Load Rating Guidance Document

Issue Date: 2019

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 South Carolina Department of Transportation (SCDOT) Bridge Maintenance Office and Federal Highway Administration (FHWA). This Guidance Document will be reviewed 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 LOAD RATERS 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 AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS 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.

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CHAPTER 1 INTRODUCTION

1.1 PURPOSE

The purpose of this Guidance Document is to define the SCDOT's 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 meeting this definition needs to be inspected or load rated per the National Bridge Inspection Standards (NBIS).

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 Load and Resistance Factor Design (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 Rating (LRFR) – 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. A bridge with an Operating Level Rating RF>1 for an HL-93 will have adequate capacity for infinite use of normal legal loads with no impact to its service life.

Operating Rating (ASR, LFR) – 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.

Undersized Bridge (state-owned) – A structure, including supports, erected over an obstruction such as water; having a passageway for carrying traffic or other moving loads; exhibiting characteristics of a bridge, such as a foundation and/or piles but shorter than the minimum National Bridge Inventory (NBI) length (20 feet), excluding pipes and culverts and that should be included in the state database.

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
ASR	Allowable Stress Rating
BDM	SCDOT Bridge Design Manual
BFP	Bridge File Policy
BIGD	Bridge Inspection Guidance Document
BMO	SCDOT Bridge Maintenance Office
ED	SCDOT Engineering Directive
EOR	Engineer of Record
EV	Emergency Vehicle
FCM	Fracture Critical Member
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
LRSF	Load Rating Summary Form
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
SBME	State Bridge Maintenance Engineer

Abbreviation	Term
SCDOT	South Carolina Department of Transportation
SHV	Specialized Hauling Vehicle
SI&A	Structure Inventory and Appraisal
SU	Single Unit (Truck)

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, Current Edition
Manual for Bridge Evaluation (MBE), Current Edition

SCDOT Publications

Bridge Design Manual (BDM) (2006)
Bridge Design Memorandums
Bridge File Policy (BFP) (hot link to be provided)
Bridge Inspection Guidance Document (BIGD) (hot link to be provided)
Bridge Management Parametric Study – Final Report (hot link to be provided)
Digital Signatures Manual
SCDOT Engineering Directive (ED) 11 – Procedures for Posting or Changing Weight Limits on Bridges
ED 18 – Bridge Security and Release of Plans
ED 35 – Emergency Procurement of Construction and Consultant Services
ED 44 – Procedures for Removing Closed Bridges from the State System
ED 68 – National Highway System (NHS) Bridge Replacement Project Prioritization Process
ED 70 – Load Restricted Bridge Replacement Prioritization Process
Supplemental to the Manual on Uniform Traffic Control Devices (MUTCD)

FHWA Publications

Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges
MUTCD
Metrics for the Oversight of the National Bridge Inspection Program (2017)
Recommended Framework for a Bridge Inspection Quality Control/Quality Assurance (QC/QA) Program

Other

American Institute of Steel Construction, 1990, Iron and Steel Beams 1873 to 1952
National Cooperative Highway Research Program (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, NBIS

1.5 COORDINATION

Users should direct questions concerning the applicability or requirements of the referenced documents to the State Bridge Maintenance Engineer (SBME) 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 SBME 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 Bridge Maintenance Office (BMO) 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 specialized hauling vehicles (SHVs), 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 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. For detailed information, see the Bridge Management Parametric Study – Final Report referenced in Section 1.4 of this Guidance Document.

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 LRFD HL-93 Design Truck + Lane, HL-93 Design Tandem + Lane and the HL-93 Truck Train + Lane, and the Load Factor Design (LFD) 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.) – Load and Resistance Factor Rating (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 – Load Factor Rating (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, ‘SHV’ stands for Specialized Hauling Vehicle and ‘SU’ stands for Single Unit truck):

- 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 (Specialized Hauling Vehicle)
- SHV-SU5 (Specialized Hauling Vehicle)
- SHV-SU6 (Specialized Hauling Vehicle)
- SHV-SU7 (Specialized 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, 17th Edition (LFD) and the AASHTO LRFD Bridge Design Specifications, 7th Edition with interims through 2016 (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 Specifications. 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, 2nd Edition with interims through 2016. A load factor of 1.3 (average of load factors based on routine permit type, unlimited crossings mixed with traffic and a Distribution Factor assuming two or more lanes) was applied to all Permit Loads according to Table 6A.4.5.4.2a-1 of the AASHTO MBE. A load factor of 1.45 was applied to all Legal Trucks according to 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 SU 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 SU Trucks, the SC-SHV1A (65k) Truck (non-interstate only) generally controlled, although the Modified AASHTO SC Type 3 Truck controls in some isolated cases. However, since the evaluation of controlling vehicles was performed based on normalized shears and moments (force effects of legal trucks divided by the HL-93 Design Truck + Lane force effect) versus by comparing Rating Factors, the SC-SHV1B truck could also control and should also be included in the load rating analysis for 3-axle SU Trucks.
- For 4- or-more axle SU Trucks, the SC-SHV2A (66k) Truck (non-interstate only) generally controlled when considering normalized force effects, although an AASHTO SU4 Truck controls in some isolated cases. Analyze also for all AASHTO Legal SHV vehicles (SU4, SU5, SU6 and SU7) and also include the SC-SHV2B truck since it could control when considering Rating Factors versus normalized gross weights.
- 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

The study results show the HL-93 Design Truck + Lane load controls the Rating Factor over all standard 110k, 120k, and 130k permit trucks for all span lengths and critical force effects. However, there are instances when the special permit cranes control over the HL-93 Design Truck + Lane load as noted below:

- For 1-span arrangements, the HL-93 Design Truck + Lane load generally controls, although the SC Crane # 527568 (177.7k) controls for spans lengths from 70’-150’ in both end shear and 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, the HL-93 Design Truck + Lane load generally controls, although:
  - Permit Cranes (SC Crane # 544726 (160k) or SC Crane # 527568 (177.7k)) control over the HL-93 Design Loading Truck + Lane load in the 55’ – 110’ span lengths for shear points of interest.
  - Permit Crane # 527568 (177.7k) controls over the HL-93 Design Truck + Lane load in the 70’ – 140’ span lengths for moment at .4L of end spans and .5L of the center span.
  - Either the SC Crane # 544726 (160k) or SC Crane # 527568 (177.7k) controls over the HL-93 Design Truck + Lane load for the 25’- 40’ span lengths for maximum negative moment at interior bents.

2.3.3 Emergency Vehicles

Emergency vehicles should always be included in the rating analysis.

CHAPTER 3 LOAD RATING CHECKING AND QA/QC

3.1 GENERAL REQUIREMENTS

Load rating results shall be checked for accuracy as part of the QA/QC process.

3.2 QUALIFICATIONS OF LOAD RATING PERSONNEL

Load ratings and load rating checks shall be performed by individuals familiar with the MBE and this Guidance Document and qualified to perform load ratings. 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 (Engineer of Record (EOR)). The QC Engineer and QA Engineer shall be independent individuals (not the individual performing the load rating), shall have familiarity with the load rating process, the MBE and this Guidance Document, and shall have qualifications equal to or exceeding the load rater.

3.3 COMPUTER SOFTWARE AND COMPUTER SOFTWARE VERIFICATION

SCDOT requires the use of AASHTOWare BrR, version 6.8.3 load rating software for all structure types supported by this software. AASHTOWare BrR can be used to load rate concrete culverts as well as steel rolled beam, steel girder, steel floor beam, prestressed concrete girder, concrete slab, concrete girder, timber beam, and steel truss bridges using the Allowable Stress Rating (ASR), LFR, or LRFR methods.

If a specialized structure type or specific structural components 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 SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2). A table of preferred alternative software is listed in Appendix A3.1 to this chapter. The load rater should attempt to utilize and must obtain approval for software from this list prior to requesting approval for other alternative software. If Microsoft EXCEL and / or PTC Mathcad are used for purposes related to the load rating, pre-approval by SCDOT for using either EXCEL or PTC Mathcad 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 (LRSF),
- Documentation of the QC process (complete the "Quality Control Engineer" box on the LRSF).

3.5.1.1 QC Review Checklist

In addition to completing the "Quality Control Engineer" box on the LRSF, consultants shall utilize a standardized checklist to document the QC process for all bridges they have load rated. An image of the standardized QC Review Checklist and a link to an online version of the checklist are included in Appendix A3.2 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 and submit the spreadsheet on a monthly basis. An image of the standardized QC Review Tracking Sheet and a link to an online version of the tracking sheet are included in Appendix A3.3 of this chapter.

3.5.2 QA Review

Consultants shall not perform QA review for their own load ratings; QA review shall be performed by a different consultant than the consultant that performed the load rating analysis. QA review shall be performed on a monthly basis for a sample set of all load ratings submitted by consultants the previous month. The QA review shall include the following:

- Review of the QC Review documentation (QC Review Checklist),
- Review of the LRSF,
- Confirmation that a QC review was completed for the selected load ratings,
- Confirmation that each QC comment received a response and was resolved,
- Verification of consistency in load rating procedures among all consultants involved in the load rating process,
- Documentation of the QA process (complete the "Quality Assurance Engineer" box on the LRSF).

3.5.2.1 QA Review Checklist

The QA Engineer shall use a standardized checklist to document the QA process for all bridges included in his or her review. An image of the standardized QA Review Checklist and a link to an online version of the checklist are included in Appendix A3.4 of this chapter.

3.5.2.2 QA Tracking Spreadsheet

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 NHS
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, it 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). An image of the standardized QA Review Tracking Sheet and a link to an online version of the tracking sheet are included in Appendix A3.5 of this chapter. The QA Engineer shall also fill in the last column “Date QA Review Performed” after QA review is completed.

APPENDIX A3.1: PREFERRED ALTERNATIVE LOAD RATING SOFTWARE

Table A3.1. Preferred Alternative Load Rating Software

Preferred Alternative Software	Software Purpose
CSI Bridge	General Finite Element Analysis & Complex Steel
LARSA	General Finite Element Analysis & Complex Steel
SAP	General Finite Element Analysis
GT STRUDL	General Finite Element Analysis
STAAD.Pro	General Finite Element Analysis
MIDAS	General Finite Element Analysis
CANDE	Complex Culvert
CONSPAN	Prestressed Concrete Girder
PGSuper	Prestressed Concrete Girder
PSBeam	Prestressed Concrete Girder
CONBOX	Reinforced or Post Tensioned Concrete Girder
NSBA Simon	Steel Girder
STLBRIDGE	Steel Girder
MDX	Curved or Complex Steel Girder
Merlin Dash	Curved or Complex Steel Girder
DESCUS	Curved or Complex Steel Girder
LEAP Bridge Steel	Curved or Complex Steel Girder
RAM Steel Beam	Curved or Complex Steel Girder
BRASS	Concrete Substructure
FB Pier	Substructure / Foundation
FB Multipier	Substructure / Foundation
Ensoft Lpile	Substructure / Foundation
Ensoft Group	Substructure / Foundation
RC Pier	Substructure / Foundation
spColumn	Substructure / Foundation
RAM Concrete Structural System	Substructure / Foundation

APPENDIX A3.2: QC REVIEW CHECKLIST

Load Rating QC Review Checklist

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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:

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. If BrR was not used, hand calculations to verify software were provided as required and formally checked.
☐	5. The Load Rating Summary (LRS) Form was completed entirely and correctly.
☐	6. The LRS Form agrees with the results of the load rating / load rating check.
☐	7. BMO Approval was provided, if needed.
☐	8. Bridge Signing/Posting Form was filled out correctly, if needed.
☐	9. The "Quality Control Engineer" box on the LRS Form was completed.

QUALITY CONTROL ENGINEER

I certify that Quality Control review has been performed per the requirements of the LRGD.

Name	Company/Title
Signature	Date

A link to the latest version of the QC Review Checklist is located here: QC Review Checklist (hot link to be provided)

APPENDIX A3.3: QC REVIEW TRACKING SHEET

QC Review Tracking Sheet

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Consultant: (Enter consultant name) ***Month: (Enter month of ratings completed)***

**This table of completed and submitted Rating Packages is to be submitted for QA at the end of each month.*

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? (Appendix A18.1)	(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

A link to the latest version of the QC Review Tracking Sheet is located here: QC Review Tracking Sheet (hot link to be provided)

APPENDIX A3.4: QA REVIEW CHECKLIST

SCDOT

Load Rating QA Review Checklist

Version: 1.0
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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:

SECTION 2: LOAD RATING QC 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, including supplemental calculations, Site Assessment Form, Data Correction Form, BMO Approvals Form (if required), and Bridge Signing/Posting Form (if required).

☐ 2. If BrR was not used, hand calculations to verify software were provided as required and formally checked.

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

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

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

☐ 6. The “Quality Control Engineer” box and “Quality Assurance Engineer” box on the LRS Form were completed.

QUALITY ASSURANCE ENGINEER

I certify that Quality Assurance review has been performed per the requirements of the LRGD.

Name | Company/Title

Signature | Date

A link to the latest version of the QA Review Checklist is located here: QA Review Checklist (hot link to be provided)

APPENDIX A3.5: QA REVIEW TRACKING SHEET

A03.5_QA Load Rating Review Tracking Sheet Template.xlsm

SCDOT

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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
17	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	97401	Yes	XX/XX/XXXX
49	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	93023	Yes	XX/XX/XXXX
45	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	92703	Yes	XX/XX/XXXX
50	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	92386	Yes	XX/XX/XXXX

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
22	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	87090	Yes	XX/XX/XXXX
19	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	78474	Yes	XX/XX/XXXX
44	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	78379	Yes	XX/XX/XXXX

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
18	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	86342	Yes	XX/XX/XXXX
37	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	73521	Yes	XX/XX/XXXX

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
41	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	96505	Yes	XX/XX/XXXX
33	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	91153	Yes	XX/XX/XXXX
43	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	88492	Yes	XX/XX/XXXX

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	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	78412	Yes	XX/XX/XXXX

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	XXXXX	X	X	X	X	X	X	X	X	X	X	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	XX/XX/XXXX	25824	Yes	XX/XX/XXXX

A link to the latest version of the QA Review Tracking Sheet is located here: QA Review Tracking Sheet (hot link to be provided)

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 edition of the 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, 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 members (FCM) 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 and documented as such. 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 Bridge Inspection Team Leader requests a load rating to be performed based on inspection results.
- 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 LRFR method prior to opening the bridge to the public. An Asset ID request should be submitted by the bridge designer, SCDOT or Consultant at the Preliminary Plans phase. An image of the form and a link to an online version of the form are included in Appendix A5.1. Load Rating Submittal Packages shall be delivered at the same time as Released for Construction Plans and updated as needed with as-built plans if there have been any changes to the bridge that affect the load rating. Refer to Chapters 7 through 18 of this Guidance Document, inclusive, for SCDOT's rating policies for the various material and component types.

4.5 EXISTING BRIDGES

Refer to Section 6.9.3 of this Guidance Document for direction of when to use ASR, LFR or LRFR load rating methods.

Refer to Chapters 7 through 18 of this Guidance Document, inclusive, for SCDOT's rating policies for the various material and component types.

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 load rater's responsibility to determine the reliability and applicability of all available information used to support the rating.

Consultants needing information from the Bridge File to perform a load rating will need to first request a ProjectWise account with SCDOT. Once a ProjectWise account is established, send a request to access the Bridge File by contacting the SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2).

All new bridge designs shall require a load rating. An Asset ID request should be submitted by the bridge designer, SCDOT or Consultant at the Preliminary Plans phase. An Asset ID request should also be submitted for bridges that are discovered to not have an Asset ID. If an Asset ID number has not been assigned and is needed to complete the load rating, it may be requested by using the Asset ID Request Form. An image of the form and a link to an online version of the form are included in Appendix A5.1.

5.2 EXISTING PLANS

Existing plans are used to determine loads, bridge geometry, component cross sections and material properties. Such plans may include as-let plans, as-built plans, shop drawings, and repair plans. Design plans, also referred to as as-let 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-let 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. Any plans, sketches or diagrams created for use during the load rating shall be supplied to the SCDOT with the load rating for future reference and use.

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 load rater to determine how the documented losses will impact the load carrying capacity of the structure.

5.4 STRUCTURE INVENTORY AND APPRAISAL (SI&A) DATA

Standard NBI data fields summarized in the SI&A sheet also provide information that may be utilized to support the load rating analysis. The load rater should be cautious to verify and confirm SI&A data affecting the load rating. Erroneous SI&A data found during the load rating process must be corrected by the load rater in the inspection software and transmitted to BMO via the Data Correction Form. An image of the form and a link to an online version of the form are included in Appendix A5.2 to this chapter. See this appendix for examples of SI&A fields that can be updated and for tolerance of what SCDOT considers to be erroneous. If no discrepancies are found in the SI&A data, the Data Correction Form is not required to be submitted.

5.5 LABELING DIAGRAM

All bridges, including new bridges, are required to have a labeling diagram completed as part of the initial load rating. The labeling diagram shall be in accordance with the guidelines in Appendix A5.3. When existing plans are available, orientation and numbering of bridge elements referenced in the labeling diagram 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 conventions described in Appendix A5.3 to this chapter. Subsequent inspections and load ratings shall be performed using the same labeling convention for consistency.

5.6 SITE ASSESSMENTS

If existing plans are not available and/or bridge inspection reports and SI&A data do not contain adequate information or sufficient detail to perform the load rating, an independent Site Assessment may be required to collect the necessary data to perform the load rating. The development of record drawings or sketches documenting information gathered to complete the load rating shall follow the member naming and orientation in the labeling diagram. If a labeling diagram does not exist, one shall be created for use prior to the Site Assessment.

Prior to performing a Site Assessment, notify the SBME or designated representative to document the additional effort required for the Site Assessment and obtain approval for the added effort (see Bridge Maintenance Office Approvals Form in Appendix A20.2). To obtain approval for the additional effort to perform a Site Assessment, the consultant would be expected to provide scoping details for the Site Assessment regarding the expected traffic control requirements, bridge access equipment needed (i.e. snooper truck, ladders, man lift etc.), and the expected deterioration or members that would need to be measured. Consultants should be expected to provide their own traffic control and provisions for bridge access.

