AASHTO | American Association of State Highway and Transportation Officials







THE MANUAL FOR BRIDGE EVALUATION

2026 | 4th Edition

FOREWORD

The *Manual for Bridge Evaluation* (MBE) was first adopted by the AASHTO Highways Subcommittee on Bridges and Structures in 2005. The MBE combined the *Manual for Condition Evaluation of Bridges* with the *Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges* to provide Owners with a single document for evaluating and load rating bridges.

The *Manual for Bridge Evaluation*, Fourth Edition incorporates the Interim Revisions issued to the Third Edition, as well as many other improvements. Major updates include gusset plate additions and examples, a new load testing chapter, segmental bridge updates, material property corrections, permit truck equation, updates from the new National Bridge Inspection Standards (NBIS), National Transportation Safety Board (NTSB) recommendations from the Fern Hollow bridge collapse, and various updates to capacity equations.

AASHTO Highways Committee on Bridges and Structures

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

PREFACE

The Manual for Bridge Evaluation (MBE) offers assistance to Bridge Owners at all phases of bridge inspection and evaluation. An abbreviated table of contents follows this preface. Detailed tables of contents precede Sections 1 through 8.

Appendix A includes nine illustrative examples (A1 through A9), previously in the *Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges*, two (A10 and A11) that were added in the Interim Revisions for the Second Edition of this title, and three more (A12, A13, and A14) added in this new Fourth Edition. All examples are rated using the LRFR method. In addition, Examples A1 and A2 are also rated using the ASR and LFR methods, A4 is also rated using the ASR method, and A11 is also rated using the LFR method. To clarify which rating method is being illustrated, examples using multiple methods are generally divided into Parts A through C and their articles are numbered accordingly as follows:

- Part A, LRFR;
- Part B, ASR and LFR; and
- Part C, example summary.

For ease of reference, the table of contents for Appendix A includes a summary table of the bridge types, rated members, rating live loads, limit states for evaluation, and rating methods, with the starting page number for each example and, in the case of Examples A1, A2, A4, and A11, for each rating method. The typical detailed table of contents follows this summary table.

Appendix A includes numerous citations of other AASHTO bridge publications. To save space, the following shorthand has been adopted:

- "AASHTO Standard Specifications" refers to the AASHTO *Standard Specifications for Highway Bridges*, 17th Edition, HB-17;
- "LRFD Design" refers to the current edition of the *AASHTO LRFD Bridge Design Specifications*, Tenth Edition, LRFDBDS-10; and
- "MBE" refers to this publication, *The Manual for Bridge Evaluation*, Fourth Edition, MBE-4.

AASHTO Publications Staff

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

ABBREVIATED TABLE OF CONTENTS

SECTION 1: INTRODUCTION 1-i
SECTION 2: BRIDGE FILES AND DOCUMENTATION 2-i
SECTION 3: BRIDGE MANAGEMENT SYSTEMS 3-i
SECTION 4: INSPECTION PROCEDURES 4-i
SECTION 5: MATERIAL TESTING 5-i
SECTION 6: LOAD RATING 6-i
SECTION 7: FATIGUE EVALUATION OF STEEL BRIDGES 7-i
SECTION 8: LOAD TESTING 8-i
APPENDIX A: ILLUSTRATIVE EXAMPLES . . . . . A-i

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

TABLE OF CONTENTS

1.1—PURPOSE 1-1
1.2—SCOPE 1-1
1.3—APPLICABILITY 1-2
1.4—QUALITY 1-2
1.4.1—Provisions to Support the NBIS Requirements 1-3
1.4.2—QC/QA Procedures 1-3
1.5—DEFINITIONS AND TERMINOLOGY 1-4
1.6—REFERENCES 1-6

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

TABLE OF CONTENTS

2.1—INTRODUCTION 2-1
2.2—PROVISIONS TO SUPPORT THE NBIS REQUIREMENTS 2-1
2.2.1—General File Information 2-2
2.2.2—Field Inspection Information 2-3
2.2.3—Critical Findings and Actions Taken 2-3
2.2.4—Waterway Information 2-4
2.2.5—Significant Correspondence 2-4
2.2.6—Other Inspection Procedures or Requirements 2-4
2.2.7—Load Rating Documentation 2-5
2.2.8—Posting Documentation 2-5
2.2.9—Scour Assessment 2-6
2.2.10—Scour Plan of Action 2-6
2.3—SUPPLEMENTAL DOCUMENTATION IN BRIDGE FILE 2-6
2.3.1—General 2-6
2.3.2—Plans and Drawings 2-6
2.3.3—Construction Documentation 2-6
2.3.4—Original Design Documentation 2-7
2.3.5—Unique Considerations 2-7
2.3.6—Utilities and Ancillary Attachments 2-7
2.3.7—Maintenance and Repair History 2-8
2.3.8—Additional Waterway Documentation 2-8
2.3.9—Traffic Data 2-8

