given to the local "911" service.
9. Refer to the SCDOT Supplement to the Manual on Uniform Traffic Control Devices (MUTCD) for additional information regarding required posting signs.



R12-SC100



R12-SC101



R12-SC6

Figure 19.4-1. SCDOT Allowable Load Posting Signs

19.5 POSTING DOCUMENTATION

The posting limits shall be documented on the Bridge Signing/Posting Form found in Appendix A19.1. Documentation of any special considerations required in developing the posting limits should be included in the "Comments" section of the Bridge Signing/Posting Form found in Appendix A19.1. Bridge inspectors should also provide a picture of the posting signs as a part of each routine inspection.

APPENDIX A19.1: BRIDGE SIGNING/POSTING FORM

SCDOT

Bridge Signing/Posting Form

Version: 1.0
Page 1 of 1

SECTION 1: GENERAL BRIDGE DATA				
(8) Asset ID:	(2) District:	(3) County:	(7) Facility Carried:	(6) Feature Crossed:
	Select District	Select County		

SECTION 2: SIGN INFORMATION

Please check required signs and note load limits in their boxes. Each load limit should be the lesser of the restricted load or federal maximum/truck weight for interstate bridges or state maximum/truck weight for non-interstate bridges.

BRIDGE WEIGHT LIMIT - TONS SINGLE VEHICLE 2 OR 3 AXLES ___ T 4 OR MORE ___ T COMBINATIONS 3 OR 4 AXLES ___ T 5 OR MORE ___ T	BRIDGE WEIGHT LIMIT - TONS SINGLE VEHICLE 2 OR 3 AXLES ___ T 4 OR MORE ___ T COMBINATIONS 3 OR 4 AXLES ___ T 5 OR MORE ___ T ___ MI AHEAD
☐	☐

WEIGHT LIMIT
SINGLE AXLE ___ T
TANDEM AXLE ___ T

☐

SECTION 3: COMMENTS

LOAD RATING ENGINEER	
Name:	
Company:	
Date:	

QUALITY CONTROL ENGINEER	
Name:	
Company:	
Date:	

A link to the latest version of the Bridge Signing/Posting Form is located here: Bridge Signing/Posting Form

Commented [RP9]: Add hotlink once form is finalized and the form is saved on SCDOT website

CHAPTER 20 LOAD RATING DOCUMENTATION

20.1 LOAD RATING DELIVERABLES

All deliverables will be made electronically and will be transferred to a SCDOT maintained ProjectWise location. Access will be provided for electronic submittal of final documentation. Please coordinate electronic submittals with the SCDOT Bridge Maintenance Office.

20.2 LOAD RATING SUMMARY

Load ratings for each bridge asset shall be summarized and documented on the SCDOT Load Rating Summary Form. Load Rating Summary Forms for ASR/LFR ratings and LRFR ratings are shown in Appendix A20.1.

20.2.1 Load Rating Summary Form Naming Convention

The electronic PDF naming convention for the Load Rating Summary Form shall be as follows:
[*Asset ID*]_LR Summary_ [*Condition*] _ [*Date*].pdf

Use "As-built" for the *Condition* field if the Load Rating Summary Form is for either a new bridge or an existing bridge that has not experienced deterioration requiring changes to the load rating analysis.

Use "Deteriorated" for the *Condition* field if the Load Rating Summary Form is for a bridge that has experienced deterioration affecting the load rating of the bridge as compared to the "As-built" load rating.

20.2.2 Load Rating as Part of an Inspection or Independent Rating

20.2.2.1 Load Rating Calculations and Supporting Data

The following will be delivered for each completed load rating:

1. .XML File: Provide a BrR input file (.XML file) or other approved computer program input files and .PDF of EXCEL, Mathcad or other design aid tools, as applicable (no hard copy). PDF output files shall be in a format that can be checked by hand. Executable files may be requested by SCDOT on a case-by case basis.
2. .PDF of LRS Form: Provide a completed Load Rating Summary Form in .PDF format, digitally signed and sealed.
3. Supplemental Calculations: Provide supporting calculations (.PDF electronic files).
4. Site Assessment Forms: If a site assessment was required to complete the load rating, include a .PDF copy of the Site Assessment Form, which would include notes or photographs documenting the level of deterioration assumed for completing the load rating. For additional Site Assessment information that does not affect the load rating analysis, include the Site Assessment Supplemental Findings form. If inadequate or no plan information was available to complete the load rating analysis and field measurements were taken, provide additional documentation of field information if the Site Assessment Form does not have adequate space to show it. See Section 5.4 of this guidance document for additional information.
5. QC Review Checklist: Provide a completed QC Review Checklist in .PDF format. Refer to Chapter 3 of this guidance document for other required QC/QA forms.
6. Bridge Maintenance Office Approvals Form: Provide a Bridge Maintenance Office Approvals Form, if necessary, documenting any approvals for deviations to standard procedures as noted in this guidance document. See Appendix A20.2 for a copy of this form.

20.2.2.2 Load Rating Summary Form

The following steps shall be used to complete the Load Rating Summary Form:

1. Enter relevant information to identify the asset and to summarize the load rating information in the EXCEL spreadsheet for the Load Rating Summary Form. For guidance on using the EXCEL sheet which contains the Load Rating Summary Form, see "Bridge Load Rating Summary (LRS) Worksheet Guide" in Appendix A20.1.
2. In the "Additional Remarks" sections, add comments, assumptions or considerations relevant to the load rating that would be helpful for explaining nuances of the structure that were considered in developing the load rating model in BrR.
3. In accordance with Section 3.2 of this guidance document, the individual performing the load rating or the individual performing the load rating check shall be a professional engineer licensed in the state of South Carolina or shall be under the supervision of a professional engineer licensed in the State of South Carolina and the load rating shall be certified by the professional engineer. The professional engineer seal and signature shall be digitally applied to the Load Rating Summary Form and must comply with the SCDOT Digital Signatures Manual.

APPENDIX A20.1: BRIDGE LOAD RATING SUMMARY (LRS) FORMS AND WORKSHEET GUIDE

Commented [RP10]: Update title and page number in List of Appendices

ASR/LFR BRIDGE LOAD RATING SUMMARY

Version 1.0
OCT 2018

Page 1 of 2

SECTION 1 - GENERAL BRIDGE DATA

(8) Asset ID	Route Type	(27) Year Built		(90) Date of Inspection	Date of Analysis
(9) Bridge Location		(7) Facility Carried		(6) Feature Intersected/Route Crossing	
(49) Length	(11) Milepost	(2) District	(3) County	(22) Owner	Inspection District
(45, 43a, 43b) Bridge Description			(31) Design Vehicle HS-20	(108A) Existing Wearing Surface Type & Depth	
Rating Program & Version		Rating Method		AASHTO Reference	
(58) Deck	(59) Superstructure	(60) Substructure	(62) Culvert	(113) Scour Critical	

SECTION 2A - INVENTORY RATINGS - Design Vehicles and AASHTO Legal Trucks

Rating Vehicle	Controlling Configuration	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
H-20	Truck	20					
H-20 Lane	Lane	20					
HS-20	Truck	36					
HS-20 Lane	Lane	36					
Alternate Military Loading	Truck	24					
Modified AASHTO SC - Type 3	Truck	25					
Modified AASHTO SC - Type 3S2	Truck	36.6					
AASHTO - Type 3-3	Truck	40					
2 - 0.75 Type 3-3 + 0.2 klf Lane	Truck	60					

SECTION 2B - INVENTORY RATINGS - Specialized Hauling Vehicles (SHV)

Rating Vehicle	Controlling Configuration	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
SC-SHV1A	Truck	32.5					
SC-SHV1B	Truck	35					
SC-SHV2A	Truck	33					
SC-SHV2B	Truck	40					
SC-SHV3A	Truck	42.5					
SC-SHV3B	Truck	45					
SC Representative School Bus	Truck	17.525					
SC-SU2	Truck	20					
SU4	Truck	27					
SU5	Truck	31					
SU6	Truck	34.75					
SU7	Truck	38.75					

This ASR/LFR Load Rating is based on: ☐ Design Plans ☐ Design Plans & Approved Shop Drawings ☐ Other (Please explain in Remarks)

SECTION 3 - BRIDGE LOAD RATING SUMMARY

Controlling Truck	Bridge Factor	Bridge Color	Load Posting Required?	Max Axle Weight if Posting Req.