An image of the template for documenting information affecting the load rating as a result of a Site Assessment and a link to an online version of the form are included in Appendix A5.4 to this chapter.

If, during the Site Assessment, the load rater discovers a structural or safety related defect which qualifies as a Critical Finding – Priority A – “A Flag” or Critical Finding – Priority B – “B Flag”, in accordance with Chapter 8 of the BIGD, he/she shall report the finding(s) to the applicable SCDOT district and the BMO within two (2) business days by using the Critical Deficiencies Form found in the BIGD. Once the form is submitted by the load rater, verification that the critical deficiency has been addressed is the responsibility of the district.

5.7 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-let 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: ASSET ID REQUEST FORM

SCDOT

Asset ID Request Form

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SECTION 1: CONTACT INFORMATION	
Name of Person Requesting Data:	
Requestor's Email:	
Requestor's Phone:	
Requestor's Company/Title: *(enter SCDOT if in-house request)*	
Date of Request:	

SECTION 2: REQUEST ASSET ID NUMBER						
(2) DISTRICT: Select District			(3) COUNTY: Select County			
PROJECT NUMBER:			DATE OF PRELIMINARY PLANS:			
OLD ASSET ID(S) *(if applicable)*:						
LOCATION: *(Town, Municipality, Distance from known Town/Landmark):*						
FACILITY CARRIED: *(What the bridge carries):*						
FEATURE INTERSECTED: *(What the bridge spans over):*						
BRIDGE COORDINATES:						
LATITUDE:		degrees		minutes		seconds
LONGITUDE:		degrees		minutes		seconds

SECTION 3: SCDOT ROAD DATA SERVICES RESPONSE *(will contact requester for additional information, if needed)*

Send to SCDOT Road Data Services   Road Data Services: Return to Sender

A link to the latest version of the Asset ID Request Form is located here: Asset ID Request Form (hot link to be provided)

APPENDIX A5.2: DATA CORRECTION FORM

SCDOT

Data Correction Form

Version: 1.0
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SECTION 1: CONTACT INFORMATION	
Name of Person Requesting Data:	
Requestor's Email:	
Requestor's Phone:	
Requestor's Company/Title: *(enter SCDOT if in-house request)*	
Date of Request:	

SECTION 2: DATA CORRECTION

The following are SI&A fields that should be noted if discrepancies are found in SCDOT Bridge Database. Fields not listed can also be included if other discrepancies are found. Reference the Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (1995). Additional guidance is as follows:

- *For quantifiable fields such as SI&A No. 49, discrepancies should be noted if correct data is not within 5% or 1 ft., whichever is greater, or if the load rater determines that the discrepancy from values in the database is significant and impactful.*
- *Fields shown on this form that cannot be updated in inspection software are SI&A Nos. 1, 2, 3, 6, 7, 9, 11, 16, 17, and 26.*
- *Fields SI&A Nos. 6 and 7 should be updated per standardized naming guidance for Feature(s) Intersected and Facility Crossed. See appendix in Bridge Inspection Guidance Document.*
- *Fields with NBI condition ratings that should match the most recent inspection report are SI&A Nos. 58, 59, 60, 61, 62, 90, and 91.*
- *Fields that shall be updated after completion of load rating QC and may need to be updated if errors are found during load rating QA are SI&A Nos. 41, 63, 64, 65, 66, 70, 411, and 418.*
- *Field SI&A No. 418 should reflect the NBI condition ratings during the load rating; the first digit is the deck rating, the second digit is the superstructure rating, and the third digit is the substructure rating.*

(8) Asset ID:	(2) District	(3) County:
	Select District	Select County

NBI DATA FIELD: *See note above this table.*	INCORRECT DATA: *Enter data as it currently appears in the SCDOT Database.*	RECOMMENDED CORRECTED DATA: *Enter recommended correction to existing data.*	UPDATED IN INSPECTION SOFTWARE? *Select 'Yes' or 'No'. If No, Form must go to Road Data Services.*
(1) State Name			Select Response
(2) District			Select Response
(3) County			Select Response
(6) Feature(s) Intersected			Select Response
(7) Facility Carried			Select Response
(9) Location			Select Response
(11) Milepost			Select Response
(16) Latitude			Select Response
(17) Longitude			Select Response
(26) Functional Class			Select Response
(27) Year Built			Select Response
(28) Number of Lanes; On (A), Under (B)			Select Response
(31) Design Vehicle			Select Response
(33) Bridge Median			Select Response
(34) Skew			Select Response
(41) Traffic Status			Select Response
(42) Type of Service; On (A), Under (B)			Select Response
(43) Structure Type – Main Spans			Select Response
(44) Structure Type – Approach Spans			Select Response

Data Correction Form

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NBI DATA FIELD: *See note above this table.*	INCORRECT DATA: *Enter data as it currently appears in the SCDOT Database.*	RECOMMENDED CORRECTED DATA: *Enter recommended correction to existing data.*	UPDATED IN INSPECTION SOFTWARE? *Select 'Yes' or 'No'. If No, Form must go to Road Data Services.*
(45) Number of Main Spans			Select Response
(46) Number of Approach Spans			Select Response
(48) Length of Maximum Span			Select Response
(49) Structure Length			Select Response
(50) Curb or Sidewalk Width; Left (A), Right (B)			Select Response
(52) Deck Width			Select Response
(58) Deck Condition Rating			Select Response
(59) Superstructure Condition Rating			Select Response
(60) Substructure Condition Rating			Select Response
(61) Channel and Channel Protection			Select Response
(62) Culvert and Condition Rating			Select Response
(63) Method of Operating Rating			Select Response
(64) Operating Rating			Select Response
(65) Method of Inventory Rating			Select Response
(66) Inventory Rating			Select Response
(70) Bridge Posting			Select Response
(90) Inspection Date			Select Response
(91) Inspection Frequency			Select Response
(101) Parallel Structure			Select Response
(104) NHS			Select Response
(106) Year Reconstructed			Select Response
(108) Wearing Surface			Select Response
(411) Date of Load Rating			Select Response
(418) Conditions During Rating			Select Response
			Select Response
			Select Response
			Select Response
			Select Response
			Select Response

SECTION 3: SCDOT ROAD DATA SERVICES RESPONSE

(will contact requester for additional information, if needed)

Send to SCDOT Road Data Services | Road Data Services: Return to Sender

A link to the latest version of the Data Correction Form is located here: Data Correction Form (hot link to be provided)

APPENDIX A5.3: STANDARDIZED BRIDGE ORIENTATION AND LABELING CONVENTION

The purpose of creating a labeling diagram for all bridges, both new and existing, is to provide a reference and naming convention for all subsequent load ratings and inspections. If existing plans are available for the bridge, the labeling convention should match the existing plans. Labeling diagrams shall be submitted with the initial load rating.

Orientation and numbering of bridge elements shall be as shown on the plans whenever available. When plans are not available, the numbering of piers, beams etc. shall be oriented as described in this appendix.

Labeling diagrams should always include a north arrow to provide a reference to the cardinal directions. For bridges over rivers and streams, stream orientation shall be established facing downstream with the left bank on the left facing downstream and the right bank on the right facing downstream. For tidal rivers, downstream shall be considered in the direction of the ebb (outgoing) tide.

The running direction of the roadway (upstation or in the direction of increasing mile posts) shall be used to establish orientation of bridge element numbering. For bridges oriented on a predominantly east/west axis, incremental numbering of span numbers and bridge elements, such as substructure bent numbering, shall increase from west to east, and girder/stringer numbering shall increase from north to south. For truss bridges, there will be a north truss and a south truss, and panel points shall be numbered in increasing order from west to east as shown in Figure A5.3-1.

For bridges oriented on a predominantly north/south axis, incremental numbering of span numbers and bridge elements, such as substructure bent numbering, shall increase from south to north, and girder/stringer numbering shall increase from west to east. For truss bridges, there will be a west truss and an east truss and panel points shall be numbered in increasing order from south to north as shown in Figure A5.3-1.

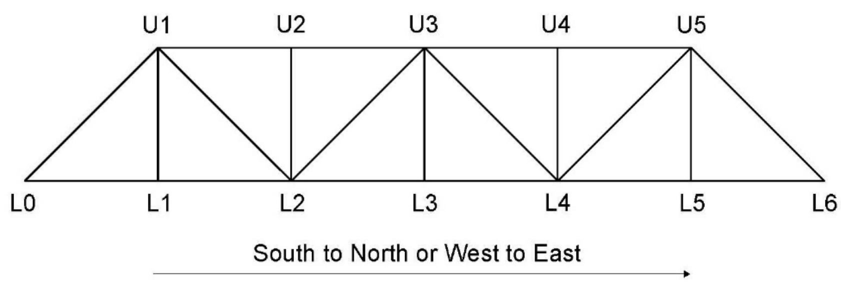

Figure A5.3-1. Truss Elevation Labeling Convention

Span numbering shall start with the number 1 with girder, beam or stringer numbering tied to the respective increasing span number (i.e. start with Girder 1-1 in Span 1, then with Girder 2-1 in Span 2). See Figure A5.3-2. Similarly, Floor Beam (FB) numbering shall be tied to increasing span numbering (i.e. starting with FB 1-1 along Span 1, then starting with FB 2-1 along Span 2). For multi-span continuous bridges, the first floor beam on the subsequent span shall be the one located directly over the pier between the spans. See Figure A5.3-3. Note: for Figures A5.3-2 and A5.3-3, the labeling convention applies to both simple span and continuous girders.

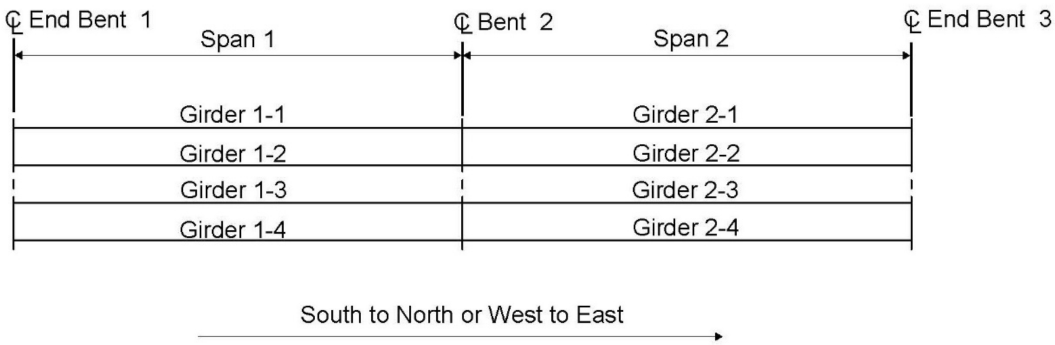

Figure A5.3-2. Girder Plan View Labeling Convention

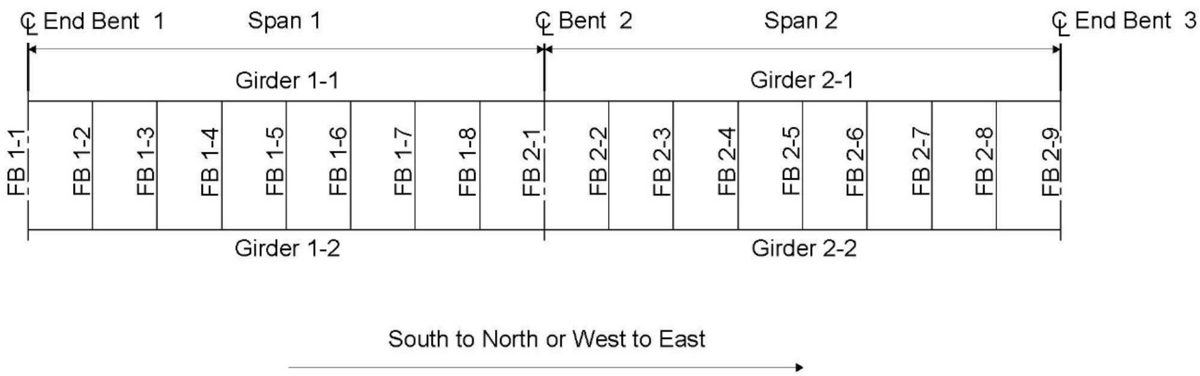

Figure A5.3-3. Girder and Floor Beam Plan View Labeling Convention

Substructure units shall start with the number 1 at the abutment or end bent (i.e. Abutment/End Bent 1, Pier/Bent 2, Pier/Bent 3, Pier/Bent 4, and Abutment/End Bent 5 for a 4-span bridge). Column and footing numbering shall increase from left to right for each bent. If new columns or footings are added outside the existing columns and footings, as in the case of a bridge widening, use an alpha designation for the added columns and footings corresponding to the nearest adjacent column or footing.

Each pile in a substructure shall have a unique number assigned to it. Pile numbers shall be assigned in the direction of the stationing from left to right. Pile numbers are composed of two parts: the first number corresponds to the bent number and the second number is the unique pile number within the substructure component. If piles are added within a substructure unit, the unit maintains the numbering of the original piles and adds an alpha character to the designation of the new pile. When piles are added outside of the existing piles, as in the case of a bridge widening, label new piles with new numbers, starting with the lowest unused number. Refer to Figures A5.3-4 through A5.3-6.

A sample labeling diagram developed from as-built plans of an existing bridge in the SCDOT database is shown in Figure A5.3-7.