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

TABLE OF CONTENTS

3.1—INTRODUCTION 3-1
3.2—OBJECTIVES OF BRIDGE MANAGEMENT SYSTEMS 3-2
3.3—COMPONENTS OF A BRIDGE MANAGEMENT SYSTEM 3-2
3.3.1—Information Management 3-3
3.3.1.1—Bridge Inventory, General Condition Ratings, and Bridge Element Ratings 3-3
3.3.1.1.1—Bridge Inventory 3-3
3.3.1.1.2—General Condition Ratings 3-3
3.3.1.1.3—Bridge Element Ratings 3-4
3.3.1.2—Agency Performance Measures 3-4
3.3.1.3—Preservation and Improvement Action Data 3-7
3.3.1.4—Cost Data and Financial Plans 3-7
3.3.2—Data Integration 3-8
3.3.2.1—Data Analysis 3-8
3.3.2.2—Risk Assessment 3-9
3.3.2.3—Agency Rules 3-11
3.3.2.4—Cost–Benefit Analysis 3-12
3.3.2.4.1—Condition-Driven Cost–Benefit Analysis 3-13
3.3.2.4.2—Improvement Cost–Benefit Analysis 3-13
3.3.2.4.3—Lifecycle Cost–Benefit Analysis 3-13
3.3.2.5—Prioritization and Optimization 3-15
3.3.2.5.1—Multi-Objective Optimization 3-16
3.3.3—Decision Support 3-17
3.4—REFERENCES 3-18

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

TABLE OF CONTENTS

4.1—INTRODUCTION 4-1
4.2—PROVISIONS TO SUPPORT THE NBIS REQUIREMENTS. . . . 4-1
4.2.1—Bridge Inspection Organization 4-1
4.2.2—Qualifications of Personnel 4-2
4.2.3—Inspection Types 4-3
4.2.3.1—Initial Inspection 4-3
4.2.3.2—Routine Inspection 4-3
4.2.3.3—In-Depth Inspection 4-4
4.2.3.4—Non-Redundant Steel Tension Member Inspection 4-5
4.2.3.5—Underwater Inspection 4-5
4.2.3.6—Special Inspection 4-6
4.2.3.7—Damage Inspection 4-6
4.2.4—Inspection Interval 4-7
4.2.4.1—Initial Inspection Interval 4-7
4.2.4.2—Routine Inspection Interval 4-8
4.2.4.3—In-Depth Inspection Interval 4-8
4.2.4.4—Non-Redundant Steel Tension Member Inspection Interval 4-8
4.2.4.5—Underwater Inspection Interval 4-8
4.2.4.6—Special Inspection Interval. . . . 4-9
4.2.4.7—Damage Inspection Interval 4-9
4.2.5—Inspection Procedures 4-9
4.2.5.1—General 4-9
4.2.5.2—Initial Inspection Procedures 4-11
4.2.5.3—Routine Inspection Procedures. . . . 4-11
4.2.5.4—In-Depth Inspection Procedures. . . . 4-12
4.2.5.5—Non-Redundant Steel Tension Member Inspection Procedures 4-12
4.2.5.6—Underwater Inspection Procedures. . . . 4-13
4.2.5.7—Special Inspection Procedures 4-13
4.2.5.8—Damage Inspection Procedures 4-13
4.2.5.9—Complex Bridge Inspection Procedures 4-14
4.2.6—Collection of Element-Level Data 4-14
4.3—INSPECTION PRACTICES 4-15
4.3.1—General 4-15
4.3.2—Safety 4-15
4.3.2.1—Safety for Inspectors. . . . 4-15
4.3.2.2—Public Safety 4-16
4.3.3—Planning, Scheduling, and Equipment 4-17
4.3.3.1—Planning 4-17
4.3.3.2—Scheduling 4-18
4.3.3.3—Equipment 4-18
4.3.3.3.1—Access Methods and Equipment 4-18
4.3.3.3.2—Inspection Methods and Equipment 4-19

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

4.3.4—Inspection Forms and Reports 4-20
4.3.4.1—Field Notebooks 4-20
4.3.4.2—Reports 4-21
4.3.5—Inspection Techniques 4-21
4.3.5.1—Field Measurements 4-22
4.3.5.2—Cleaning 4-23
4.3.5.3—Condition Rating Inspection of Bridges 4-24
4.3.5.4—Critical Inspection Findings 4-25
4.3.5.5—Decks 4-25
4.3.5.5.1—Concrete Decks 4-26
4.3.5.5.2—Prestressed Concrete Deck Panels 4-27
4.3.5.5.3—Steel Decks 4-28
4.3.5.5.4—Timber Decks 4-29
4.3.5.5.5—Expansion Joints 4-29
4.3.5.5.6—Railings, Sidewalks, and Curbs 4-30
4.3.5.5.7—Drainage 4-31
4.3.5.5.8—Lighting 4-31
4.3.5.5.9—Deck Overlays 4-32
4.3.5.6—Superstructure 4-32
4.3.5.6.1—Steel Beams, Girders, and Box Sections 4-32
4.3.5.6.2—Reinforced Concrete Beams, Girders, and Box Sections 4-34
4.3.5.6.3—Prestressed Concrete Beams, Girders, and Box Sections 4-34
4.3.5.6.4—Timber Systems 4-35
4.3.5.6.5—Floor Systems 4-36
4.3.5.6.6—Trusses 4-36
4.3.5.6.7—Cables 4-38
4.3.5.6.8—Diaphragms and Cross-Frames 4-38
4.3.5.6.9—Lateral Bracing, Portals, and Sway Frames 4-39
4.3.5.6.10—Rivets, Bolts, and Welded Connections 4-39
4.3.5.6.11—Pins and Hangers 4-40
4.3.5.6.12—Bearings 4-42
4.3.5.6.13—Paint 4-43
4.3.5.6.14—Utilities 4-44
4.3.5.6.15—Arches 4-45
4.3.5.7—Substructure 4-45
4.3.5.7.1—Abutments 4-46
4.3.5.7.2—Retaining Walls 4-47
4.3.5.7.3—Piers and Bents 4-47
4.3.5.7.4—Bridge Stability and Movements 4-49
4.3.5.8—Scour and Waterway Inspections 4-50
4.3.5.8.1—Substructure/Culvert Scour Inspection 4-50
4.3.5.8.2—Underwater Inspection 4-52
4.3.5.8.3—Inspection of Waterways 4-52