SECTION 4 - REMARKS & SIGN/SEAL

Load Rating Engineer		Quality Control Engineer		Quality Assurance Engineer ☐ Yes ☐ No	
Name:		Name:		Name:	
Company:		Company:		Company:	
Date:		Date:		Date:	

Remarks:

Insert Stamp

ASR/LFR BRIDGE LOAD RATING SUMMARY

Version 1.0
OCT 2018
Page 2 of 2

SECTION 1 (PAGE 2) - GENERAL BRIDGE DATA

(8) Asset ID	Route Type	(27) Year Built		(90) Date of Inspection	Date of Analysis
(9) Bridge Location	(7) Facility Carried	(6) Feature Intersected/Route Crossing			
(49) Length	(11) Milepost	(2) District	(3) County	(22) Owner	Inspection District
(45, 43a, 43b) Bridge Description	(31) Design Vehicle HS-20	(108A) Existing Wearing Surface Type & Depth			
Rating Program & Version	Rating Method	AASHTO Reference			
(58) Deck	(59) Superstructure	(60) Substructure	(62) Culvert	(113) Scour Critical	

SECTION 5 - OPERATING RATINGS - Design Vehicles & AASHTO Legal Trucks

Rating Vehicle	Controlling Configuration	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
H-20	Truck	20					
H-20 Lane	Lane	20					
HS-20	Truck	36					
HS-20 Lane	Lane	36					
Alternate Military Loading	Truck	24					
Modified AASHTO SC - Type 3	Truck	25					
Modified AASHTO SC - Type 3S2	Truck	36.6					
AASHTO - Type 3-3	Truck	40					
2 - 0.75 Type 3-3 + 0.2 klf Lane	Truck	60					

SECTION 6A - OPERATING RATINGS - SC Specialized Hauling Vehicles (SHV) - Legal on Non-Interstate and Permit on Interstate

Rating Vehicle	Controlling Configuration	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
SC-SHV1A	Truck	32.5					
SC-SHV1B	Truck	35					
SC-SHV2A	Truck	33					
SC-SHV2B	Truck	40					
SC-SHV3A	Truck	42.5					
SC-SHV3B	Truck	45					

SECTION 6B - OPERATING RATINGS - Two Miscellaneous SHV & AASHTO SHV - Legal on all roads

Rating Vehicle	Controlling Configuration	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
SC Representative School Bus	Truck	17.525					
SC-SU2	Truck	20					
SU4	Truck	27					
SU5	Truck	31					
SU6	Truck	34.75					
SU7	Truck	38.75					

SECTION 6C - OPERATING RATINGS - Standard Permit Vehicles & Typical Cranes

Rating Vehicle	Controlling Configuration	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
SC - 100k	Truck	50					
SC - 120k	Truck	60					
SC - 130k	Truck	65					
SC Crane #544726	Truck	80					
SC Crane #527568	Truck	88.85					

SECTION 6D - OPERATING RATINGS - Emergency Vehicles (EV)

Rating Vehicle	Controlling Configuration	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
EV2	Truck	28.75					
EV3	Truck	43					

Additional Remarks:

A link to the latest version of the Load Rating Summary Form is located here (click on the ASR-LFR Summary tab): Load Rating Summary Form

Commented [RP11]: Add hotlink once form is finalized and the form is saved on SCDOT website

SCDOT

LRFR BRIDGE LOAD RATING SUMMARY

Version 1.0
OCT 2018

Page 1 of 2

SECTION 1 - GENERAL BRIDGE DATA					
(8) Asset ID	Route Type	(27) Year Built		(90) Date of Inspection	Date of Analysis
(9) Bridge Location		(7) Facility Carried		(6) Feature Intersected/Route Crossing	
(49) Length	(11) Milepost	(2) District	(3) County	(22) Owner	Inspection District
(45, 43a, 43b) Bridge Description		(31) Design Vehicle (On Plans) HL-93 (Design Truck)		(108A) Existing Wearing Surface Type & Depth	
Rating Program & Version		Rating Method		AASHTO Reference	
(58) Deck	(59) Superstructure	(60) Substructure		(62) Culvert	(113) Scour Critical