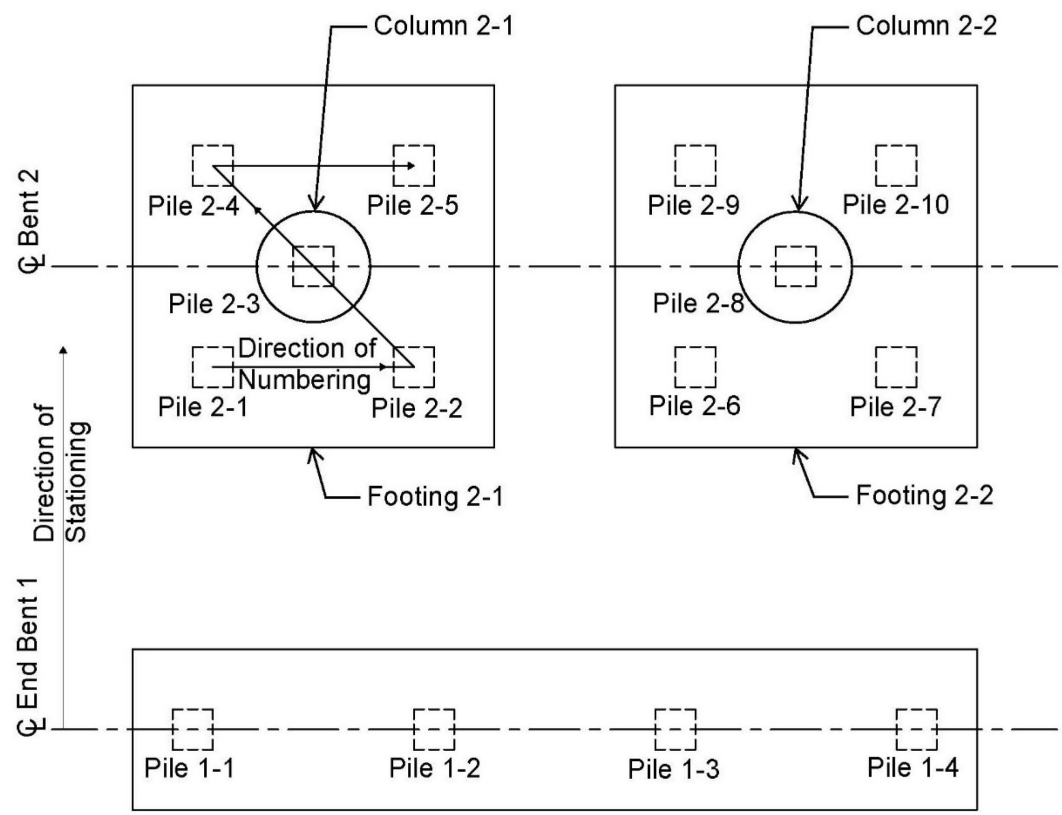

Figure A5.3-4. Standard Pile Labeling Convention

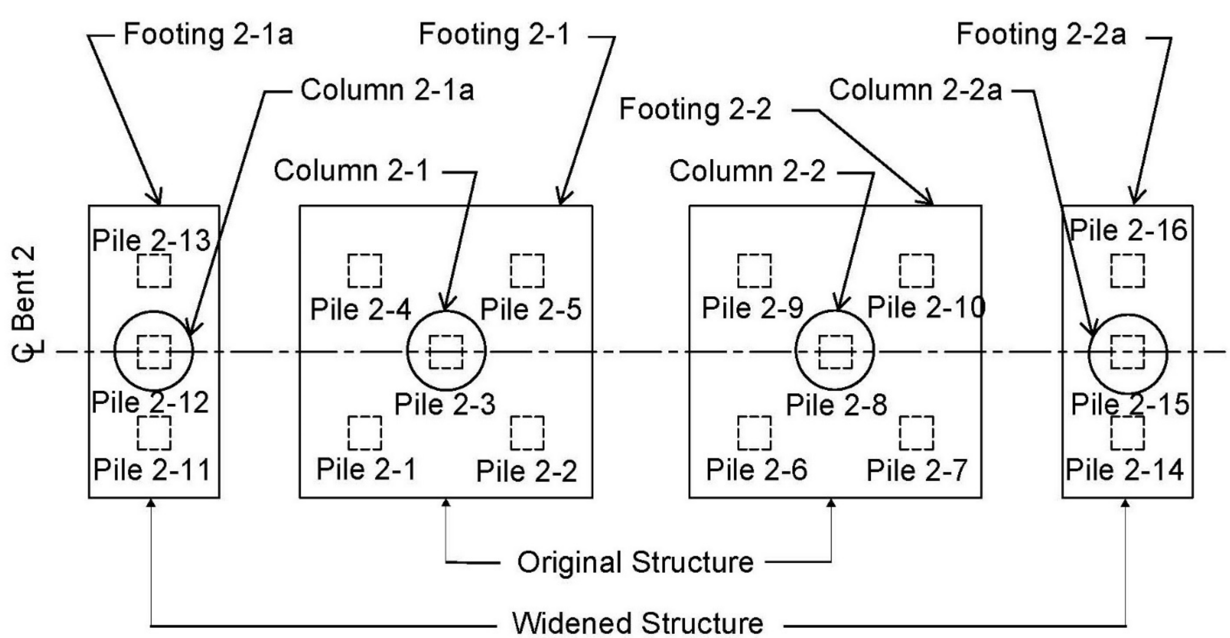

Figure A5.3-5. Labeling Convention for Widened Substructure with Added Piles

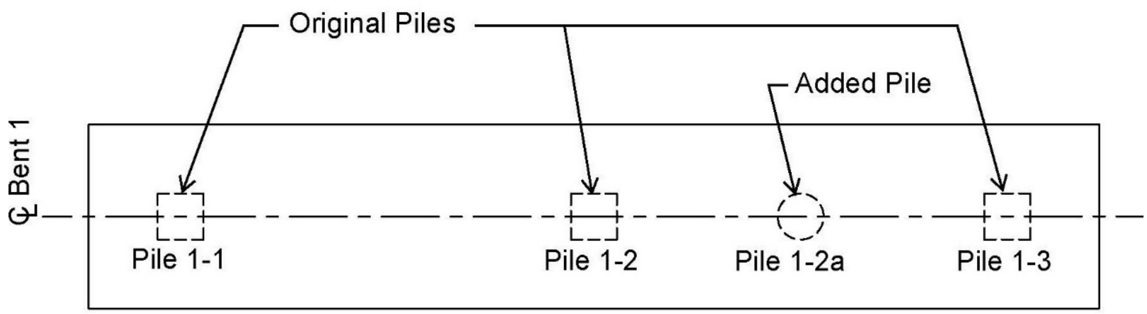

Figure A5.3-6. Pile Numbering for an Added Pile

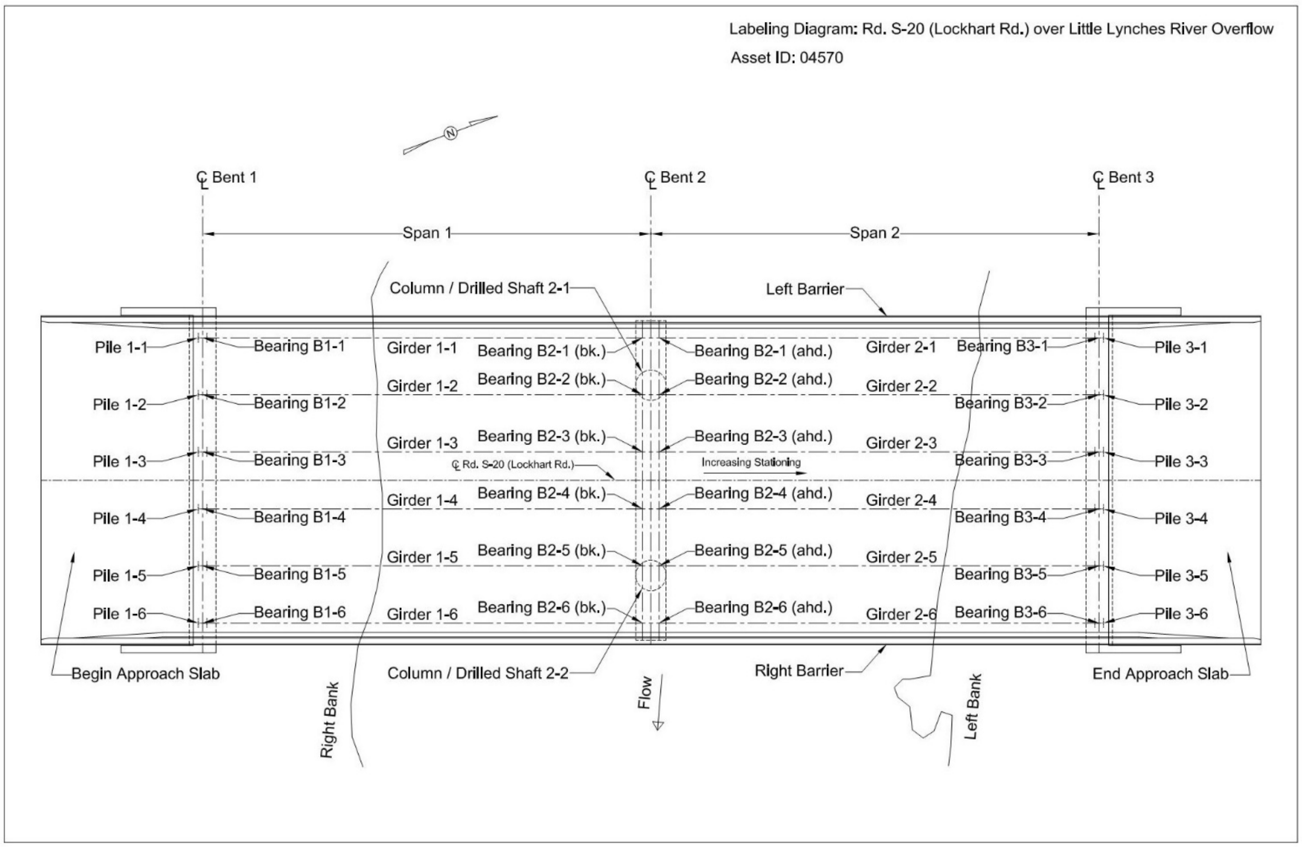

Figure A5.3-7. Sample Labeling Diagram

APPENDIX A5.4: SITE ASSESSMENT FORM

Site Assessment Form

Version: 1.0
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SECTION 1: GENERAL BRIDGE DATA				
(8) Asset ID:	(2) District:	(3) County:	(9) Bridge Location:	Site Assessment Date:
	Select Distri	Select Count		

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. Only include site assessment critical findings which impact the load rating; however, all critical findings should be reported in the "Critical Deficiencies Form" (see Bridge Inspection Guidance Document).

Site Assessment Form

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

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. Include information on specialized equipment, traffic control, or other needs to perform secondary Site Assessment.

Site Assessment Form

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

SECTION 4: FIELD SKETCHES

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

Site Assessment Form

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

SECTION 5: PHOTOGRAPHS

Include photos of information to assist with the load rating only. Also include photos of postings for weight or other restrictions, e.g. signs showing "1-Lane Bridge". 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

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

SECTION 5: PHOTOGRAPHS

Include photos of information to assist with the load rating only. Also include photos of postings for weight or other restrictions, e.g. signs showing "1-Lane Bridge". 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 (hot link to be provided)

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 inspection or site assessment.

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, 17th Ed. 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 load rater 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 and Legal 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 and the footnotes to 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, EVs 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
	Lane Type Loading (Neg. M only)	2- 0.75 AASHTO Type 3-3 + .2 klf Lane	6.5-1
	Lane Type Loading (Span > 200 ft)	1- 0.75 AASHTO Type 3-3 + .2 klf Lane	6.5-1

* In addition to the vehicles listed, include SC-SHV1B (70k) (Fig. 6.5-2b) for load ratings of non-interstate bridges.

**In addition to the vehicles listed, include SC-SHV2B (80k) (Fig. 6.5-2b) for load rating of non-interstate bridges.

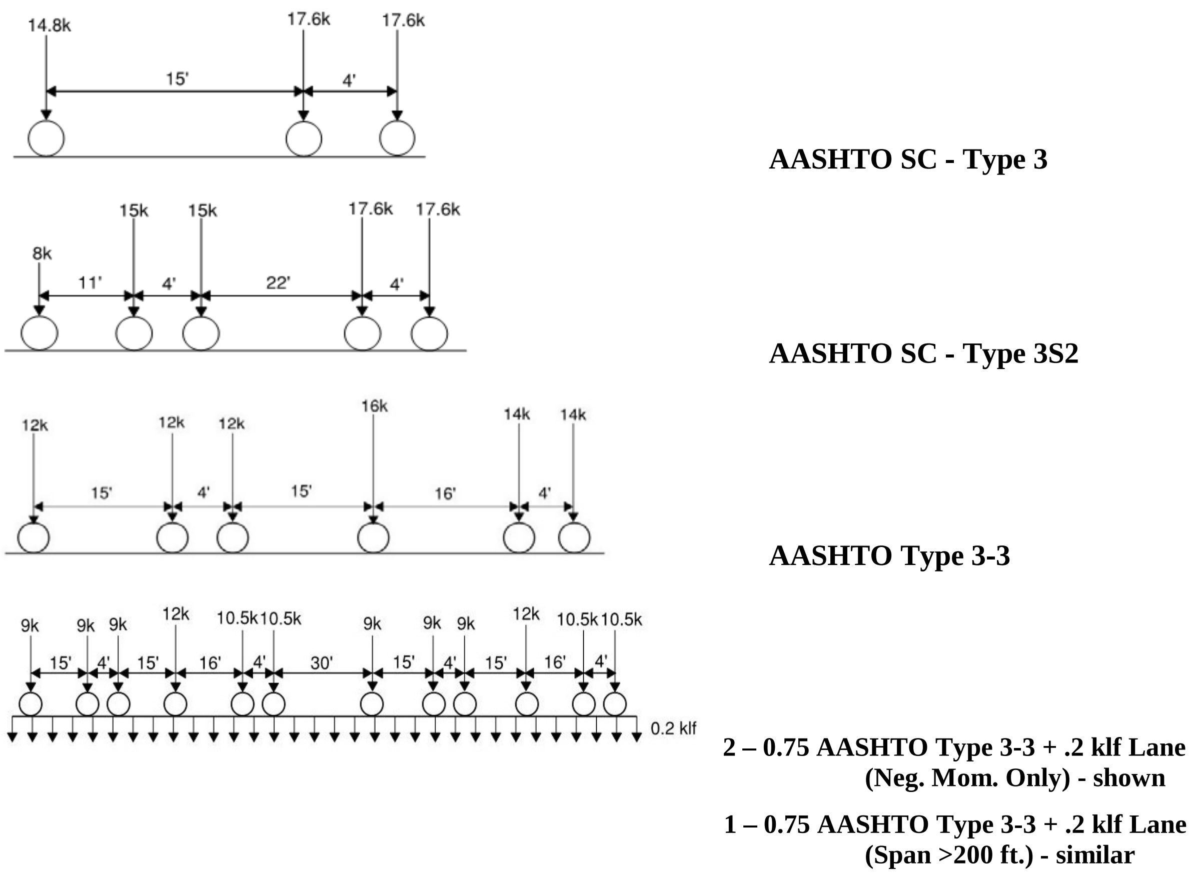
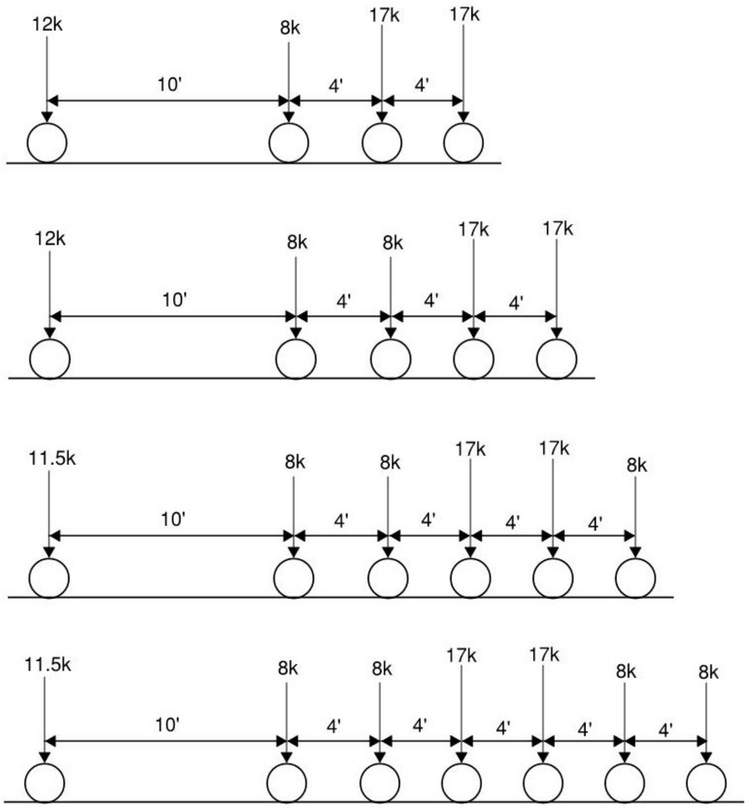


Figure 6.5-1. Legal Loads (Showing Axle Loads)



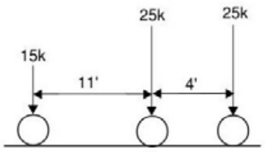
AASHTO SHV – SU4

AASHTO SHV – SU5

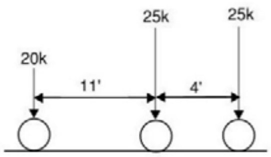
AASHTO SHV – SU6

AASHTO SHV – SU7

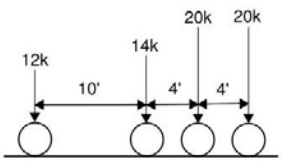
Figure 6.5-2a. AASHTO Specialized Hauling Vehicles (Showing Axle Loads)



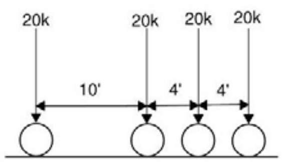
SC-SHV1A (65k)



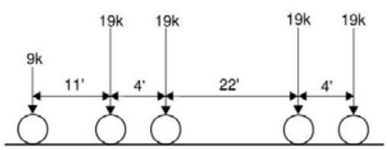
SC-SHV1B (70k)



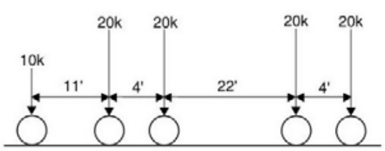
SC-SHV2A (66k)



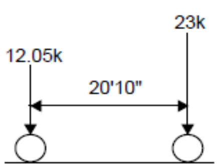
SC-SHV2B (80k)



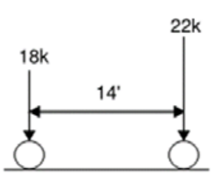
SC-SHV3A (85k)



SC-SHV3B (90k)

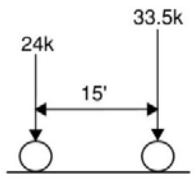


SC Representative School Bus

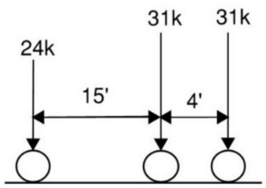


SC-SU2

Figure 6.5-2b. South Carolina Specialized Hauling Vehicles and Other Posting Vehicles (Showing Axle Loads)

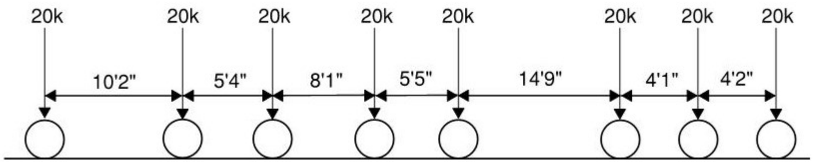


EV2 (57.5k)

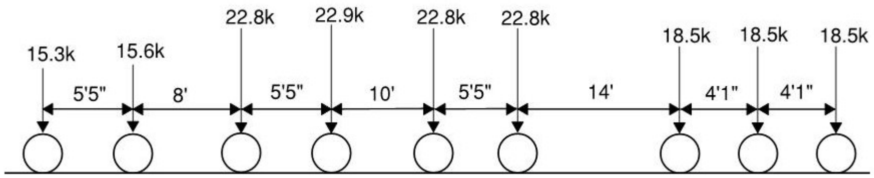


EV3 (86k)

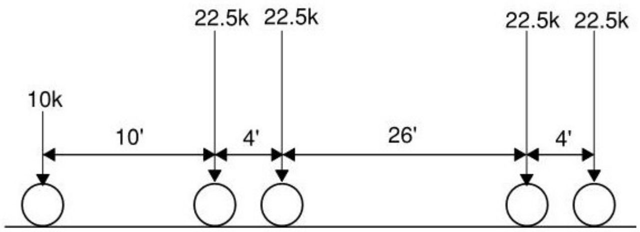
Figure 6.5-3. Emergency Vehicles (Showing Axle Loads)



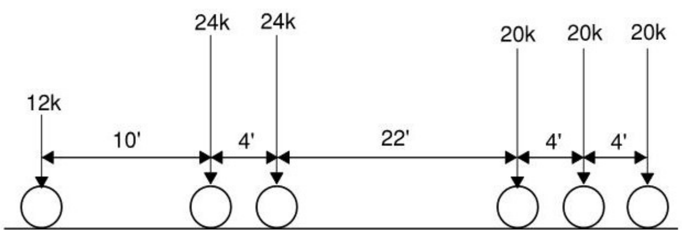
SC Crane #544726 (160k)



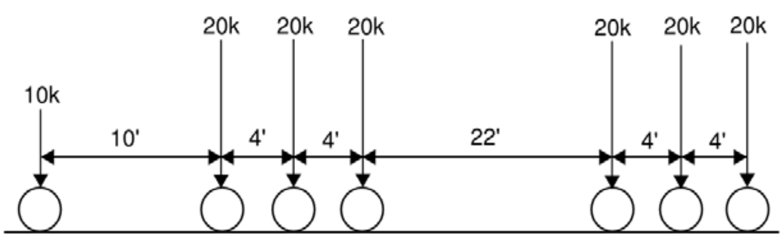
SC Crane # 527568 (177.7k)



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 American Society of Civil Engineers 7, Current 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 SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2). Impact loading for culverts shall be in accordance with MBE Section 6A5.12.10.3b for LRFR ratings and 6B.6.4 for ASR and LFR ratings.