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

4.3.5.8.4—Channel Protection Features—Dolphins and Fenders 4-53
4.3.5.9—Box Culverts as Bridges 4-54
4.3.5.10—Corrugated Metal Plate Structures 4-55
4.3.5.11—Approaches 4-55
4.3.5.11.1—Approach Slabs 4-56
4.3.5.11.2—Approach Pavement 4-56
4.3.5.11.3—Drainage 4-57
4.3.5.11.4—Traffic Safety Features 4-57
4.3.5.11.5—Embankment Slopes 4-58
4.3.5.12—Encroachments 4-58
4.3.5.13—Signs 4-58
4.3.6—Complex Bridge Inspections 4-59
4.3.6.1—Movable Bridges 4-59
4.3.6.2—Suspension Bridges 4-60
4.3.6.3—Cable-Stayed Bridges 4-61
4.3.6.4—Tied Arch Bridges 4-61
4.3.6.5—Prestressed Concrete Segmental Bridges 4-61
4.3.7—Fatigue-Prone Details and Non Redundant Steel Tension Members 4-62
4.3.7.1—Fatigue-Prone Details 4-63
4.3.7.2—Non-Redundant Steel Tension Members 4-63
4.3.8—Data Collection for Load Rating 4-64
4.3.8.1—Field Data Collection 4-65
4.3.8.2—Observation under Traffic 4-66
4.3.8.3—Loading Determination 4-66
4.4—REFERENCES 4-67

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

TABLE OF CONTENTS

5.1—GENERAL 5-1
5.2—FIELD TESTS. 5-1
5.2.1—Concrete Field Tests. 5-1
5.2.1.1—Strength Methods 5-2
5.2.1.2—Sonic Methods 5-3
5.2.1.3—Ultrasonic Techniques 5-3
5.2.1.4—Magnetic Methods 5-4
5.2.1.5—Electrical Methods 5-5
5.2.1.6—Nuclear Methods. 5-6
5.2.1.7—Thermography. 5-6
5.2.1.8—Radar 5-6
5.2.1.9—Radiography 5-6
5.2.1.10—Endoscopes 5-7
5.2.2—Steel Field Tests. 5-7
5.2.2.1—Radiography 5-8
5.2.2.2—Magnetic Particle Examination 5-9
5.2.2.3—Eddy Current Examination. 5-10
5.2.2.4—Dye Penetrant Examination 5-10
5.2.2.5—Ultrasonic Examination 5-11
5.2.3—Timber Field Tests 5-12
5.2.3.1—Penetration Methods 5-13
5.2.3.2—Electrical Methods 5-13
5.2.3.3—Ultrasonic Techniques 5-14
5.3—MATERIAL SAMPLING. 5-15
5.4—LABORATORY TESTS 5-16
5.5—INTERPRETATION AND EVALUATION OF TEST RESULTS 5-18
5.6—TESTING REPORTS 5-19
5.7—REFERENCES 5-20

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

TABLE OF CONTENTS

6.1—SCOPE 6-1
6.1.1—Assumptions 6-1
6.1.2—Condition of Bridge Members 6-2
6.1.3—Evaluation Methods 6-3
6.1.4—Bridges with Unknown Structural Components 6-4
6.1.5—Component-Specific Evaluation 6-4
6.1.5.1—Decks 6-4
6.1.5.2—Substructures 6-4
6.1.6—Evaluation of Complex Structures 6-5
6.1.7—Nonredundant Structures 6-5
6.1.8—Qualifications and Responsibilities 6-5
6.1.9—Documentation of Load Rating 6-5
6.1.10—References 6-6
PART A—LOAD AND RESISTANCE FACTOR RATING 6-9
6A.1—INTRODUCTION 6-9
6A.1.1—General 6-9
6A.1.2—Scope 6-9
6A.1.3—Philosophy 6-10
6A.1.4—Application of *AASHTO LRFD Bridge Design Specifications* 6-10
6A.1.5—Load and Resistance Factor Rating 6-11
6A.1.5.1—Design Load Rating 6-11
6A.1.5.2—Legal Load Rating 6-12
6A.1.5.3—Permit Load Rating 6-12
6A.2—LOADS FOR EVALUATION 6-12
6A.2.1—General 6-12
6A.2.2—Permanent Loads and Load Factors 6-12
6A.2.2.1—Dead Loads: *DC* and *DW* 6-12
6A.2.2.2—Permanent Loads Other Than Dead Loads: *P* 6-13
6A.2.2.3—Load Factors 6-13
6A.2.3—Transient Loads 6-13
6A.2.3.1—Vehicular Live Loads (Gravity Loads): *LL* 6-13
6A.2.3.2—Application of Vehicular Live Load 6-14
6A.2.3.3—Dynamic Load Allowance: *IM* 6-15
6A.2.3.4—Pedestrian Live Loads: *PL* 6-15
6A.2.3.5—Wind Loads: *WL* and *WS* 6-15
6A.2.3.6—Temperature Effects: T_G and T_U 6-16
6A.2.3.7—Earthquake Effects: *EQ* 6-16
6A.2.3.8—Creep and Shrinkage: *CR* and *SH* 6-16
6A.3—STRUCTURAL ANALYSIS 6-17
6A.3.1—General 6-17
6A.3.2—Approximate Methods of Structural Analysis 6-17
6A.3.3—Refined Methods of Analysis 6-18