SECTION 2 - INVENTORY AND OPERATING LOAD RATINGS

Rating Vehicle	Rating Level	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
HL-93 Truck + lane	Inventory	36					
HL-93 Truck Train + Lane (90%)	Inventory	32.4					
HL-93 Tandem + Lane	Inventory	25					
HL-93 Truck + lane	Operating	36					
HL-93 Truck Train + Lane (90%)	Operating	32.4					
HL-93 Tandem + Lane	Operating	25					

This LRFR Load Rating is based on: ☐ Design Plans ☐ Design Plans & Approved Shop Drawings ☐ Other (Please explain in Remarks)

SECTION 3 - BRIDGE LOAD RATING SUMMARY

Controlling Truck	Bridge Factor	Bridge Color	Load Posting Required?	Max Axle Weight if Posting Req.

SECTION 4 - REMARKS & SIGN/SEAL

Load Rating Engineer		Quality Control Engineer		Quality Assurance Engineer ☐ Yes ☐ No	
Name:		Name:		Name:	
Company:		Company:		Company:	
Date:		Date:		Date:	

Remarks:

Insert Stamp

The ADTT value listed below is to be used to establish Legal and Permit γ_{LL} factors.

SECTION 5A - LEGAL & PERMIT RATINGS - AASHTO Legal Trucks

(30) ADT Year	(29) ADT	(109) Truck % ADT	ADTT (ADT x Truck % ADT)

Rating Vehicle	Rating Level	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
Modified AASHTO SC - Type 3	Legal	25					
Modified AASHTO SC - Type 3S2	Legal	36.6					
AASHTO - Type 3-3	Legal	40					
2 - 0.75 Type 3-3 + 0.2 klf Lane	Legal	60					
Modified AASHTO SC - Type 3	Permit	25					
Modified AASHTO SC - Type 3S2	Permit	36.6					
AASHTO - Type 3-3	Permit	40					
2 - 0.75 Type 3-3 + 0.2 klf Lane	Permit	60					

SCDOT

LRFR BRIDGE LOAD RATING SUMMARY

Version 1.0
OCT 2018

Page 2 of 2

SECTION 1 (PAGE 2) - GENERAL BRIDGE DATA					
(8) Asset ID	Route Type	(27) Year Built		(90) Date of Inspection	Date of Analysis
(9) Bridge Location	(7) Facility Carried	(6) Feature Intersected/Route Crossing			
(49) Length	(11) Milepost	(2) District	(3) County	(22) Owner	Inspection District
(45, 43a, 43b) Bridge Description	(31) Design Vehicle HL-93 (Design Truck)	(108A) Existing Wearing Surface Type & Depth			
Rating Program & Version	Rating Method	AASHTO Reference			
(58) Deck	(59) Superstructure	(60) Substructure	(62) Culvert	(113) Scour Critical	

SECTION 5B - LEGAL RATINGS - SC Specialized Hauling Vehicles (SHV) - Legal on Non-Interstate Only (Permit on Interstate)

Rating Vehicle	Rating Level	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
SC-SHV1A	Legal	32.5					
SC-SHV1B	Legal	35					
SC-SHV2A	Legal	33					
SC-SHV2B	Legal	40					
SC-SHV3A	Legal	42.5					
SC-SHV3B	Legal	45					

SECTION 5C - LEGAL RATINGS - Two Miscellaneous SHV & AASHTO SHV

Rating Vehicle	Rating Level	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
SC Representative School Bus	Legal	17.525					
SC-SU2	Legal	20					
SU4	Legal	27					
SU5	Legal	31					
SU6	Legal	34.75					
SU7	Legal	38.75					

SECTION 5D - LEGAL RATINGS - Emergency Vehicles (EV)

Rating Vehicle	Rating Level	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
EV2	Legal	28.75					
EV3	Legal	43					