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.

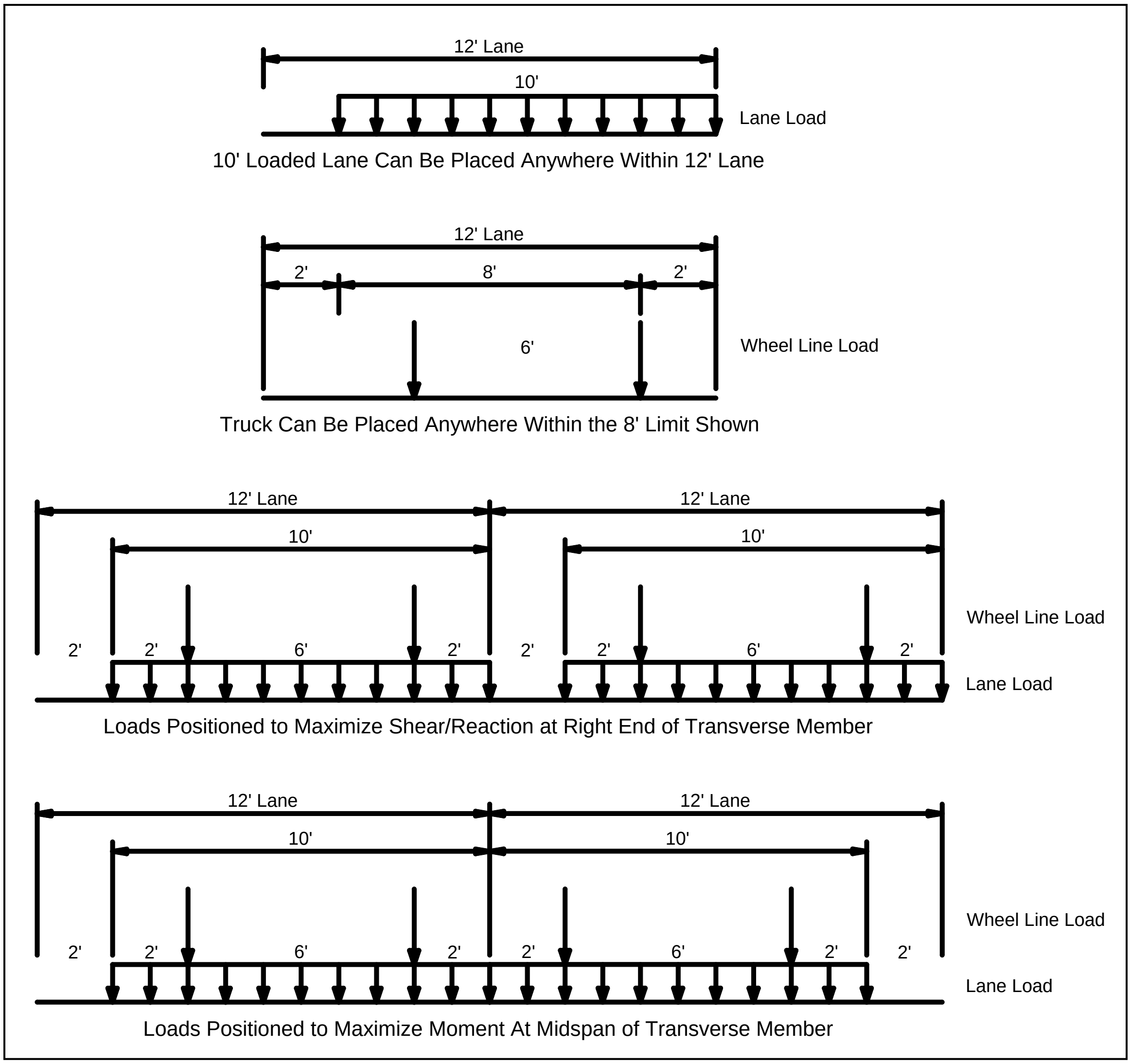


Figure 6.7.2-1. Examples of Live Load Positioning Using the LRFR Method

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 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 17th 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 SHVs and EVs 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 legal load rating level as described in Section 6.5.

All bridges are required to be rated for permit vehicles at the permit load rating 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

All bridges should be rated using the LRFR methodology initially. For alternative results, bridges should be rated using the LFR methodology, except for timber and masonry bridges, which should be rated using ASR. BMO approval is not required for use of alternative rating methods.

6.9.4 When to Use Field Evaluation and Documented Engineering Judgment

Field evaluation and documented engineering judgment can be used in Inventory and Operating 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 shall include supporting calculations and assumptions for the critical locations to demonstrate how the 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 in accordance with the MBE, Article 6A.4.5.4. For span lengths greater than 300 feet, permit loads should be determined for conditions specific to the bridge being rated. 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 SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2).

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 Average Daily Truck Traffic (ADTT) used to select the live load factors shall be taken from the SI&A Sheet. The value should be obtained using the following equation:

ADTT = Average Daily Traffic (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 load rater 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 SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2). 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 OR MATERIAL 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 SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2). 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, or
3. There is a public need to allow larger vehicles to cross a bridge than the conventional analysis will allow.

Material testing on a case-by-case basis may be considered, subject to approval by the SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2), when:

1. Existing plans are not available to establish material strengths to use during load rating,
2. Material strength estimates, based on year built, would produce an overly conservative load rating, or
3. When there is reason to suspect that material strength could have decreased due to deterioration, such as concrete deterioration.

Refer also to Section 19.2.2 of this Guidance Document for direction from the MBE on material sampling for bridge evaluation.

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]: 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
CALIFORNIA REDWOOD (Surfaced dry, Used at 19% max. m.c.)									
Clear Heart Structural	4" and less thick any width	2300	—	1550	145	425	2150	1,400,000	Redwood Inspection Service
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.)									
Dense Select Structural	2" to 4" thick 2" to 4" wide	2450	—	1400	95	455	1850	1,900,000	West Coast Lumber Inspection Bureau and Western Wood Products Association (see footnotes 2 through 9)
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	

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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 Commercial Decking	Decking	—— ——	2150 1800	——	——	(Stresses apply at 15% moisture content)		1,900,000 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	

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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	

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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	

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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.)									National Lumber Grades Author. (A Canadian agency. See footnotes 2 through 8 and 12)
Select Structural	2" to 4" thick 6" and wider	1200	1350	800	70	280	900	1,300,000	
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.)									Southern Pine Inspection Bureau
Selected Structural	2" to 4" thick 2" to 4" wide	2100	——	1250	90	405	1600	1,800,000	
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	

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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	

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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

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[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.

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

Combination Symbol	Number of Laminations	Allowable unit stresses: Extreme Fiber in Bending F_b[4 5]	Tension Parallel to Grain F_t	Compression Parallel to Grain F_c	Compression ⊥ to Grain: Tension Face $F_{c\perp}$	Compression ⊥ to Grain: 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

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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

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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.

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.

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CHAPTER 7 REINFORCED CONCRETE DECKS

7.1 INTRODUCTION

This section covers the rating of reinforced concrete decks. In accordance with Section 6.1.5.1 of the MBE, stringer supported concrete deck slabs that are carrying normal traffic satisfactorily need not be routinely evaluated for load capacity. 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 OTHER DECKS

8.1 INTRODUCTION

This section covers the rating of timber and metal decks.

8.2 TIMBER DECKS

In accordance with Section 6.1.5.1 of the MBE, Timber decks that exhibit excessive deformations under normal traffic loads are considered suitable candidates for further evaluation and often control the rating.

8.2.1 Policies and Guidelines

Timber decks shall be rated for bending and horizontal shear capacity.

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 bridge decks 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.

8.3 METAL DECKS

Metal decks may include orthotropic steel decks, orthotropic aluminum decks, open grid metal (steel or aluminum) decks, partially or completely filled metal (steel or aluminum) grid decks, unfilled metal grid decks composite with a reinforced concrete slab cast on top of the metal grid, corrugated metal pans filled with bituminous asphalt or another surfacing material, or extruded aluminum decks.

In accordance with Section 6.1.5.1 of the MBE, stringer supported metal decks that are carrying normal traffic satisfactorily need not be routinely evaluated for load capacity.

8.3.1 Policies and Guidelines

Due to lack of specific guidance from the MBE, load rating analysis of metal decks, if required due to inspection findings, shall be in accordance with engineering principles and requirements of Section 9.8 of the AASHTO LRFD Bridge Design Specifications, Current Edition.

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.

Superimposed dead loads (e.g. curbs, barriers, raised sidewalks, parapets, railings, future wearing surfaces) placed after the concrete deck slab has cured, shall be distributed to the girders in accordance with the BDM.

If a sacrificial layer for the bridge deck was considered in the design of the bridge, the weight of the sacrificial layer shall be included in dead load calculations for load rating but shall not be considered to provide structural contribution for the load rating analysis.

Prior to September 12, 1990, bridge decks were designed for no sacrificial layer and a 2” top clear cover. Therefore, for bridges designed prior September 12, 1990, consider the top 2” as effective in load rating analyses unless noted otherwise on the as-built drawings.

Design Memorandum DM08/90 dated September 12, 1990 designated the top ¼” of a bridge deck as sacrificial and Design Memorandum DM0196 dated February 14, 1996 increased the top clear cover from 2” to 2 ½”, which is consistent with the current BDM. Therefore, for bridges designed between September 12, 1990 and February 14, 1996, consider the top 1 ¾” as effective, and consider the top 2 ¼” as effective for bridges designed after February 14, 1996, unless noted otherwise on the as-built plans.

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 System 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, and 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. Member Loads: Miscellaneous member loads not covered in Structure Typical Section input (i.e. haunch weight, sign loads, utility loads, etc.) should be input as separate load cases to facilitate modifications for future load rating updates and to facilitate checking/QC of loadings.
6. For Control Options in BrR for a typical reinforced concrete girder bridge, see the screenshot in Figure 9.2.1.2-1. Note: the “Ignore design and legal load shear” box should only be checked if the requirements set forth in the MBE are met.
7. For Control Options in BrR for a typical reinforced concrete slab bridge, see the screenshot in Figure 9.2.1.2-2.
8. For an Example Load Case Description input for a reinforced concrete bridge, see Figure 9.2.1.2-3.

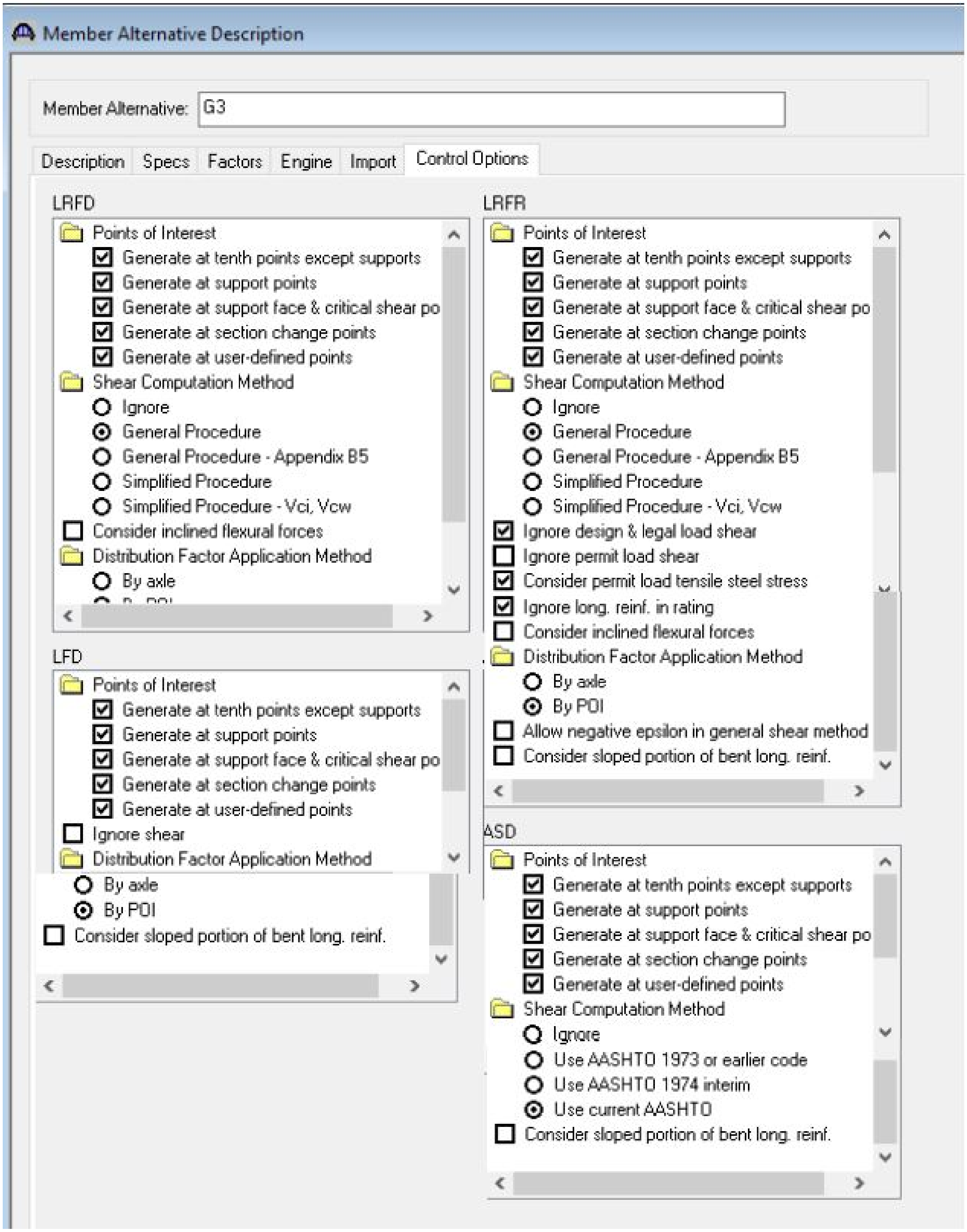


Figure 9.2.1.2-1. Control Options in BrR for Reinforced Concrete Girder Bridge

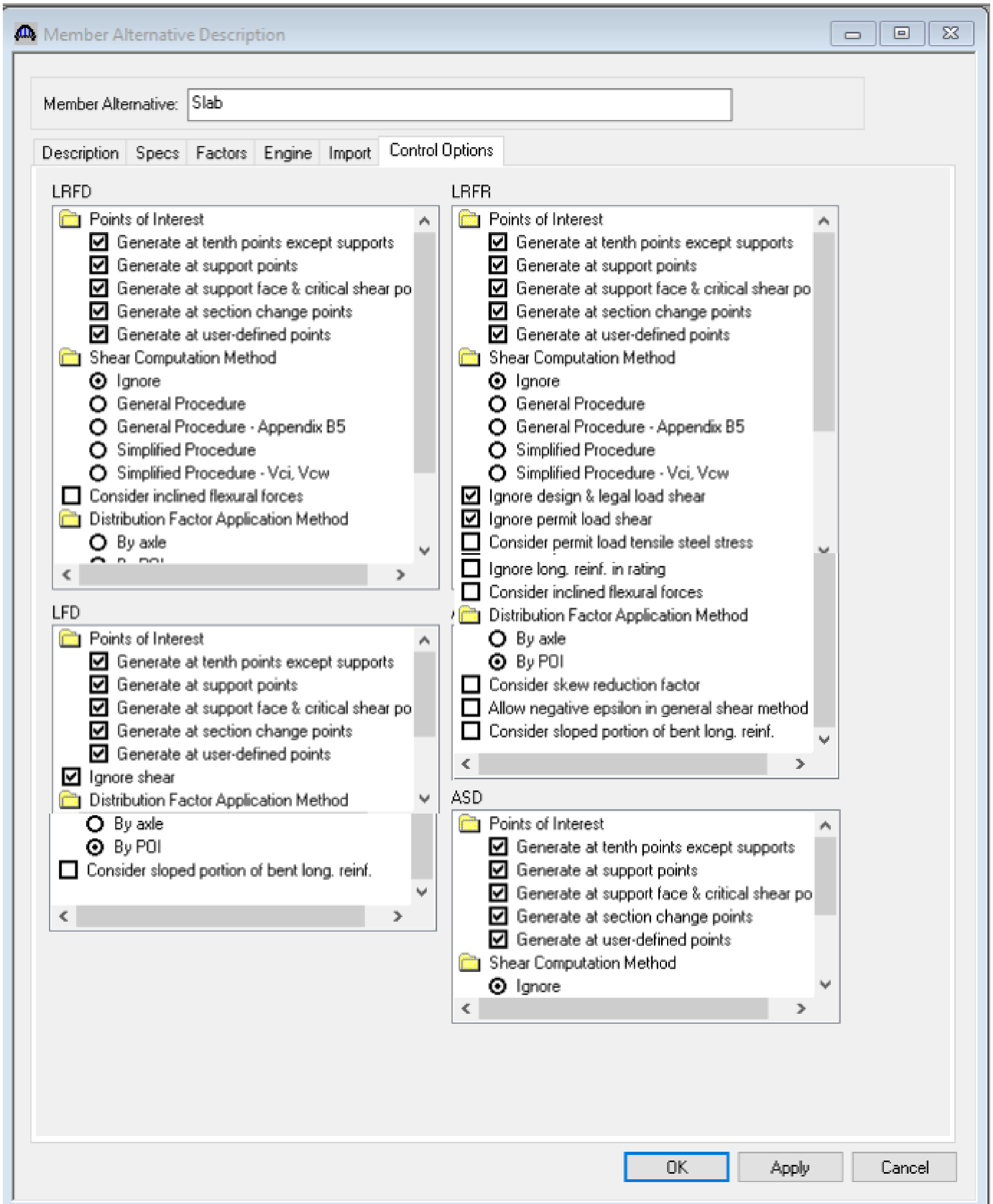
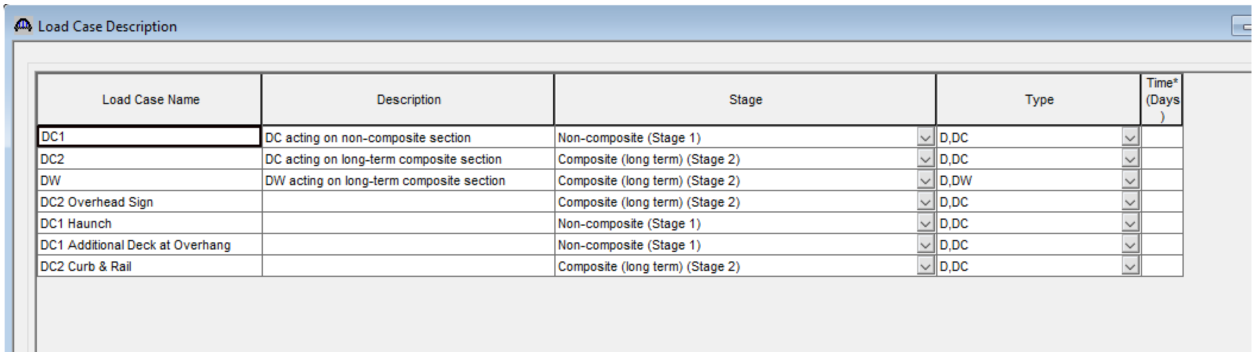


Figure 9.2.1.2-2. Control Options in BrR for Reinforced Concrete Slab Bridge



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	
DC2 Overhead Sign		Composite (long term) (Stage 2)	D,DC	
DC1 Haunch		Non-composite (Stage 1)	D,DC	
DC1 Additional Deck at Overhang		Non-composite (Stage 1)	D,DC	
DC2 Curb & Rail		Composite (long term) (Stage 2)	D,DC	

Figure 9.2.1.2-3. Example Load Case Description Input for Reinforced Concrete Bridge

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. In accordance with Article 5.12.2.1 of the LRFD Bridge Design Specifications, reinforced concrete slab bridges designed for moment in conformance with Article 4.6.2.3 of the LRFD Bridge Design Specifications may be considered satisfactory for shear.