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

6A.3.4—Analysis by Field Testing 6-19
6A.4—LOAD-RATING PROCEDURES 6-20
6A.4.1—Introduction 6-20
6A.4.2—General Load-Rating Equation 6-21
6A.4.2.1—General 6-21
6A.4.2.2—Limit States 6-22
6A.4.2.3—Condition Factor: φ_c 6-24
6A.4.2.4—System Factor: φ_s 6-25
6A.4.3—Design-Load Rating 6-26
6A.4.3.1—Purpose 6-26
6A.4.3.2—Live Loads and Load Factors 6-27
6A.4.3.2.1—Live Load 6-27
6A.4.3.2.2—Live Load Factors 6-27
6A.4.3.3—Dynamic Load Allowance 6-27
6A.4.4—Legal Load Rating 6-27
6A.4.4.1—Purpose 6-27
6A.4.4.2—Live Loads and Load Factors 6-28
6A.4.4.2.1—Live Loads 6-28
6A.4.4.2.1a—Routine Commercial Traffic 6-28
6A.4.4.2.1b—Specialized Hauling Vehicles 6-28
6A.4.4.2.2—Live Load Factors 6-30
6A.4.4.2.3—Generalized Live Load Factors: γ_L 6-31
6A.4.4.2.3a—Generalized Live Load Factors for Routine Commercial Traffic 6-31
6A.4.4.2.3b—Generalized Live Load Factors for Specialized Hauling Vehicles 6-36
6A.4.4.3—Dynamic Load Allowance: *IM* 6-37
6A.4.4.4—Rating in Tons 6-38
6A.4.5—Permit Load Rating 6-38
6A.4.5.1—Background 6-38
6A.4.5.2—Purpose 6-39
6A.4.5.3—Permit Types 6-39
6A.4.5.3.1—Routine (Annual) Permits 6-39
6A.4.5.3.2—Special (Limited Crossing) Permits 6-39
6A.4.5.4—Live Load and Load Factors 6-40
6A.4.5.4.1—Live Load 6-40
6A.4.5.4.2—Load Factors 6-40
6A.4.5.4.2a—Routine (Annual) Permits 6-41
6A.4.5.4.2b—Special (Limited-Crossing) Permits 6-42
6A.4.5.4.2c—Permit Checks Using Refined Analysis 6-43
6A.4.5.5—Dynamic Load Allowance: *IM* 6-44
6A.4.5.6—Exterior Beams 6-44
6A.4.5.7—Continuous Spans 6-44
6A.5—CONCRETE STRUCTURES 6-44
6A.5.1—Scope 6-44

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

6A.5.2—Materials 6-45
6A.5.2.1—Concrete 6-45
6A.5.2.2—Reinforcing Steel 6-45
6A.5.2.3—Prestressing Steel 6-46
6A.5.3—Resistance Factors 6-46
6A.5.4—Limit States 6-46
6A.5.4.1—Design-Load Rating 6-46
6A.5.4.2—Legal Load Rating and Permit Load Rating 6-47
6A.5.4.2.1—Strength Limit State 6-47
6A.5.4.2.2—Service Limit State 6-47
6A.5.4.2.2a—Legal Load Rating 6-47
6A.5.4.2.2b—Permit Load Rating 6-47
6A.5.5—Maximum Reinforcement 6-48
6A.5.6—Minimum Reinforcement 6-48
6A.5.7—Evaluation for Flexural and Axial Force Effects 6-48
6A.5.8—Evaluation for Shear 6-49
6A.5.9—Secondary Effects from Prestressing 6-51
6A.5.10—Temperature, Creep, and Shrinkage Effects 6-51
6A.5.11—Rating of Segmental Concrete Bridges 6-52
6A.5.11.1—Scope 6-52
6A.5.11.2—General Rating Requirements 6-52
6A.5.11.3—Application of Vehicular Live Load 6-52
6A.5.11.4—Design-Load Rating 6-53
6A.5.11.5—Service Limit State 6-54
6A.5.11.5.1—Legal Load Rating 6-54
6A.5.11.5.2—Permit Load Rating 6-54
6A.5.11.5.3—Stress Limits for Concrete 6-54
6A.5.11.6—System Factors: φ_s 6-56
6A.5.11.7—Evaluation for Shear and Torsion 6-60
6A.6—STEEL STRUCTURES 6-61
6A.6.1—Scope 6-61
6A.6.2—Materials 6-61
6A.6.2.1—Structural Steels 6-61
6A.6.2.2—Pins 6-62
6A.6.2.3—Wrought Iron 6-62
6A.6.3—Resistance Factors 6-62
6A.6.4—Limit States 6-63
6A.6.4.1—Design-Load Rating 6-63
6A.6.4.2—Legal Load Rating and Permit Load Rating 6-64
6A.6.4.2.1—Strength Limit State 6-64
6A.6.4.2.2—Service Limit State 6-64
6A.6.5—Effects of Deterioration on Load Rating 6-66
6A.6.6—Tension Members 6-69