SECTION 6 - PERMIT RATINGS - Specialized Hauling Vehicles (SHV), Standard Permit Vehicles & Typical Cranes

Rating Vehicle	Rating Level	Weight (Tons)	Controlling Member	Controlling Location	Controlling Limit State	Rating Factor	Rating (Tons)
SC-SHV1A	Permit	32.5					
SC-SHV1B	Permit	35					
SC-SHV2A	Permit	33					
SC-SHV2B	Permit	40					
SC-SHV3A	Permit	42.5					
SC-SHV3B	Permit	45					
SC Representative School Bus	Permit	17.525					
SC-SU2	Permit	20					
SU4	Permit	27					
SU5	Permit	31					
SU6	Permit	34.75					
SU7	Permit	38.75					
SC - 100k	Permit	50					
SC - 120k	Permit	60					
SC - 130k	Permit	65					
SC Crane #544726	Permit	80					
SC Crane #527568	Permit	88.85					

Additional Remarks:

A link to the latest version of the Load Rating Summary Form is located here (click on the LRFR Summary tab): Load Rating Summary Form

Commented [RP12]: Add hotlink once form is finalized and the form is saved on SCDOT website

BRIDGE LOAD RATING SUMMARY (LRS) WORKSHEET GUIDE

Purpose of Bridge Load Rating Summary Spreadsheet:

This LRS template file was developed to be used by Consultants performing bridge load ratings for the South Carolina Department of Transportation (SCDOT). Consultants are to fill in the relevant portions of the spreadsheet to complete the load rating process for each structure. The engineer of record for the rating will sign and seal the output summary sheet(s) and submit the PDF of the appropriate summary form only to SCDOT as part of the final load rating deliverable.

The purpose of this template spreadsheet is to display final rating values for an individual structure per specific designated trucks.

Instructions and Explanations of the EXCEL Based Bridge Load Rating Summary Spreadsheet:

The process stated below is the step-by-step basis for the fully functional Load Rating Summary (LRS) template. Most information in the template can be automatically populated while some portions will need to be completed by manual input of specific information.

In the first tab of the LRS template, 'Bridge Description Input', the bridge 'Asset ID', 'Created By', and 'Number of Spans' must be input and the drop down menu options must be selected. Once those steps are completed, the load rater must click the 'Populate' button for all of the bridge data to be automatically populated into the summary forms from the 'Full Bridge List-Data' tab. In the 'Description' line, input verbiage for the material and design that describes the bridge type for the majority of the structure, which should be consistent with the coding for the SI&A sheet.

ASR-LFR Load Rating Summary Form

Pull down menus are available in the EXCEL form for many of the cells. Most of these cells reference another sheet; if not, their pull down menus should be used to make a selection. Also, if the desired value cannot be found on the pull down menu, it can be typed into the cell. Cells containing a pull down menu are shaded in tan. Cells to be entered manually are shaded in light blue. All of the cells in Sections2A, 2B, 5, and 6A through 6D that are shaded light blue contain data that is automatically populated from information contained in the 'ASR-LFR BrR Results' or 'ASR-LFR BrR Results (Culvert)' tab, as applicable. These two tabs include manually input results copied and pasted from AASHTOWare Bridge Rating (BrR). The cells in Sections 2A, 2B, 5, and 6A through 6D are left shaded light blue. Although they are not manually input in the summary tab, they are a result of manually input data in one of the two ASR-LFR 'Results' tabs.

Section 1 – General Bridge Data

The first section which requires data input in the EXCEL template file is the 'General Bridge Data'.

Most of the cells will be automatically populated from the 'Full Bridge List-Data' tab once the 'Asset ID', 'Created By' and 'Number of Spans' are entered and the 'Populate' button is clicked in the 'Bridge Description Input' tab. Any cells in the 'General Bridge Data' section, not automatically populated, can be manually input by choosing from the drop down menus or manually typing in the information. All cells are input with data found in the Inspection Report (Structural Inventory and Appraisal sheet). For NBI items, the NBI item numbers are included in the cell title for easy reference. If there is a discrepancy between cells populated with data found in the Inspection Report or SI&A sheet and the bridge plans, notify the State Bridge Maintenance Engineer or designated representative.