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

Perform load rating in accordance with the MBE. The Service I check for permit loads shall be performed.

CHAPTER 10 PRESTRESSED CONCRETE GIRDER SUPERSTRUCTURES

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. If a sacrificial layer for the bridge deck was considered in the design of the bridge, the weight of the sacrificial layer shall be included in dead load calculations for load rating but shall not be considered to provide structural contribution for the load rating analysis.

   Prior to September 12, 1990, bridge decks were designed for no sacrificial layer and a 2” top clear cover. Therefore, for bridges designed prior September 12, 1990, consider the top 2” as effective in load rating analyses unless noted otherwise on the as-built drawings.

   Design Memorandum DM08/90 dated September 12, 1990 designated the top ¼” of a bridge deck as sacrificial and Design Memorandum DM0196 dated February 14, 1996 increased the top clear cover from 2” to 2 ½”, which is consistent with the current BDM. Therefore, for bridges designed between September 12, 1990 and February 14, 1996, consider the top 1 ¾” as effective, and consider the top 2 ¼” as effective for bridges designed after February 14, 1996, unless noted otherwise on the as-built plans.

3. Superimposed dead loads (e.g. curbs, barriers, raised sidewalks, parapets, railings, future wearing surfaces) placed after the concrete deck slab has cured, shall be distributed to the girders in accordance with the BDM.

4. 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.

   Unless the bridge plans clearly state the bridge was designed simple for dead load and continuous for live load, analyze the bridge as simple span for both dead load and live load.

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. If as-built plans are available, input actual strand pattern as shown in as-built plans.
2. 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.
3. Use an average humidity of 70%.
4. Load Case Description: Add Default Load Case Descriptions (DC1, DC2, and 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. 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 BDM Memo DM0108 for LRFR based on the location of the bridge.
7. Prestress Properties: Input loss method as "AASHTO Approximate." Input Jacking Stress ratio based on strand type.
8. 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. Note: the “Ignore design and legal load shear” box should only be checked if the requirements set forth in the MBE are met.
9. Member Loads: Miscellaneous member loads not covered in Structure Typical Section input (i.e. haunch weight, sign loads, utility loads, etc.) should be input as separate load cases to facilitate modifications for future load rating updates and to facilitate checking/QC of loadings.
10. Do not input deck reinforcement for simple span bridges.
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. A broken wire in a strand shall render the strand ineffective, and the girder with that strand shall be considered deteriorated.
13. 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)
14. Do not define the haunch for prestressed girder bridges. Include haunch as a member load, but structural properties should not be used.
15. Prestressed Girder Shear Reinforcement Ranges: Input shear stirrups and check box "Extends into Deck" if deck and girder are structurally composite.

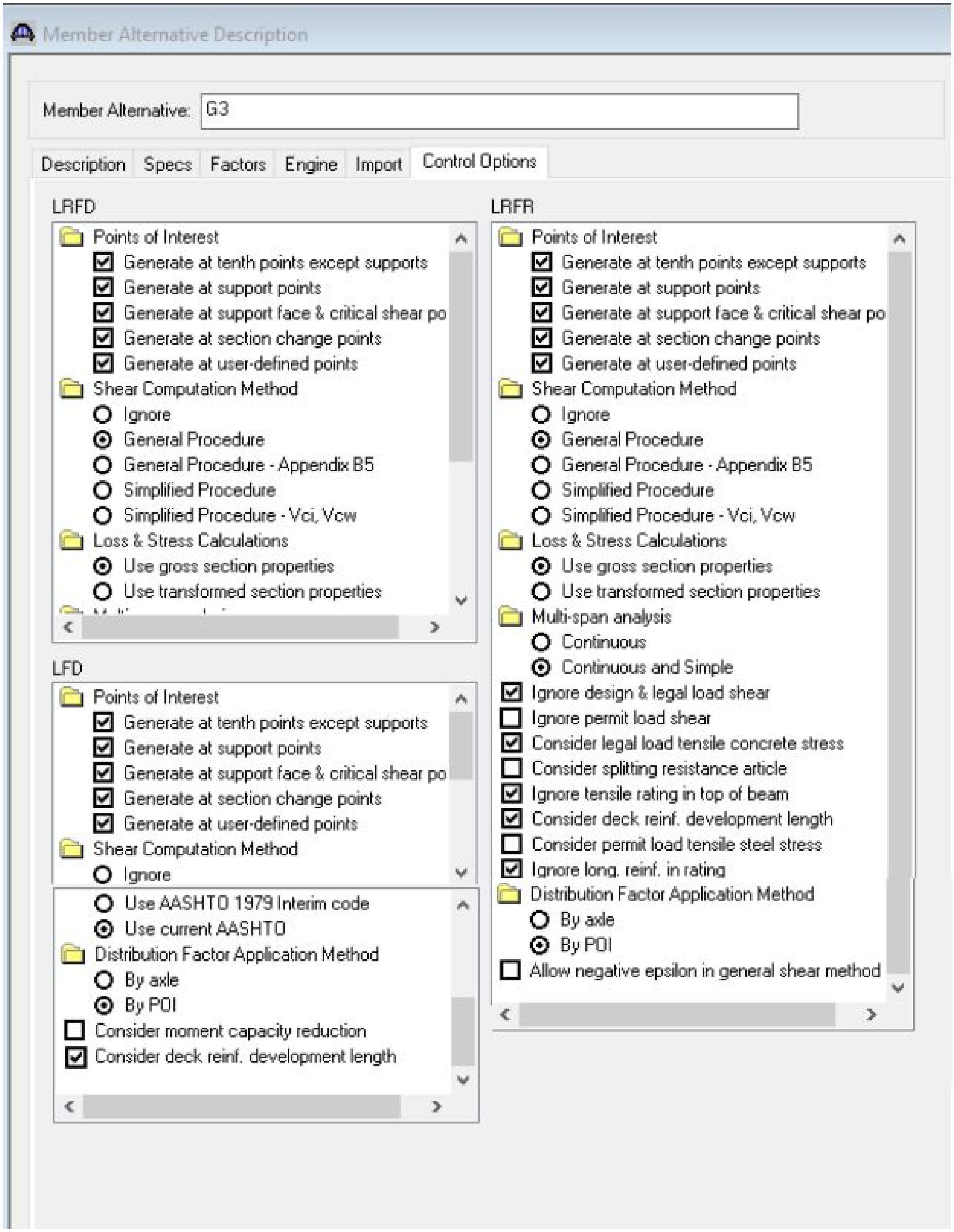
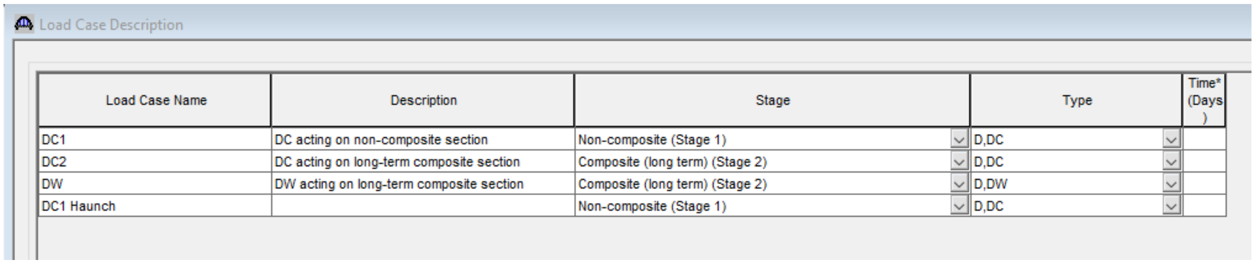


Figure 10.2.1.2-1. Control Options in BrR for Prestressed Concrete Girder Superstructure



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 for Prestressed Concrete Girder Superstructure

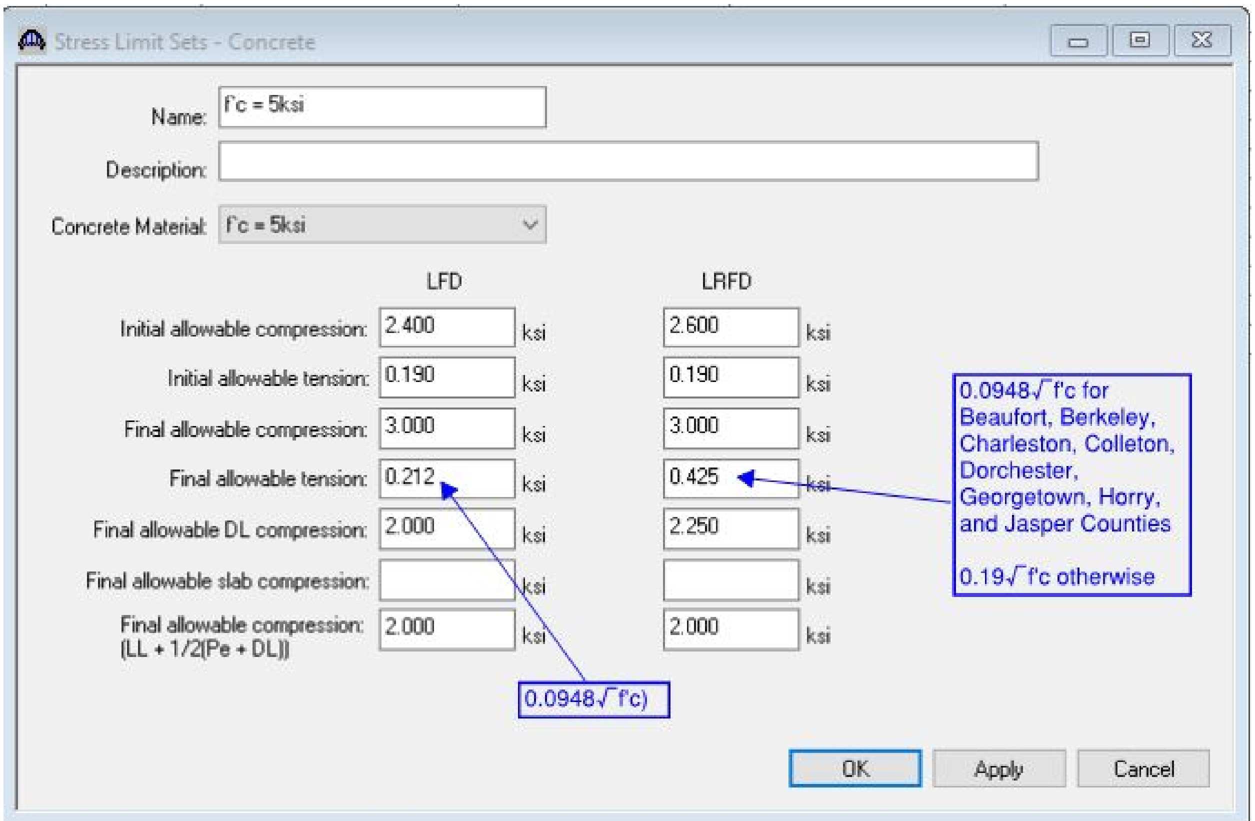


Figure 10.2.1.2-3. Prestressed Concrete Stress Limit Input

10.2.2 ASR or LFR Method

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

10.2.3 LRFR Method

Perform load rating in accordance with the MBE. The Service III check for legal loads and the Service I check for permit loads shall be performed.

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

When plans are available and note the applicable steel strengths, 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.

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. For negative moment regions with shear studs, the load rater may utilize the reinforcing steel in the deck and the steel girder to determine composite action.

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 the SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2). 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 the SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2).

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. If a sacrificial layer for the bridge deck was considered in the design of the bridge, the weight of the sacrificial layer shall be included in dead load calculations for load rating but shall not be considered to provide structural contribution for the load rating analysis.

   Prior to September 12, 1990, bridge decks were designed for no sacrificial layer and a 2" top clear cover. Therefore, for bridges designed prior September 12, 1990, consider the top 2" as effective in load rating analyses unless noted otherwise on the as-built drawings.

   Design Memorandum DM08/90 dated September 12, 1990 designated the top ¼" of a bridge deck as sacrificial and Design Memorandum DM0196 dated February 14, 1996 increased the top clear cover from 2" to 2 ½", which is consistent with the current BDM. Therefore, for bridges designed between September 12, 1990 and February 14, 1996, consider the top 1 ¾" as effective, and consider the top 2 ¼" as effective for bridges designed after February 14, 1996, unless noted otherwise on the as-built plans.

7. Superimposed dead loads (e.g. curbs, barriers, raised sidewalks, parapets, railings, future wearing surfaces) placed after the concrete deck slab has cured, shall be distributed to the girders in accordance with the BDM.
8. Fatigue rating is not typically performed.
9. 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 as appropriate:

- 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 load rater 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 rolled shapes into Steel Beam Shape window. Plate girders are defined in the Member Alternative Description.
2. 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.
3. Load Case Description: Add Default Load Case Descriptions (DC1, DC2, and 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. Member Alternative Description: Add minimum 5% for additional self-load to account for materials such as welds. Stiffener weight should be accounted for through either point loads or, in the case of a large number of stiffeners, the stiffener load can be applied as a uniform load.
6. 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.
7. Member Loads: Miscellaneous member loads not covered in Structure Typical Section input (i.e. haunch weight, sign loads, utility loads, etc.) should be input as separate load cases to facilitate modifications for future load rating updates and to facilitate checking/QC of loadings.
8. Do not input deck reinforcement for simple span bridges.
9. Define deck profile if girder is structurally composite with deck.
10. If deck is composite with girders, input shear connectors as “composite” in Connector ID field.
11. 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.