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

6A.6.6.1—Links and Hangers 6-70
6A.6.6.2—Eyebars 6-70
6A.6.7—Noncomposite Compression Members. 6-70
6A.6.8—Combined Axial Compression and Flexure. 6-71
6A.6.9—I-Sections in Flexure. 6-72
6A.6.9.1—General 6-72
6A.6.9.2—Composite Sections 6-73
6A.6.9.3—Non-Composite Sections 6-74
6A.6.9.4—Encased I-Sections. 6-74
6A.6.9.5—Cross Section Proportion Limits 6-74
6A.6.9.6—Riveted Members. 6-74
6A.6.9.7—Diaphragms and Cross-Frames. 6-75
6A.6.10—Evaluation for Shear 6-75
6A.6.10.1—End Panels 6-75
6A.6.11—Box Sections in Flexure. 6-77
6A.6.11.1—Diaphragms and Cross-Frames 6-77
6A.6.12—Evaluation of Critical Connections 6-77
6A.6.12.1—General. 6-77
6A.6.12.2—Bearing-Type Connections. 6-78
6A.6.12.3—Slip-Critical Connections 6-78
6A.6.12.4—Pinned Connections 6-78
6A.6.12.5—Riveted Connections 6-78
6A.6.12.5.1—Rivets in Shear 6-79
6A.6.12.5.2—Rivets in Shear and Tension 6-80
6A.6.12.6—Gusset Plates.. 6-80
6A.6.12.6.1—Resistance Reduction for DL/LL Ratio 6-81
6A.6.12.6.2—Fastener Shear Resistance. 6-82
6A.6.12.6.3—Bolt Slip Resistance 6-83
6A.6.12.6.4—Bearing Resistance at Fastener Holes 6-84
6A.6.12.6.5—Multilayered Gusset and Splice Plates 6-85
6A.6.12.6.6—Gusset Plate Shear Resistance 6-86
6A.6.12.6.7—Gusset Plate Compressive Resistance 6-86
6A.6.12.6.7a—Whitmore Section and Partial Shear Plane Compressive Resistance. 6-88
6A.6.12.6.7b—Basic Corner Check Compressive Resistance. 6-91
6A.6.12.6.8—Gusset Plate Tensile Resistance 6-96
6A.6.12.6.9—Chord Splices 6-98
6A.6.12.6.10—Edge Slenderness 6-100
6A.6.12.6.11—Refined Analysis 6-101
6A.7—WOOD STRUCTURES 6-102
6A.7.1—Scope 6-102
6A.7.2—Materials 6-103
6A.7.3—Resistance Factors 6-103
6A.7.4—Limit States 6-103

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

6A.7.4.1—Design-Load Rating 6-103
6A.7.4.2—Legal Load Rating and Permit Load Rating 6-103
6A.7.5—Dynamic Load Allowance 6-103
6A.7.6—Evaluation of Critical Connections 6-104
6A.8—POSTING OF BRIDGES 6-104
6A.8.1—General 6-104
6A.8.2—Posting Loads 6-104
6A.8.3—Posting Analysis 6-105
6A.8.4—Regulatory Signs 6-107
6A.8.5—Speed Limits 6-107
6A.9—SPECIAL TOPICS 6-108
6A.9.1—Evaluation of Unreinforced Masonry Arches 6-108
6A.9.1.1—General 6-108
6A.9.1.2—Method of Analysis 6-108
6A.9.1.3—Allowable Stresses in Masonry 6-109
6A.9.2—Historic Bridges 6-109
6A.9.3—Railroad Flatcar Bridges 6-119
6A.10—RATING OF CULVERTS 6-110
6A.10.1—Scope 6-110
6A.10.2—General Rating Requirements 6-111
6A.10.3—Structural Analysis of Culverts 6-111
6A.10.3.1—Rectangular Concrete Culverts 6-111
6A.10.3.2—Concrete Arches, Metal, Thermoplastic, and Fiberglass Pipe and Other Metal Culvert Types 6-114
6A.10.3.3—Finite Element Modeling 6-114
6A.10.4—Load Rating Equation for Culverts 6-115
6A.10.5—Limit States 6-116
6A.10.6—Resistance Factors 6-118
6A.10.7—Condition Factors 6-9118
6A.10.8—System Factor: φ_s 6-118
6A.10.9—Materials 6-118
6A.10.10—Loads for Evaluation 6-118
6A.10.10.1—Dead Loads 6-118
6A.10.10.2—Earth Pressure 6-118
6A.10.10.2.1—Vertical Earth Pressure: *EV* 6-118
6A.10.10.2.2—Horizontal Earth Pressure: *EH* 6-118
6A.10.10.2.3—Uniform Surcharge Loads: *ES* 6-119
6A.10.10.3—Live Loads 6-119
6A.10.10.3.1—Live Load Distribution 6-120
6A.10.10.3.2—Dynamic Load Allowance: *IM* 6-122
6A.10.10.3.3—Approaching Wheel Load: *AW* 6-122
6A.10.10.3.4—Pavements 6-122
6A.10.11—Concrete Culverts 6-124
6A.10.11.1—Rating for Shear 6-124