Sections 2A and 2B – Inventory Ratings

For LFR inventory ratings, use all Design Vehicles, AASHTO Legal Trucks, and Specialized Hauling Vehicles (SHV) in the form. These were determined by the parametric study. The Controlling Member, Controlling Location, Controlling Limit State and Rating Factor are automatically populated from information input in one of the two ASR-LFR 'Results' tabs.

1) Controlling Member
   For the controlling member section, the following information explains the abbreviations.

Abbreviation for Form	Abbreviation Meaning
G1	Girder 1 – Exterior Girder
G2	Girder 2 – Interior Girder

2) Controlling Location
   The following example explains how to report the controlling location.

Abbreviation for Form	Abbreviation Meaning
1.5	Span 1 controls at midspan
2.7	Span 2 controls at the 0.7 point of the span

3) Rating (Tons)
   This is automatically calculated based on the rating factor and tonnage of the rating vehicle.
4) Load Rating Basis
   This section indicates if the load rating is based on Design Plans, As-Built Plans, Design Plans & Approved Shop Drawings, or Other. When "Other" is used, an explanation must be provided in the Remarks section. (e.g., Approved Shop Drawings only or Field Measurements, etc.).

For more information on the results of the Parametric Study and vehicles used, see Chapters 2 and 6 of the LRGD.

Section 3 – Bridge Load Rating Summary

All of the fields in this section are to be manually input and calculated based on the ratings input/output in Sections 2A, 2B, 5, and 6A through 6D of the template. Note that if a Load Posting is required, the load rater must also complete the 'Bridge Signing/Posting' Form (see Appendix A19.1 to Chapter 19).

Section 4 – Remarks & Sign/Seal

1) In the text box under 'Remarks', any critical assumptions that were made for the load rating are included. If needed, the bottom of Page 2 of the LRS Form has extra room for additional remarks. Note that information obtained from Inspection Reports or Site Assessments should not be included in this section, nor should information shown in Supplemental Calculations. Some examples for remarks to be included are listed below:
   a. Items requiring BMO Approval or deviation from standard manual procedures. See standard 'Bridge Maintenance Office Approvals' Form in Appendix A20.2 to Chapter 20.
   b. Load Rating program other than BrR was used.
2) Provide name and company of the engineer who performed the load rating analysis. Provide date rating was completed.

3) Provide name and company of the Quality Control Engineer. Provide date review was completed. QC Engineer should also complete QC Review Checklist (see Appendix A3.1 to Chapter 3).

4) Check 'yes' or 'no' for a Quality Assurance Engineer. If yes, include name of Quality Assurance Engineer, company and the date the review was completed. QA Engineer should also complete QA Review Checklist (see Appendix A3.3 to Chapter 3).

5) Once the load rating has been completed, checked and reviewed, a Professional Engineer (EOR) licensed in the State of South Carolina will digitally seal and sign the final copy in this section. Note that the EOR may or may not be the same individual who performed the load rating, but the rating must have been performed under the direction, guidance, and review of the EOR.

Sections 5 and 6A to 6D – Operating Ratings

The required cells are filled in the same way as for the Inventory Ratings in Section 2 (above). The Operating Ratings for the Design Vehicles, AASHTO Legal Trucks, South Carolina SHVs, AASHTO SHVs, Standard Permit Vehicles, two (2) frequent South Carolina cranes, and Emergency Vehicles are automatically populated from information contained in one of the two ASR-LFR 'Results' tabs. Note that South Carolina SHVs (Section 6A) are considered "legal" on non-interstate bridges only and require a permit for traversing interstate bridges. For more information on the results of the Parametric Study and vehicles used, see Chapters 2 and 6 of the LRGD.