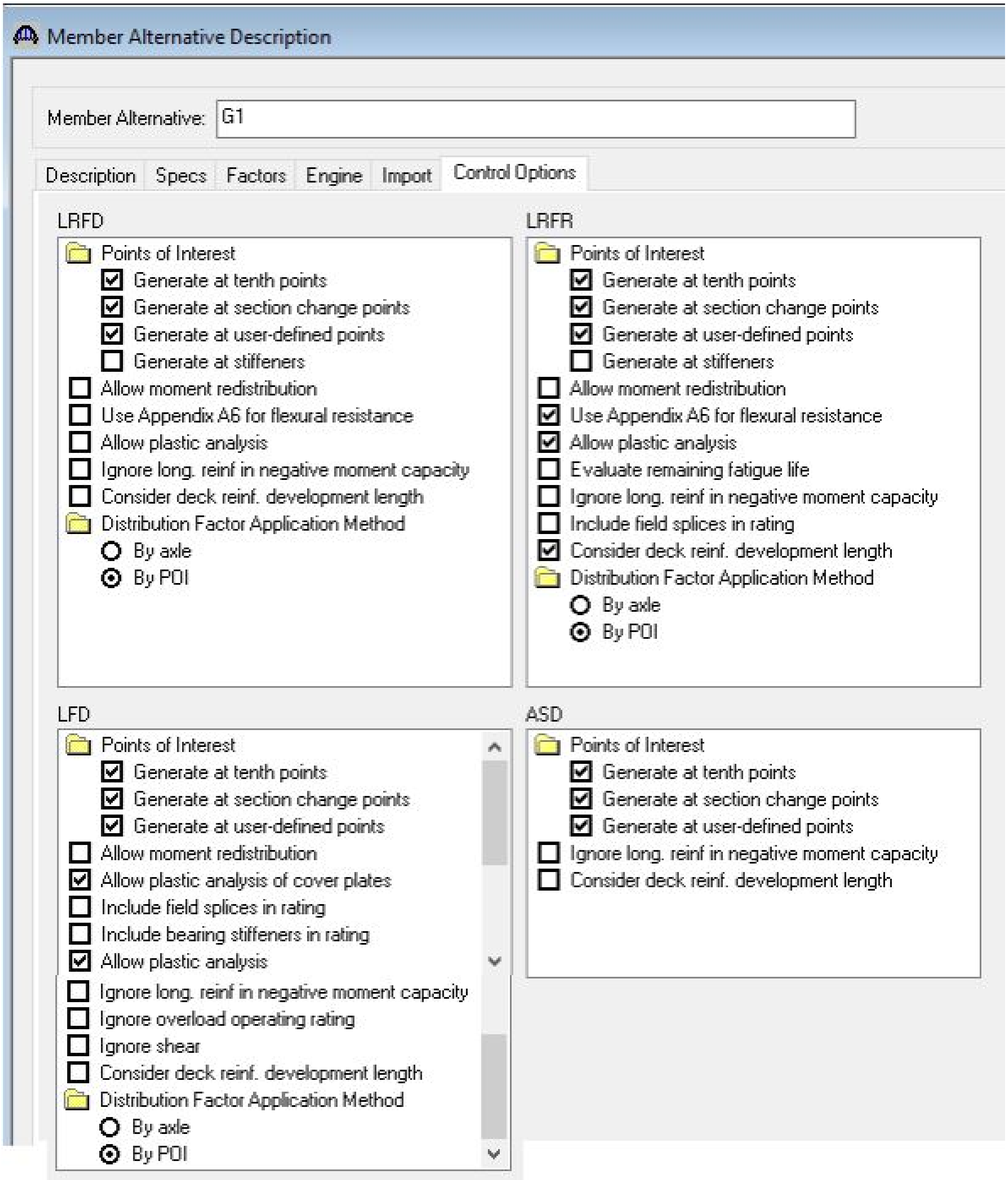
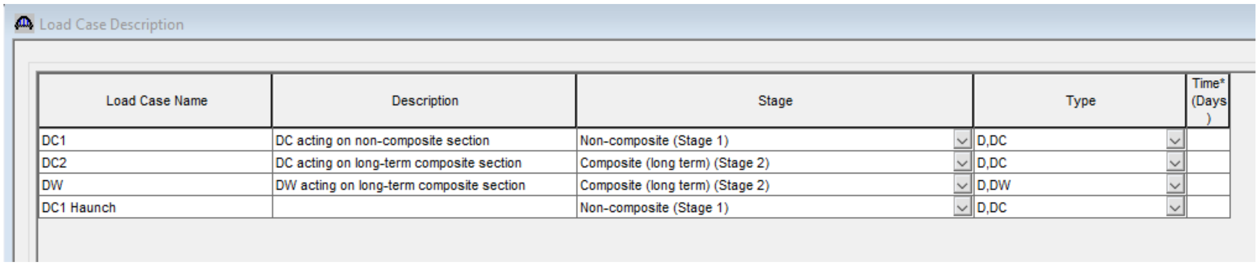


Figure 11.2.2.2-1. Control Options in BrR for Steel Girder Superstructure



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 11.2.2.2-2. Example Load Case Description Input for Steel Girder Superstructure

11.2.3 ASR or LFR Method

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

11.2.4 LRFR Method

Perform load rating in accordance with the MBE. The Service II check for permit loads shall be performed.

CHAPTER 12 STEEL TRUSS SUPERSTRUCTURES

12.1 INTRODUCTION

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

12.2 POLICIES AND GUIDELINES

When plans are available and note the applicable steel strengths, 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.

Superimposed dead loads (e.g. curbs, barriers, raised sidewalks, parapets, railings, future wearing surfaces) placed after the concrete deck slab has cured, shall be distributed to the stringers in accordance with the BDM.

If a sacrificial layer for the bridge deck was considered in the design of the bridge, the weight of the sacrificial layer shall be included in dead load calculations for load rating but shall not be considered to provide structural contribution for the load rating analysis.

Prior to September 12, 1990, bridge decks were designed for no sacrificial layer and a 2” top clear cover. Therefore, for bridges designed prior September 12, 1990, consider the top 2” as effective in load rating analyses for composite stringers and floor beams unless noted otherwise on the as-built drawings.

Design Memorandum DM08/90 dated September 12, 1990 designated the top ¼” of a bridge deck as sacrificial and Design Memorandum DM0196 dated February 14, 1996 increased the top clear cover from 2” to 2 ½”, which is consistent with the current BDM. Therefore, for bridges designed between September 12, 1990 and February 14, 1996, consider the top 1 ¾” as effective, and consider the top 2 ¼” as effective for composite stringers and floor beams of bridges designed after February 14, 1996, unless noted otherwise on the as-built plans.

Use the following guidelines for specific bridge members:

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. 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 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. 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 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 current 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. Use Truss System Superstructure when inputting into BrR. Link trusses that are similar.
2. Load Case Description: Add Default Load Case Descriptions (DC1, DC2, and DW). Add load cases for additional loads not covered in Structure Typical Section.
3. Input diaphragms and loads into Structure Framing Plan Details.
4. Create a different Superstructure Definition for timber stringers or reinforced concrete decks that span between floor beams.
5. 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 built before October 2010.

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

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 in timber stringers.
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. Depending on the length of the split, the load rater shall determine if the split shall be considered to affect the member capacity and thus 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.

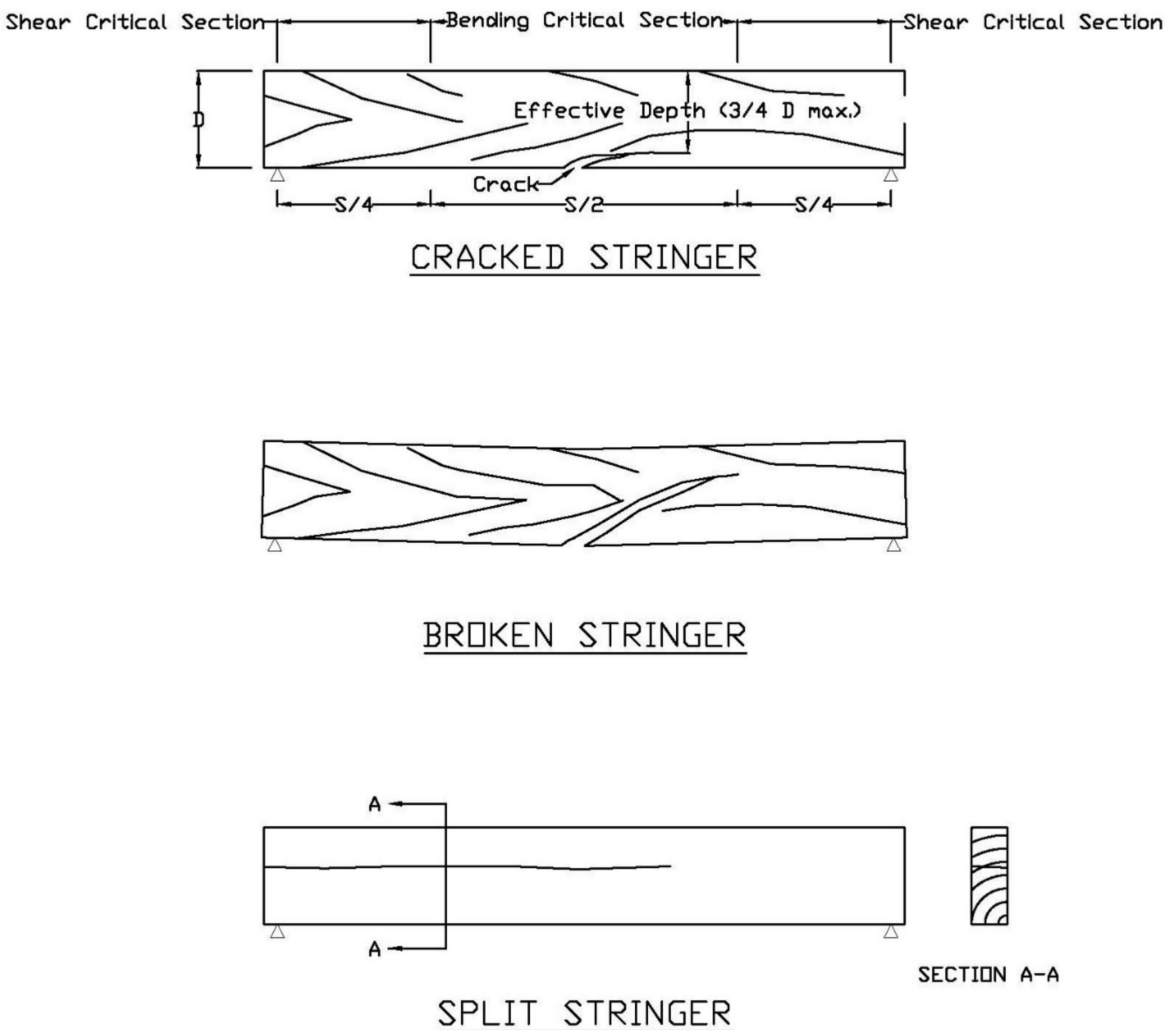


Figure 13.2-1. Cracked, Broken and Split Timber Stringer Defects

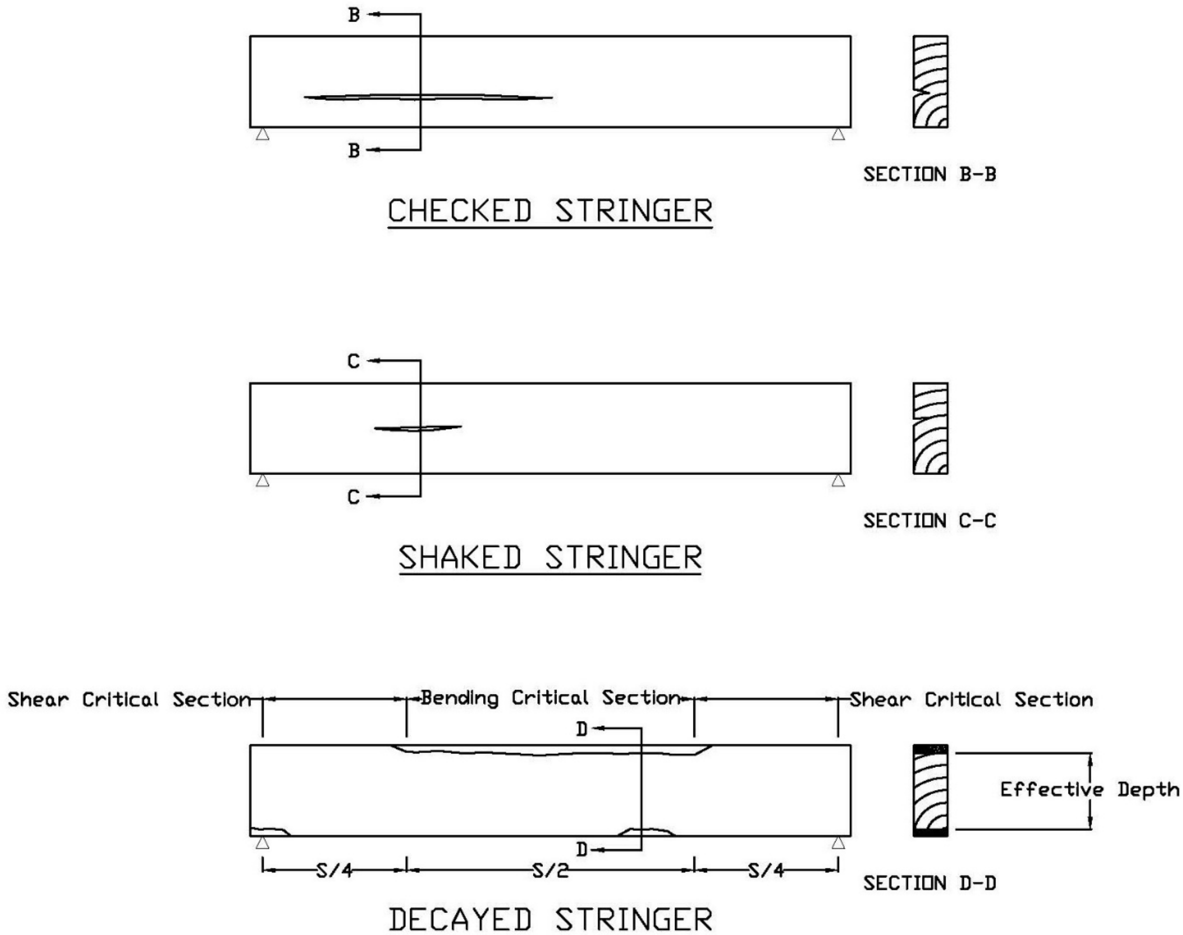


Figure 13.2-2. Checked, Shaked and Decayed Timber Stringer Defects

13.2.1 Software-Specific SCDOT Policy

13.2.1.1 BrR Input

For Control Options in BrR, see Figure 13.2.1.1-1. For an Example Load Case Description input, see Figure 13.2.1.1-2.

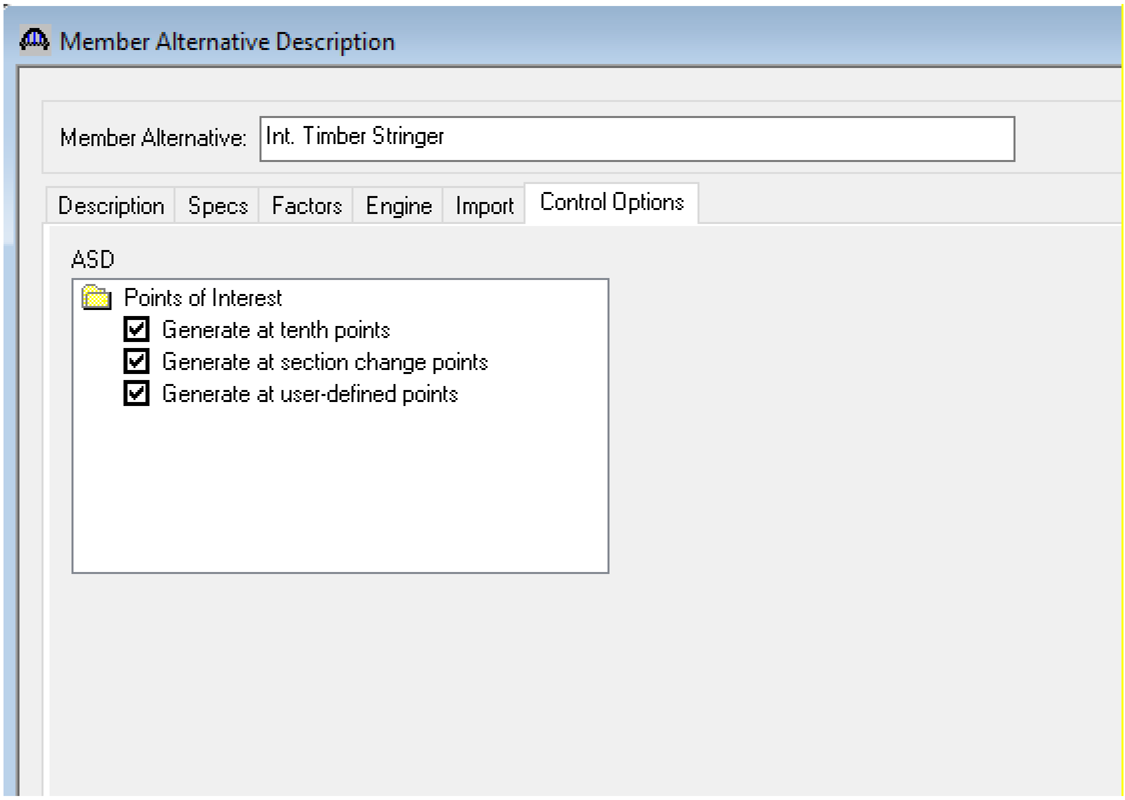
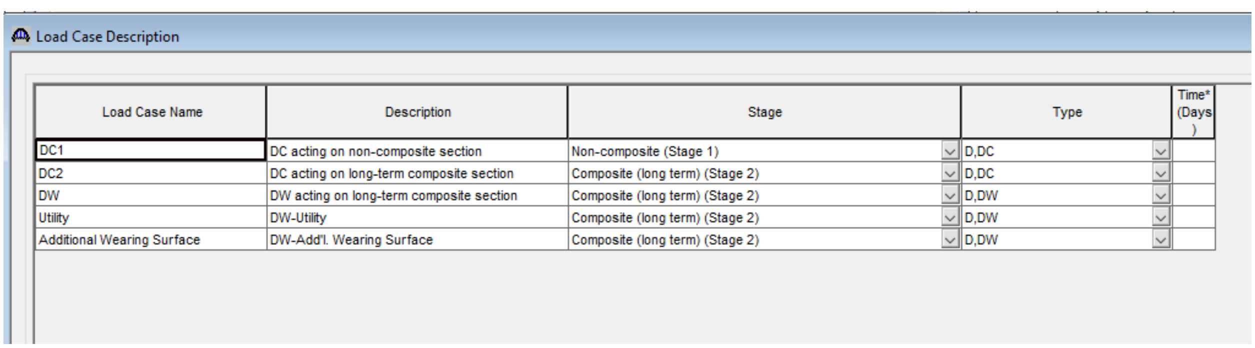


Figure 13.2.1.1-1. Control Options in BrR for Timber Superstructure


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	
Utility	DW-Utility	Composite (long term) (Stage 2)	D,DW	
Additional Wearing Surface	DW-Add'l. Wearing Surface	Composite (long term) (Stage 2)	D,DW	

Figure 13.2.1.1-2. Example Load Case Description Input for Timber Superstructure

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.
4. Load rating analysis may be warranted for substructures with an unusual geometry or configuration (i.e. hammerhead caps with large overhangs, straddle bents, C-bents, etc.) or under heavy overweight permit loads, where these substructure components may control the rating.