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

6A.10.12—Metal Culverts . . . 6-125
6A.10.13—Thermoplastic and Fiberglass Culverts . . . 6-125
6A.11—REFERENCES . . . 6-125
APPENDIX A6A—LOAD AND RESISTANCE FACTOR RATING FLOW CHART . . . 6-129
APPENDIX B6A—LIMIT STATES AND LOAD FACTORS FOR LOAD RATING . . . 6-130
APPENDIX C6A—LRFD DESIGN LIVE LOAD (HL-93) (LRFD DESIGN ARTICLE 3.6.1) . . . 6-133
APPENDIX D6A—AASHTO LEGAL LOADS . . . 6-134
APPENDIX E6A—LIVE LOAD MOMENTS ON LONGITUDINAL STRINGERS OR GIRDERS (SIMPLE SPAN) . . . 6-137
APPENDIX F6A—VARIATION IN MOMENT RATIO WITH SPAN LENGTH . . . 6-139
APPENDIX G6A—RATING OF CONCRETE COMPONENTS FOR COMPRESSION PLUS BENDING . . . 6-140
APPENDIX H6A—RATING OF STEEL MEMBERS FOR COMPRESSION PLUS BENDING . . . 6-141
APPENDIX I6A—RATING OF STEEL COMPRESSION MEMBERS WITH ECCENTRIC CONNECTIONS (SECANT FORMULA METHOD) . . . 6-143
PART B—ALLOWABLE STRESS RATING AND LOAD FACTOR RATING . . . 6-145
6B.1—GENERAL . . . 6-145
6B.1.1—Application of Standard Design Specifications . . . 6-146
6B.2—RATING LEVELS . . . 6-146
6B.2.1—Inventory Rating Level . . . 6-146
6B.2.2—Operating Rating Level . . . 6-146
6B.3—RATING METHODS . . . 6-146
6B.3.1—Allowable Stress: *AS* . . . 6-147
6B.3.2—Load Factor: *LF* . . . 6-147
6B.4—RATING EQUATION . . . 6-147
6B.4.1—General . . . 6-147
6B.4.2—Allowable Stress . . . 6-148
6B.4.3—Load Factor . . . 6-148
6B.5—NOMINAL CAPACITY: C . . . 6-148
6B.5.1—General . . . 6-148
6B.5.2—Allowable Stress Method . . . 6-149
6B.5.2.1—Structural Steel . . . 6-149
6B.5.2.1.1—Combined Stresses . . . 6-170
6B.5.2.1.2—Batten Plate Compression Members . . . 6-170
6B.5.2.2—Wrought Iron . . . 6-171
6B.5.2.3—Reinforcing Steel . . . 6-171
6B.5.2.4—Concrete . . . 6-171
6B.5.2.4.1—Bending . . . 6-172
6B.5.2.4.2—Columns . . . 6-172
6B.5.2.4.3—Shear (Diagonal Tension) . . . 6-173
6B.5.2.5—Prestressed Concrete . . . 6-174
6B.5.2.6—Masonry . . . 6-174
6B.5.2.7—Timber . . . 6-176
6B.5.3—Load Factor Method . . . 6-177

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

6B.5.3.1—Structural Steel 6-177
6B.5.3.2—Reinforced Concrete 6-180
6B.5.3.3—Prestressed Concrete 6-180
6B.6—LOADINGS 6-182
6B.6.1—Dead Load: *D* 6-182
6B.6.2—Rating Live Load 6-183
6B.6.2.1—Wheel Loads (Deck) 6-183
6B.6.2.2—Truck Loads 6-183
6B.6.2.3—Lane Loads 6-185
6B.6.2.4—Sidewalk Loadings 6-185
6B.6.2.5—Live Load Effects: *L* 6-185
6B.6.3—Distribution of Loads 6-186
6B.6.4—Impact: *I* 6-186
6B.6.5—Deflection 6-186
6B.6.6—Longitudinal Loads 6-186
6B.6.7—Environmental Loads 6-186
6B.6.7.1—Wind 6-186
6B.6.7.2—Earthquake 6-187
6B.6.7.3—Temperature, Creep, and Shrinkage 6-187
6B.6.7.4—Stream Flow 6-187
6B.6.7.5—Ice Pressure 6-188
6B.6.7.6—Permanent Loads Other Than Dead Loads 6-188
6B.7—POSTING OF BRIDGES 6-188
6B.7.1—General 6-188
6B.7.2—Posting Loads 6-190
6B.7.3—Posting Analysis 6-195
6B.7.4—Regulatory Signs 6-195
6B.7.5—Speed Limits 6-196
6B.8—PERMITS 6-196
6B.8.1—General 6-196
6B.8.2—Routine Permits 6-196
6B.8.3—Controlled Permits 6-197
6B.8.4—Escorted Permits 6-197
6B.9—RATING OF CULVERTS 6-197
6B.10—REFERENCES 6-198
APPENDIX A6B 6-200
APPENDIX B6B 6-201
APPENDIX C6B—LIVE LOAD MOMENTS ON LONGITUDINAL STRINGERS OR GIRDERS 6-202
APPENDIX D6B—STRINGER LIVE LOAD REACTIONS ON TRANSVERSE FLOOR BEAMS AND CAPS (INTERMEDIATE TRANSVERSE BEAMS) (SIMPLE SPAN ONLY) 6-206
APPENDIX E6B—STRINGER LIVE LOAD REACTIONS ON TRANSVERSE FLOOR BEAMS AND CAPS (END TRANSVERSE BEAMS) (SIMPLE SPAN ONLY) 6-208