LRFR Load Rating Summary Form

Pull down menus are available in the EXCEL form for many of the cells. Most of these cells reference another sheet; if not, their pull down menus should be used to make a selection. Also, if the desired value cannot be found on the pull down menu, it can be typed into the cell. Cells containing a pull down menu are shaded in tan. Cells to be entered manually are shaded in light blue. All of the cells in Sections 2, 5A through 5D, and 6 that are shaded light blue contain data that is automatically populated from information contained in either the 'LRFR BrR Results – Simple', 'LRFR BrR Results – Con't', or 'LRFR BrR Results (Culvert)' tab, as applicable. These three tabs include manually input results copied and pasted from AASHTOWare Bridge Rating (BrR). The cells in Sections 2, 5A through 5D, and 6 are left shaded light blue. Although they are not manually input in the summary tab, they are a result of manually input data in one of the three LRFR 'Results' tabs.

Section 1 – General Bridge Data

The first section which requires data input in the EXCEL template file is the 'General Bridge Data' tab.

1) Most of the cells will be automatically populated from the 'Full Bridge List-Data' tab once the 'Asset ID', 'Created By' and 'Number of Spans' are entered and the 'Populate' button is clicked in the 'Bridge Description Input' tab. Any cells in the 'General Bridge Data' section, not automatically populated, can be manually input by choosing from the drop down menus or manually typing in the information. All cells are input with data found in the Inspection Report or Structural Inventory and Appraisal. For NBI items, the NBI item numbers are included in the cell title for easy reference. If there is a discrepancy between cells populated with data found in the Inspection Report or SI&A sheet and the bridge plans, notify the State Bridge Maintenance Engineer or designated representative.

2) If the rating is for a structure that has not yet been built, fill in as much of general bridge data as possible and leave the rest blank. The unknown data will be completed once the structure is built and has been inventoried by the Bridge Inspector.

Section 2 – Inventory and Operating Load Ratings

The results from AASHTOWare Bridge Rating (BrR) should be input into the appropriate tab of the three LRFR 'Results' tabs, and the Controlling Member, Controlling Location, Controlling Limit State and Rating Factor will automatically populate in the 'LRFR Summary' tab. For simple span bridges or culverts, if referenced accurately, the rows for the HL-93 Truck Train + Lane (90%) will not populate.

1) Controlling Member
For the controlling member section, the following information explains the abbreviations.

Abbreviation for Form	Abbreviation Meaning
G1	Girder 1 – Exterior Girder
G2	Girder 2 – Interior Girder

2) Controlling Location
The following example explains how to report the controlling location.

Abbreviation for Form	Abbreviation Meaning
1.5	Span 1 controls at midspan
2.7	Span 2 controls at the 0.7 point of the span

3) Rating (Tons)
This is automatically calculated based on the rating factor and tonnage of the rating vehicle.

4) Load Rating Basis
This section indicates if the load rating is based on Design Plans, As-Built Plans, Approved Shop Drawings, or Other. When "Other" is used, an explanation must be provided in the Remarks section. (e.g., Approved Shop Drawings only or Field Measurements, etc.).

Section 3 – Bridge Load Rating Summary

All of the fields in this section are to be manually input and calculated based on the ratings input/output in Sections 5A though 5D of the template. Note that if a Load Posting is required, the load rater must also complete the 'Bridge Signing/Posting' Form (see Appendix A19.1 to Chapter 19).

Section 4 – Remarks & Sign/Seal

1) In the text box under 'Remarks', any assumptions that were made for the load rating are included. See Section 4 in ASR-LFR guidance section of this memo for some examples of remarks to be included. Note that information obtained from Inspection Reports or Site Assessments should not be included in this section, nor should information shown in Supplemental Calculations. If needed, the bottom of Page 2 of the LRS Form has extra room for additional remarks.

2) Provide name and company of the engineer who performed the load rating analysis. Provide date rating was completed.

3) Provide name and company of the Quality Control Engineer. Provide date review was completed. QC Engineer should also complete QC Review Checklist (see Appendix A3.1 to Chapter 3).

4) Check 'yes' or 'no' for a Quality Assurance Engineer. If yes, include name of Quality Assurance Engineer, company and the date the review was completed. QA Engineer should also complete QA Review Checklist (see Appendix A3.3 to Chapter 3).

5) Once the load rating has been completed, checked and reviewed, a Professional Engineer (EOR) licensed in the State of South Carolina will digitally seal and sign the final copy in this section. Note that the EOR may or may not be the same individual who performed the load rating, but the rating must have been performed under the direction, guidance, and review of the EOR.