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 may be used for load rating of concrete or masonry substructures, subject to approval by the SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2). 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. Load rating analysis may be warranted for substructures with an unusual geometry or configuration (i.e. integral steel pier caps, steel bents with long unbraced lengths, etc.) or under heavy overweight permit loads, where these substructure components may control the rating.
5. Steel pier caps classified as FCMs 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 may be used for load rating of steel substructures, subject to approval by the SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2). 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 rater.
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 may be used for load rating of timber substructures, subject to approval by the SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2). 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. If BrR returns a rating factor of 0.00 on the inside of the exterior walls and per MBE 6.1.4, if it has been carrying normal traffic for an appreciable period of time and shows no distress, the typical frequency of inspections (i.e. 24 months) shall be maintained and the culvert shall be monitored for further deterioration. Increase the wall reinforcing steel in BrR in 20% increments until the wall does not control the ratings. This increase shall be documented in the LRSF. If the culvert is showing signs of significant deterioration, the load rating shall be coordinated with the SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2).
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 LRSF.
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 it has been carrying normal traffic for an appreciable period of time and shows no distress, the typical frequency of inspections (i.e. 24 months) shall be maintained, and the culvert shall be monitored for further deterioration. Increase reinforcing steel in BrR in top slab, bottom slab, or any walls in 20% increments to overcome dead load effects and increase the capacity until the rating is 1.00 or greater. This increase shall be documented in the LRSF with the following note: "This culvert is under deep fill and need not be load rated for live loads per MBE Section 6A.5.12.10.3a. The rating file is only to be used for inputting into the SCDOT automated permitting system." If the culvert is showing signs of significant deterioration, the load rating shall be coordinated with the SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2).

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.

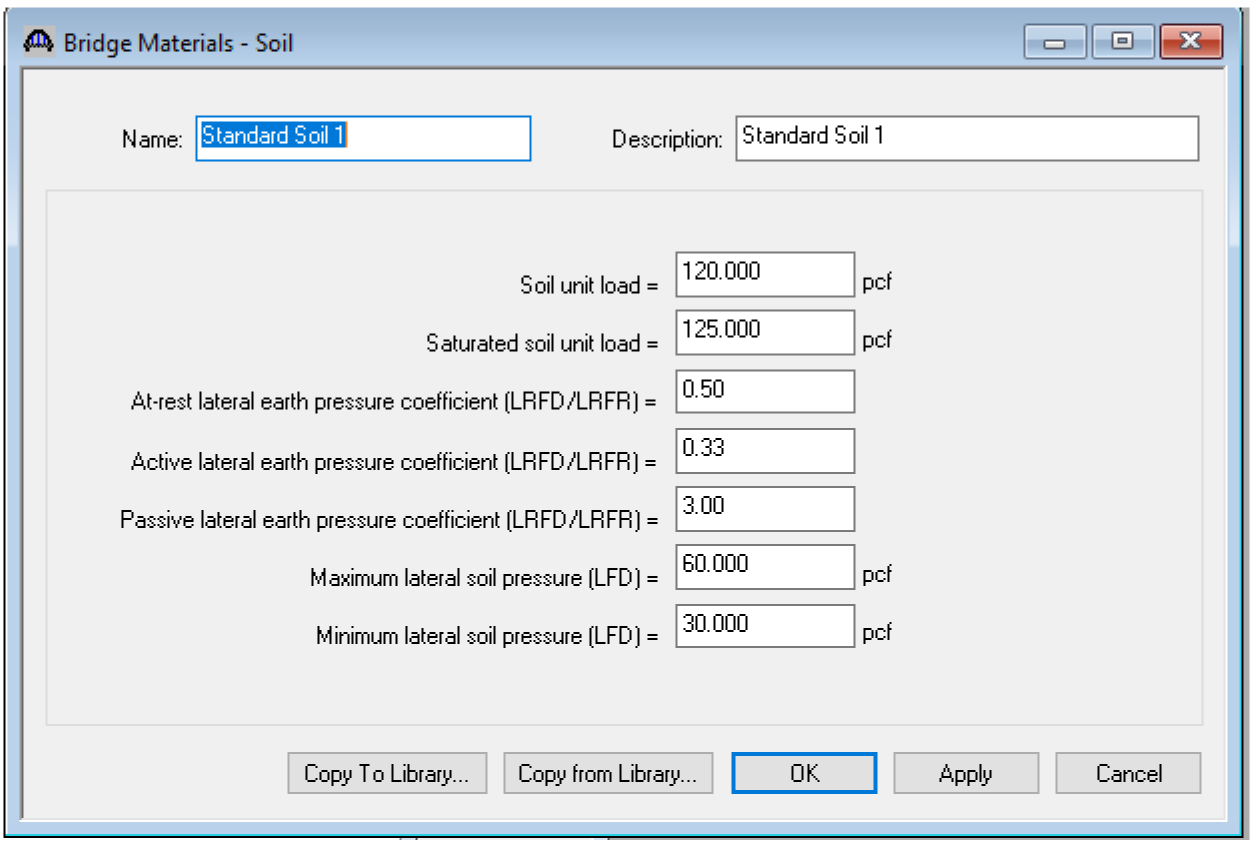


Figure 17.2.1.1-1. Concrete Box Culvert Soil Properties for BrR

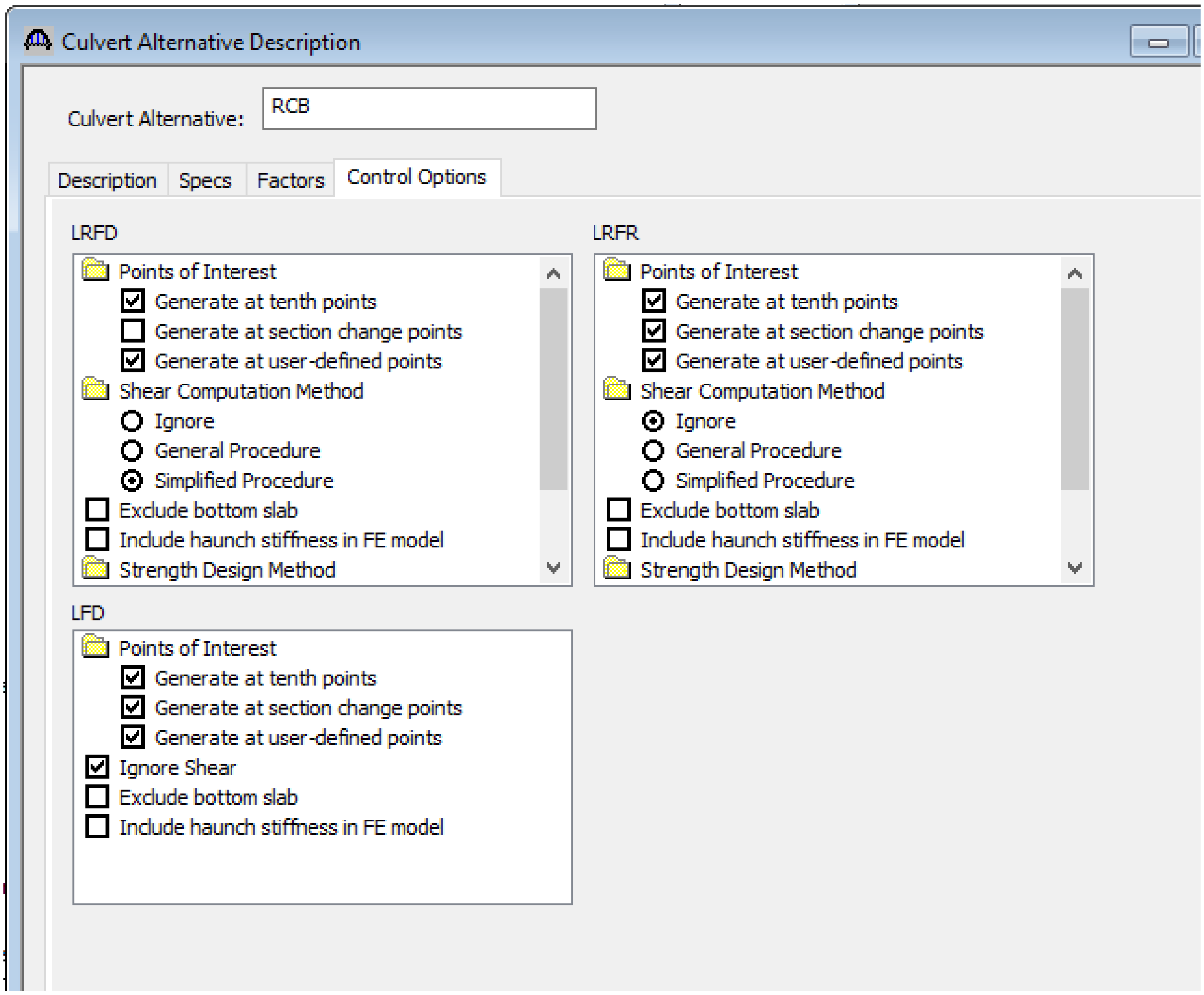


Figure 17.2.1.1-2. Control Options in BrR for Concrete Box Culvert

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

It is recognized that 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 SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2).

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

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 (NBI 008)	Facility Carried (NBI 007)	Features Intersected (NBI 006)	County (NBI 003)	Location (NBI 009)	District (NBI 002)	Structure Material, Main (NBI 43A)	Structure Type, Main (NBI 43B)
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
2298	SC 170	Chechessee River	Beaufort	10 miles SW of Beaufort	6	Prestressed Concrete Continuous	Stringer / Multi-Beam or Girder
2303	SC 171	Wappoo Creek	Charleston	1 mile S. of US17 James Island	6	Steel	Movable - Bascule
2662	SC 170	Broad River	Beaufort	6 miles SW of Beaufort	6	Prestressed Concrete Continuous	Stringer / Multi-Beam or Girder
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 EB	Wando River	Charleston	Near Charleston	6	Prestressed Concrete Continuous	Segmental Box Girder
8238	I-526 WB	Wando River	Charleston	Near Charleston	6	Prestressed Concrete Continuous	Segmental Box Girder
8516	I-526	Cooper River	Berkeley	In North Charleston	6	Steel Continuous	Truss -Thru
8617	SC 30	Ashley and Wappoo	Charleston	In Charleston	6	Prestressed Concrete Continuous	Box Beam or Girders - Single or Spread
8720	SC 517	ICWW	Charleston	10.1 miles NE of Charleston	6	Prestressed Concrete Continuous	Stringer / Multi-Beam or Girder
9824	US 17	Cooper River, Town Creek	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. Before weight limit posting is recommended, posting avoidance options should be discussed with the SBME or designated representative as these options may require additional analysis (see Bridge Maintenance Office Approvals Form in Appendix A20.2).

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.

However, 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.
- Posting avoidance techniques outlined in Sections 19.2.2 through 19.2.5, including performing load tests on the structure, using a Service III limit state below 1.0, incorporating alternative rating methods or incorporating the stiffness of the traffic barrier, shall not be used at the design stage for new bridges. New bridges shall be designed so they do not require weight limit posting or posting avoidance techniques.

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, performing a load test on a structure, or performing material testing to determine material properties to use in the load rating. Refer to Section 5.3 of the MBE for guidance on material sampling for bridge evaluation. In accordance with Section 6A.5.2.1 and 6A.6.2 of the MBE, nominal values of strength for tested materials are typically taken as the mean value minus 1.65 standard deviation to provide a 95% confidence limit. Average test values should not be used.

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 if the latest bridge inspection is showing no signs of either shear or flexural distress and upon approval by the SBME or designated representative (see Bridge Maintenance Office Approvals Form in Appendix A20.2). 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, the load rater should investigate the use of other load rating methods (ASR or LFR) to minimize load posting effects. BMO approval is not required for the use of alternative rating methods. Note that regardless of the alternative rating methods used for load posting, the LRFR, LFR or ASR values are to be reported in the NBI.

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 LRSF and the inspectors should be alerted in the “Remarks” section of the LRSF to verify the conditions of the barriers and barrier-to-deck interface when performing subsequent inspections. The SBME or designated representative shall be notified immediately if discrepancies found during the field inspection invalidate the previous analysis assumptions (see Bridge Maintenance Office Approvals Form in Appendix A20.2).

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 depicted on the Bridge Signing / Posting Form in Appendix A19.1.
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. If ASR/LFR is used for the posting of bridges, then the Operating Capacity shall be used for the limit of posting. Limits below the Operating Capacity can be used at the SCDOT's discretion (see Bridge Maintenance Office Approvals Form in Appendix A20.2). IF LRFR is used for posting, then follow the MBE. When considering legal trucks, the design level of reliability shall be used for the limit of posting for LRFR load ratings. Limits below the design level of reliability can be used at the SCDOT's discretion for permit trucks. Current state practice is to use ASR/LFR for the posting of bridges.
6. Sign R12-6-48 is the primary load posting sign to be used. For bridges that require additional axle restrictions to account for any potential shear failures that could occur from an individual axle loading, sign R12-7-60 shall be placed below the R12-6-48 sign.
7. To provide advanced warning of a weight restricted bridge, sign R12-6.1-48 is to be placed below sign R12-6-48 and 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 District Office is responsible for the coordination of information being released to local officials in the event of a bridge being weight restricted. The District Engineering Administrator may be involved to coordinate information to local stakeholders.
9. If a posting requirement is found due to a load rating, the Signing/Posting Form will be submitted to BMO, and BMO will route the form to District Maintenance. The installation of posting signs is noted as an 'A' Flag critical finding. The repair work shall be completed within 30 days. For more information, see BIGD.
10. Refer to the SCDOT Supplement to the MUTCD for additional information regarding required posting signs.

19.5 POSTING DOCUMENTATION

The posting limits shall be documented on the Bridge Signing/Posting Form. An image of the form and a link to an online version of the form are included 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 are required to take pictures of the posting signs as a part of each routine inspection so that load raters can verify the posting signs accurately reflect the current load rating.

APPENDIX A19.1: BRIDGE SIGNING/POSTING FORM

SCDOT

Bridge Signing/Posting Form

Version: 1.0
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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 sign(s) 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.

R12-6-48

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

Sign Required? ☐ Yes ☐ No

R12-7-60

WEIGHT LIMIT
SINGLE AXLE ___ T
TANDEM AXLE ___ T

Sign Required? ☐ Yes ☐ No

R12-6.1-48

* ___ MI AHEAD

Sign Required? ☐ Yes ☐ No

Required # of **R12-6-48** Signs: ________________*
Required # of **R12-6.1-48** Signs: ________________*
Required # of **R12-7-60** Signs: ________________*
*Fields with an asterisk and placement of signs are to be determined by SCDOT Staff.

SECTION 3: COMMENTS

LOAD RATING ENGINEER	
Name:	
Company/Title:	
Date:	

QUALITY CONTROL ENGINEER	
Name:	
Company/Title:	
Date:	

A link to the latest version of the Bridge Signing/Posting Form is located here: Bridge Signing/Posting Form (hot link to be provided)

CHAPTER 20 LOAD RATING DOCUMENTATION

20.1 LOAD RATING DELIVERABLES

All deliverables will be made electronically and will be transferred to the SCDOT Bridge File maintained on SCDOT's ProjectWise directory. Access will be provided for electronic submittal of final documentation. Please coordinate electronic submittals with the BMO. Refer to the BFP (see Section 1.4 of this Guidance Document) for required naming convention of all electronic deliverables.

20.2 LOAD RATING SUMMARY

20.2.1 Load Rating as Part of an Inspection or Independent Rating

20.2.1.1 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. Actual EXCEL or Mathcad files may be requested by SCDOT on a case-by case basis.

2. .PDF of LRSF: Provide a completed LRSF in .PDF format, digitally signed and sealed. The individuals performing the QC review and QA review (if applicable) shall provide their name, company, title, and date on the LRSF. Copies of the LRSF for either ASR/LFR load ratings or for LRFR load ratings and a link to online versions of the forms are included in Appendix A20.1 to this chapter.

3. Supplemental Calculations: Provide supporting calculations (.PDF electronic files). If software other than BrR is used, provide documentation of the computer program's results by means of longhand calculations or an independent software analysis program in accordance with Section 3.3 of this Guidance Document. PDF output files shall be in a format that can be checked by hand.

4. If the structure being load rated is a complex bridge, provide analysis documentation describing the load rating methodology and software used in the analysis of the complex bridge in accordance with Section 18.2.2 of this Guidance Document.

5. 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. 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.

6. 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.

7. Bridge Maintenance Office Approvals Form (if necessary): Provide a Bridge Maintenance Office Approvals Form documenting any approvals for deviations to standard procedures as noted in this Guidance Document. An image of the form and a link to an online version of the form are included in Appendix A20.2 of this chapter.

20.2.1.2 Load Rating Summary Form

The LRSF EXCEL workbook does not summarize load rating results for every bridge type, configuration and span length. The load rater shall verify that all load rating requirements are satisfied per the MBE. The following steps shall be used to complete the LRSF:

1. Enter relevant information to identify the asset and to summarize the load rating information in the EXCEL Workbook for the LRSF. For guidance on using the EXCEL Workbook which contains the LRSF, see "Bridge Load Rating Summary (LRS) Workbook 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 LRSF and must comply with the SCDOT Digital Signatures Manual.

20.3 LOAD RATING NAMING CONVENTION

The BrR input file (.XML file) should be capable of having multiple alternatives for modification to the load rating over the life of the structure while still preserving the original as-built load rating.

The name of the bridge definition shall be the 4- or 5-digit Asset ID.

In the bridge definition window, the 'Bridge ID', 'NBI Structure ID', and 'Name' shall all be the Asset ID.

20.3.1 General Bridge Definition

In the general description box of the bridge definition window, the load rating history of the structure should be summarized per guidance in this section. Each load rating occurrence should include the condition of the bridge ("As-built" or "Deteriorated"), the consultant name (or SCDOT), the engineer's initials, and the date the file was created (or checked) for both the as-built bridge alternatives and deteriorated condition bridge alternatives. The most recent iteration of rating files should be near the top of the tree structure of load rating files, and consequently, the alternatives should be listed most recent to oldest, top to bottom, in the general description box. All dates included in the file descriptions shall be in YYYY-MM-DD format.