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

APPENDIX F6B—FORMULAS FOR MAXIMUM SHEAR[a] AT ANY PANEL POINT (NO IMPACT INCLUDED) (SIMPLE SPAN ONLY) 6-210
APPENDIX G6B—FORMULAS FOR MAXIMUM SHEAR AT ANY POINT ON SPAN (NO IMPACT INCLUDED) (SIMPLE SPANS ONLY) 6-211
APPENDIX H6B—FORMULAS FOR MAXIMUM SHEAR AT ANY POINT ON SPAN (NO IMPACT INCLUDED) (SIMPLE SPANS ONLY) 6-212
APPENDIX I6B—FORMULAS FOR MOMENT SHEAR AT ANY POINT ON SPAN (NO IMPACT INCLUDED) (SIMPLE SPANS ONLY) 6-213
APPENDIX J6B—FORMULAS FOR MAXIMUM MOMENT AT ANY POINT ON SPAN (NO IMPACT INCLUDED) (SIMPLE SPANS ONLY) 6-214
APPENDIX K6B—FORMULAS FOR STEEL COLUMNS[a] 6-215
APPENDIX L6B—FORMULAS FOR THE CAPACITY, *C*, OF TYPICAL BRIDGE COMPONENTS BASED ON THE LOAD FACTOR METHOD 6-217
L6B.1—GENERAL 6-217
L6B.2—CAPACITY OF STEEL MEMBERS (PART D, STRENGTH DESIGN METHOD) 6-217
L6B.2.1—Sections in Bending 6-217
L6B.2.1.1—Compact, Braced, Noncomposite 6-217
L6B.2.1.2—Compact, Composite 6-217
L6B.2.1.3—Noncompact, Noncomposite 6-218
L6B.2.1.4—Noncompact, Composite, Positive Moment Section 6-218
L6B.2.1.5—Noncompact, Composite, Negative Moment Section 6-219
L6B.2.2—Sections in Shear 6-219
L6B.2.3—Sections in Shear and Bending (Article 10.48.8.2) 6-219
L6B.2.4—Compression Members 6-227
L6B.2.4.1—Concentrically Loaded Members 6-227
L6B.2.4.2—Combined Axial Load and Bending 6-228
L6B.2.5—Capacity Based on Overload Provisions of Article 10.57 6-228
L6B.2.5.1—Noncomposite Beams 6-228
L6B.2.5.2—Composite Beams 6-228
L6B.2.5.3—Web Compressive Stress 6-228
L6B.2.6—Gusset Plates 6-228
L6B.2.6.1—Fasteners 6-228
L6B.2.6.2—Multilayered Gusset and Splice Plates 6-229
L6B.2.6.3—Gusset Plate Shear Resistance 6-230
L6B.2.6.4—Gusset Plate Compressive Resistance 6-231
L6B.2.6.5—Gusset Plate Tensile Resistance 6-232
L6B.2.6.6—Chord Splices 6-233
L6B.2.6.7—Edge Slenderness 6-235
L6B.2.6.8—Refined Analysis 6-235
L6B.3—REINFORCED CONCRETE MEMBERS (AASHTO *STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES*, 17TH EDITION, 8.16) 6-236
L6B.3.1—Sections in Bending 6-236
L6B.3.1.1—Rectangular Sections with Tension Reinforcement Only 6-236
L6B.3.1.2—Tee Section (Flanged) with Tension Reinforcement Only 6-236
L6B.3.1.2.1—Compression Zone within Flange Area 6-236

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

L6B.3.1.2.2—Compression Zone Includes Both Flange Area and a Portion of the Web 6-236
L6B.3.2—Sections in Compression 6-236
L6B.3.3—Sections in Shear 6-236
L6B.4—PRESTRESSED CONCRETE MEMBERS (SECTION 9) 6-236
L6B.4.1—Sections in Bending 6-236
L6B.4.1.1—Rectangular Sections without Nonprestressed Reinforcement 6-236
L6B.4.1.2—Tee (Flanged) Sections without Nonprestressed Reinforcement. 6-236
L6B.4.1.2.1—Compression Zone within Flange Area 6-236
L6B.4.1.2.2—Compression Zone Includes Flange Area and Part of Web 6-237
L6B.4.2—Sections in Shear 6-237