Sections 5A to 5D and 6 – Legal & Permit Ratings

1) Under Section 5A, the traffic data, as found on the Inspection Report, is automatically populated from the 'Full Bridge List-Data' tab. The ADTT shown on this form shall also be used to compute the Legal and Permit Live Load Factors (γ_{LL}) input in the load rating model.
2) The required cells are filled in the same way as in Section 2 (above). The Legal and Permit Ratings are different for the same vehicles due to the different live load factors for 'Legal' and 'Permit' rating levels. The Legal and Permit Ratings for the AASHTO Legal Trucks, South Carolina SHVs, AASHTO SHVs, Emergency Vehicles, Standard Permit Vehicles, and two (2) frequent South Carolina cranes are automatically populated from data input in one of the three LRFR 'Results' tabs. Note that South Carolina SHVs (Section 5B for Legal) are considered "legal" on non-interstate bridges only and require a permit for traversing interstate bridges. For more information on the results of the Parametric Study and vehicles used, see Chapters 2 and 6 of the LRGD.

APPENDIX A20.2: BRIDGE MAINTENANCE OFFICE APPROVALS FORM

Bridge Maintenance Office Approvals Form

Version: 1.0
Page 1 of 2

SECTION 1: GENERAL BRIDGE DATA				
(8) Asset ID:	(2) District:	(3) County:	(7) Facility Carried:	(6) Feature Crossed:
	Select District	Select County		

SECTION 2: LOAD RATING ENGINEER	
Name:	
Company:	
Date:	

SECTION 3: APPROVAL REQUESTS

Check Approval(s) Being Requested	Approval Request	Load Rating Guidance Document Reference Section	Approval Status (Y/N)	Review Date	BMO Reviewer
☐	Use of load rating software other than BrR approved (general use)? *Software to be used:*	3.3			
☐	Use of load rating software other than BrR approved for concrete/masonry substructure rating? *Software to be used:*	14.3			
☐	Use of load rating software other than BrR approved for steel substructure rating? *Software to be used:*	15.3			
☐	Use of load rating software other than BrR approved for timber substructure rating? *Software to be used:*	16.3			
☐	Use of load rating software other than BrR approved for complex bridge rating? *Software to be used:*	18.2.1			
☐	Approval granted for access to Bridge File?	5.1			
☐	Site Assessment required; approval received to perform Site Assessment?	5.4			
☐	Approval granted to use alternate impact factor allowance (MBE Table C6A.4.4.3-1)?	6.7.1			
☐	Approval granted to use reduced impact factor for rating factor below 1.0 for permit load?	6.10.1			
☐	Approval of Rating Factors Less than 1.0 from use of MBE Table 6A.4.2.4-1 System Factors?	6.11.3.2			
☐	Approval granted to use load testing to improve rating factor?	6.12			

Bridge Maintenance Office Approvals Form

Version: 1.0
Page 2 of 2

SECTION 3: APPROVAL REQUESTS (CONTINUED)					
Check Approval(s) Being Requested	**Approval Request**	**Load Rating Guidance Document Reference Section**	**Approval Status (Y/N)**	**Review Date**	**BMO Reviewer**
☐	Coordination of culvert load ratings with large fills, showing signs of distress and less than 10 years in service.	17.2.1			
☐	Posting avoidance options approved? *Posting avoidance method to be used:*	19.1			
☐	Service III limit state waiver approved?	19.2.3			
☐	Alternate to LRFR load rating method approved? *Alternate load rating method to be used:*	19.2.4			
☐	Bridge Maintenance Office notified if field investigation found discrepancies that invalidate last load rating incorporating barrier stiffness.	19.2.5			
☐	Other (*Please specify*):				

SECTION 4: COMMENTS (LOAD RATING ENGINEER)

SECTION 5: COMMENTS (SCDOT REVIEWER)

A link to the latest version of the Bridge Maintenance Office Approvals Form is located here: Bridge Maintenance Office Approvals Form

Commented [RP13]: Add hotlink once form is finalized and the form is saved on SCDOT website