General description box format specifics are as follows:

> Deteriorated created by [*Consultant name or SCDOT*] ([*Load rater's initials*]) ([*Date*])
> Deteriorated checked by [*Consultant name or SCDOT*] ([*Checker's initials*]) ([*Date*])
> As-built created by [*Consultant name or SCDOT*] ([*Load rater's initials*]) ([*Date*])
> As-built checked by [*Consultant name or SCDOT*] ([*Checker's initials*]) ([*Date*])

Note that deteriorated alternatives would not be listed if the bridge has not experienced any deterioration.

The example below shows information in the general bridge description box for a sample bridge:

> Deteriorated created by Consultant123 (ABC) (2019-06-15)
> Deteriorated checked by Consultant123 (XYZ) (2019-06-20)
> As-built created by Consultant123 (ABC) (2018-08-15)
> As-built checked by Consultant123 (XYZ) (2018-08-20)

20.3.2 Superstructure Definitions

The name of each superstructure definition shall be the unique span number(s), followed by "As-built [*Date*]" or "Deteriorated [*Date*]". If a bridge has not experienced any deterioration, only "As-built [*Date*]" definitions will be defined. If a bridge has deterioration, copy the appropriate previously defined superstructure definition and create a new superstructure definition for the "Deteriorated" model. A separate superstructure alternative shall be defined for each occurrence of deterioration in any bridge component at any location. The most current superstructure definition, for example the definition with the most recent deterioration, shall be placed in the 'Bridge Alternatives' folder as the "active" definition for rating in BrR. Previous superstructure definitions should have the capability of being rated as necessary.

If the as-built alternative was developed using information other than the existing plans (such as field measurements), include a brief description of the information used and the dates the field measurements were taken. Otherwise, all as-built alternative descriptions may be left blank. For each deteriorated condition bridge alternative, the description line should include a brief description of what the deterioration was that prompted the new load rating and when the defect was discovered.

Format specifics of superstructure definition description boxes are as follows. Note the first part of the descriptions is identical to the general description box in the bridge definition.

For 'Deteriorated' alternatives:

> [*Span Number(s)*] Deteriorated ([*Date*]) created by [*Consultant name or SCDOT*] ([*Load rater's initials*]) [*reason for new rating and date of findings*]
>
> [*Span Number(s)*] Deteriorated ([*Date*]) checked by [*Consultant name or SCDOT*] ([*Checker's initials*]) [*reason for new rating and date of findings*]

The load rater may choose to also include a brief statement of specifically how deterioration was taken into account in the analysis.

Example:

> Spans 2&3 Deteriorated (2019-06-15) created by Consultant123 (ABC) due to collision damage documented in 2019-06-01 Special Inspection; 4 strands removed from Girder 1
>
> Spans 2&3 Deteriorated (2019-06-20) checked by Consultant123 (XYZ) due to collision damage documented in 2019-06-01 Special Inspection

For 'As-built' alternatives:

> [*Span Number(s)*] As-built ([*Date*]) created by [*Consultant name or SCDOT*] ([*Load rater's initials*]) [*source and date of as-built information if not existing plans*]
>
> [*Span Number(s)*] As-built ([*Date*]) checked by [*Consultant name or SCDOT*] ([*Checker's initials*]) [*source and date of as-built information if not existing plans*]

Example:

> Spans 1&4 As-built (2018-08-15) created by Consultant123 (ABC) based on field measurements obtained on 2018-08-01 site visit.
>
> Spans 1&4 As-built (2018-08-20) checked by Consultant123 (XYZ) based on field measurements obtained on 2018-08-01 site visit.

APPENDIX A20.1: BRIDGE LOAD RATING SUMMARY FORMS (LRSF) AND WORKBOOK GUIDE

ASR/LFR BRIDGE LOAD RATING SUMMARY

Version 1.0

Page 1 of 2

SECTION 1 - GENERAL BRIDGE DATA

(8) Asset ID	Route Type	(27) Year Built	(90) Date of Inspection	(411) Date Rated
(9) Bridge Location	(7) Facility Carried		(6) Feature Intersected/Route Crossing	
(49) Length	(11) Milepost	(2) District	(3) County	(22) Owner
(418) Conditions During Rating (NBI Item 58, NBI Item 59, NBI Item 60)				
(43, 44, 45, & 46) Bridge Description	(31) Design Load	(108) Existing Wearing Surface Type & Depth		
Rating Program & Version	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					

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) ☐ As-Built Plans

SECTION 3 - BRIDGE LOAD RATING SUMMARY

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

SECTION 4 - REMARKS & SIGN/SEAL

☐ Structure is part of QA sample set.

Load Rating Engineer		Quality Control Engineer		Quality Assurance Engineer	
Name:		Name:		Name:	
Company/Title:		Company/Title:		Company/Title:	
Date:		Date:		Date:	

Remarks:

Insert Stamp

SCDOT **ASR/LFR BRIDGE LOAD RATING SUMMARY**

Version 1.0

Page 2 of 2

SECTION 1 (PAGE 2) - GENERAL BRIDGE DATA

(8) Asset ID	Route Type	(27) Year Built	(90) Date of Inspection	(411) Date Rated
(9) Bridge Location	(7) Facility Carried		(6) Feature Intersected/Route Crossing	
(49) Length	(11) Milepost	(2) District	(3) County	(22) Owner
(418) Conditions During Rating (NBI Item 58, NBI Item 59, NBI Item 60)				
(43, 44, 45, & 46) Bridge Description		(31) Design Load	(108) Existing Wearing Surface Type & Depth	
Rating Program & Version	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					

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 (hot link to be provided)

LRFR BRIDGE LOAD RATING SUMMARY

Version 1.0

Page 1 of 2

SECTION 1 - GENERAL BRIDGE DATA

(8) Asset ID	Route Type	(27) Year Built	(90) Date of Inspection	(411) Date Rated
(9) Bridge Location	(7) Facility Carried		(6) Feature Intersected/Route Crossing	
(49) Length	(11) Milepost	(2) District	(3) County	(22) Owner
(418) Conditions During Rating (NBI Item 58, NBI Item 59, NBI Item 60)				
(43, 44, 45, & 46) Bridge Description	(31) Design Load	(108) Existing Wearing Surface Type & Depth		
Rating Program & Version	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	36					
HL-93 Tandem + Lane	Inventory	25					
HL-93 Truck + lane	Operating	36					
HL-93 Truck Train + Lane (90%)	Operating	36					
HL-93 Tandem + Lane	Operating	25					

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

SECTION 3 - BRIDGE LOAD RATING SUMMARY

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

SECTION 4 - REMARKS & SIGN/SEAL

☐ Structure is part of QA sample set.

Load Rating Engineer		Quality Control Engineer		Quality Assurance Engineer	
Name:		Name:		Name:	
Company/Title:		Company/Title:		Company/Title:	
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					
Lane Type Loading (Neg. M only)	Legal	40					
Lane Type Loading (Span > 200 ft)	Legal	40					
Modified AASHTO SC - Type 3	Permit	25					
Modified AASHTO SC - Type 3S2	Permit	36.6					
AASHTO - Type 3-3	Permit	40					
Lane Type Loading (Neg. M only)	Permit	40					
Lane Type Loading (Span > 200 ft)	Permit	40					

SCDOT

LRFR BRIDGE LOAD RATING SUMMARY

Version 1.0

Page 2 of 2

SECTION 1 (PAGE 2) - GENERAL BRIDGE DATA				
(8) Asset ID	Route Type	(27) Year Built	(90) Date of Inspection	(411) Date Rated
(9) Bridge Location	(7) Facility Carried		(6) Feature Intersected/Route Crossing	
(49) Length	(11) Milepost	(2) District	(3) County	(22) Owner
(418) Conditions During Rating (NBI Item 58, NBI Item 59, NBI Item 60)				
(43, 44, 45, & 46) Bridge Description	(31) Design Load		(108) Existing Wearing Surface Type & Depth	
Rating Program & Version	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 (hot link to be provided)

BRIDGE LOAD RATING SUMMARY (LRS) WORKBOOK GUIDE

Purpose of Bridge LRS Workbook:

This LRS EXCEL Workbook template file, hereafter referred to as 'the template', was developed to be used by Consultants performing bridge load ratings for the SCDOT. Consultants shall fill in the relevant portions of the template to complete the load rating process for each structure. The EOR for the rating will sign and seal the LRS output summary Form, contained within the template and hereafter referred to as 'the LRSF, and submit only the PDF of the appropriate LRSF to SCDOT as part of the final load rating deliverables.

The purpose of the LRSF is to display final rating values for an individual structure per specific designated trucks. Note the template and this guidance refer to AASHTOWare Bridge Rating (BrR) software, the preferred rating program for SCDOT. If a different program is used for rating, the template should still be used to the extent possible.

The LRSF EXCEL workbook does not summarize load rating results for every bridge type, configuration and span length. The load rater shall verify that all load rating requirements are satisfied per the MBE.

Instructions and Explanations of the LRSF:

The process stated below is the step-by-step basis for the fully functional 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 template, 'Bridge Description Input', the bridge 'Asset ID', 'Created By', and 'Number of Spans' fields must be input, and the drop down menu options must be selected. Once those steps are completed, the load rater must click the 'Populate Data' button for all of the bridge data to be automatically populated into the LRSF from the 'Master Data' tab. Note that the load rater should be sure to be working with the current Master Data since the Master Data is updated annually by SCDOT. The load rater must also select the Design Load and the Bridge Type and/or Material (3 field occurrences) that describes the bridge type for the majority of the structure, which should be consistent with the coding for the SI&A sheet. This will auto-populate the 'Bridge Description' field.

ASR-LFR Load Rating Summary Form

Most of the cells in the LRSF 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 2A, 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 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 LRSF 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 in the LRSF is the 'General Bridge Data'. Most of the cells will be automatically populated from information in the 'Master Data' tab once the 'Asset ID', 'Created By' and 'Number of Spans' fields are entered and the 'Populate Data' 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 pull-down menus or manually typing in the information. All cells are input with data found in the Inspection Report (SI&A 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, or if there are other errors on the SI&A sheet, use the standard Data Correction Form (see Appendix A5.2 to Chapter 5) to note the discrepancy. Do not manually correct the data in this section, and if there is incorrect information (e.g. structure length) that affects the load rating, note the discrepancy in the 'Remarks' section of this form (see Section 4 guidance).

In the 'Rating Program & Version' boxes, if only one rating program (e.g. BrR) was used, select this option from the pull-down in the first box, and leave the second box as 'N/A'. If a second rating program or tool was used, select it from the pull-down in the second box. If the rating program or tool used is not listed as an option in the pull-down, select 'Other', and in the 'Remarks' section, state the program or tool and how it was used.

Sections 2A and 2B – Inventory Ratings

For LFR inventory ratings, use all Design Vehicles, AASHTO Legal Trucks, and SHVs in the LRSF. 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.

Section 3 – Bridge Load Rating Summary

All of the fields in this section are to be manually input based on the ratings input/output in Sections 2A, 2B, 5, and 6A through 6D of the LRSF. 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 or information that would otherwise not be evident in the load rating should be included. If needed, the bottom of Page 2 of the LRSF 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 Bridge Maintenance Office Approvals Form in Appendix A20.2 to Chapter 20.
   b. Reinforced concrete end bent caps were rated using CSi Bridge version 20.1.0 and Mathcad 15.
   c. Bridge geometry for load rating is based on field measurements obtained on 2018-09-28.
   d. Structure length used for load rating is 184 feet as opposed to 180 feet shown in Section 1 of the LRSF.
   e. Culvert top slab reinforcing steel was increased 80% from what is shown on plans so culvert can rate out per guidance in Chapter 17.
   f. Barrier rail stiffness was considered in load rating analysis. Inspectors shall verify condition of barrier and barrier-to-deck interface during inspection.
2) Provide name, company and title of the engineer (EOR) who performed or oversaw the load rating analysis. Provide date the rating was completed.
3) Provide name, company and title of the QC Engineer. Provide date review was completed. QC Engineer should also complete QC Review Checklist (see Appendix A3.2 to Chapter 3).
4) Once the load rating has been completed, checked and QC'd, a Professional Engineer (EOR) licensed in the State of South Carolina should convert the LRSF to PDF and digitally seal and sign the final copy. 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 and guidance of the EOR.
5) After the PDF of the LRSF is signed and sealed, the QA Engineer should check the box on the LRSF if a QA Review is required. If a QA review is required, include name, company and title of the QA Engineer and the date the review was completed. The QA Engineer should also complete QA Review Checklist (see Appendix A3.4 to Chapter 3).

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 EVs 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.

LRFR Load Rating Summary Form

Most of the cells in the LRSF 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 BrR. The cells in Sections 2, 5A through 5D, and 6 are left shaded light blue. Although they are not manually input in the LRSF 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 in the LRSF is the 'General Bridge Data'.

1) Most of the cells will be automatically populated from information in the 'Master Data' tab once the 'Asset ID', 'Created By' and 'Number of Spans' fields are entered and the 'Populate Data' 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 pull-down menus or manually typing in the information. All cells are input with data found in the Inspection Report (SI&A 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, or if there are other errors on the SI&A sheet, use the standard Data Correction Form (see Appendix A5.2 to Chapter 5) to note the discrepancy. Do not manually correct the data in this section, and if there is incorrect information (e.g. structure length) that affects the load rating, note the discrepancy in the 'Remarks' section of this form (see Section 4 guidance).

   In the 'Rating Program & Version' boxes, if only one rating program (e.g. BrR) was used, select this option from the pull-down in the first box, and leave the second box as 'N/A'. If a second rating program or tool was used, select it from the pull-down in the second box. If the rating program or tool used is not listed as an option in the pull-down, select 'Other', and in the 'Remarks' section, state the program or tool and how it was used.

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 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 bridges or culverts that are single-span, if referenced accurately, the rows for the HL-93 Truck Train + Lane (90%) will not populate because this design loading would not apply.

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 based on the ratings input/output in Sections 5A through 5D of the LRSF. 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 or information that would otherwise not be evident in the load rating should 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 LRSF has extra room for additional remarks. See Section 4 in ASR-LFR guidance for some examples of remarks to be included.

2) Provide name, company and title of the engineer (EOR) who performed or oversaw the load rating analysis. Provide date the rating was completed.

3) Provide name, company and title of the QC Engineer. Provide date review was completed. QC Engineer should also complete QC Review Checklist (see Appendix A3.2 to Chapter 3).

4) Once the load rating has been completed, checked and QC'd, a Professional Engineer (EOR) licensed in the State of South Carolina should convert the LRSF to PDF and digitally seal and sign the final copy. 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 and guidance of the EOR.

5) After the PDF of the LRSF is signed and sealed, the QA Engineer should check the box on the LRSF if a QA Review is required. If a QA review is required, include name, company and title of the QA Engineer and the date the review was completed. The QA Engineer should also complete QA Review Checklist (see Appendix A3.4 to Chapter 3).

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 'Master 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, EVs, 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.

APPENDIX A20.2: BRIDGE MAINTENANCE OFFICE APPROVALS FORM

Bridge Maintenance Office Approvals Form

Version: 1.0
Page 1 of 2

SECTION 1: CONTACT INFORMATION	
Name of Person Requesting Data:	
Requestor's Email:	
Requestor's Phone:	
Requestor's Company/Title: *(enter SCDOT if in-house request)*	
Date of Request:	

SECTION 2: GENERAL BRIDGE DATA

(8) Asset ID:	(2) District:	(3) County:	(7) Facility Carried:	(6) Feature Crossed:
	Select District	Select County		

SECTION 3: APPROVAL REQUESTS

Check Approval(s) Being Requested	Approval Request	Load Rating Guidance Document Reference Section	Approval Status (Y/N)
☐	Approval granted for use of load rating software other than current approved BrR version (general use)? *Software to be used:*	3.3	
☐	Approval granted for use of load rating software other than current approved BrR version for concrete/masonry substructure rating? *Software to be used:*	14.3	
☐	Approval granted for use of load rating software other than current approved BrR version for steel substructure rating? *Software to be used:*	15.3	
☐	Approval granted for use of load rating software other than current approved BrR version for timber substructure rating? *Software to be used:*	16.3	
☐	Approval granted for use of load rating software other than current approved BrR version 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?	5.6	
☐	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 or non-destructive testing (NDT) to improve rating factor? *(In Section 4, specify subsequent action.)*	6.12	

SCDOT **Bridge Maintenance Office Approvals Form**

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SECTION 3: APPROVAL REQUESTS (CONTINUED)			
Check Approval(s) Being Requested	**Approval Request**	**Load Rating Guidance Document Reference Section**	**Approval Status (Y/N)**
☐	Approval granted to use top or bottom flange lateral bracing members in 3D or grid analysis?	11.2.1.1	
☐	Approval granted to consider the top flanges of "Through Girder" bridges as braced?	11.2.1.1	
☐	Coordination of culvert load ratings with large fills, showing signs of distress and carrying normal traffic for an appreciable period. *(In Section 4, specify subsequent action.)*	17.2.1	
☐	Posting avoidance options approved? *Posting avoidance method to be used:*	19.1	
☐	Service III limit state waiver approved?	19.2.3	
☐	Bridge Maintenance Office notified if field investigation found discrepancies that invalidate last load rating incorporating barrier stiffness. *(In Section 4, specify subsequent action.)*	19.2.5	
☐	Bridge Maintenance Office notified if the recommended posting is below the Operating capacity? *(In Section 4, specify subsequent action.)*	19.4	
☐	Other *(Please specify)*:		

SECTION 4: COMMENTS (REQUESTOR)

REQUESTOR'S SIGNATURE DATE

SECTION 5: COMMENTS (BMO REVIEWER)

BMO REVIEWER'S NAME TITLE

BMO REVIEWER'S SIGNATURE DATE

Send to SCDOT Bridge Maintenance Office **Bridge Maintenance Office: Return to Sender**

A link to the latest version of the Bridge Maintenance Office Approvals Form is located here: Bridge Maintenance Office Approvals Form (hot link to be provided)