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

TABLE OF CONTENTS

7.1—LOAD-INDUCED VERSUS DISTORTION-INDUCED FATIGUE 7-1
7.2—LOAD-INDUCED FATIGUE DAMAGE EVALUATION 7-1
7.2.1—Application 7-1
7.2.2—Estimating Stress Ranges 7-2
7.2.2.1—Calculating Estimated Stress Ranges 7-2
7.2.2.1.1—For Determination of Evaluation or Minimum Fatigue Life 7-3
7.2.2.1.2—For Determination of Mean Fatigue Life 7-4
7.2.2.2—Measuring Estimated Stress Ranges 7-4
7.2.2.2.1—For Determination of Evaluation or Minimum Fatigue Life 7-5
7.2.2.2.2—For Determination of Mean Fatigue Life 7-5
7.2.3—Determining Fatigue-Prone Details 7-5
7.2.4—Infinite-Life Check 7-5
7.2.5—Estimating Finite Fatigue Life 7-6
7.2.5.1—General 7-6
7.2.5.2—Estimating the Number of Cycles per Truck Passage 7-7
7.2.6—Fatigue Serviceability Index 7-8
7.2.6.1—Calculating the Fatigue Serviceability Index 7-8
7.2.6.2—Recommended Actions Based on Fatigue Serviceability Index 7-9
7.2.7—Strategies to Increase Fatigue Serviceability Index 7-9
7.2.7.1—General 7-9
7.2.7.2—Recalculate Fatigue Serviceability Index 7-9
7.2.7.2.1—Through Accepting Greater Risk 7-9
7.2.7.2.2—Through More Accurate Data 7-10
7.2.7.2.3—Through Truncated Fatigue Life Distribution 7-10
7.2.7.3—Retrofit 7-12
7.3—DISTORTION-INDUCED FATIGUE EVALUATION 7-12
7.3.1—Methods to Assess Distortion-Induced Cracking 7-13
7.3.2—Retrofit Options for Distortion-Induced Fatigue Cracking 7-13
7.4—FRACTURE CONTROL FOR OLDER BRIDGES 7-14
7.5—ALTERNATE ANALYSIS METHODS 7-14
7.6—REFERENCES 7-15

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

TABLE OF CONTENTS

8.1—INTRODUCTION 8-1
8.1.1—General 8-1
8.1.2—Classification of Load Tests 8-1
8.2—FACTORS WHICH INFLUENCE THE LOAD-CARRYING CAPACITY OF BRIDGES 8-2
8.2.1—General 8-2
8.2.2—Unintended Composite Action 8-2
8.2.3—Boundary Conditions 8-3
8.2.4—Participation of Secondary Members 8-3
8.2.5—Participation of Nonstructural Members 8-3
8.2.6—Portion of Load Carried by Deck 8-4
8.2.7—Transverse Distribution 8-4
8.2.8—Damage, Material Degradation and Deterioration 8-4
8.3—BENEFITS OF LOAD TESTS 8-4
8.3.1—Unknown or Low-Rated Components 8-4
8.3.2—Load Distribution 8-5
8.3.3—Deteriorated or Damaged Members 8-5
8.3.4—Fatigue Evaluation 8-5
8.3.5—Dynamic Load Allowance 8-6
8.3.6—Reliability, Risk, and Life-Cycle Performance 8-6
8.4—TYPES OF LOAD TESTS 8-6
8.4.1—Load Tests 8-6
8.4.2—Proof Load Tests 8-7
8.4.3—Dynamic Load Allowance Estimation 8-8
8.4.4—Vibrational Methods 8-8
8.4.5—Bridge Weigh-in-Motion 8-8
8.5—LOAD TEST MEASUREMENTS 8-9
8.6—WHEN NOT TO LOAD TEST 8-12
8.7—BRIDGE SAFETY AND RISK DURING LOAD TESTING 8-12
8.8—LOAD RATING THROUGH LOAD TESTING 8-13
8.8.1—Introduction 8-13
8.8.2—Diagnostic Load Tests 8-13
8.8.2.1—Introduction 8-13
8.8.2.2—Approach 8-14
8.8.2.3—Qualitative Review of Load Test Data 8-17
8.8.2.4—Development of Beamline Live Load Distribution Factors 8-18
8.8.2.5—Load Rating Through Refined Analysis 8-20
8.8.3—Proof Load Tests 8-21
8.8.3.1—Introduction 8-21
8.8.3.2—Approach 8-22
8.8.3.3—Target Proof Loads 8-23
8.8.3.3.1—Selection of Target Live-Load Factor 8-23
8.8.3.3.2—Application of Target Live-Load Factor, X_{pA} 8-25

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

8.8.3.4—Proof Load Testing Procedure. 8-26
8.8.3.5—Load Capacity and Rating 8-30
8.9—USE OF LOAD TEST RESULTS IN PERMIT DECISIONS 8-31
8.10—SERVICEABILITY CONSIDERATIONS 8-32
8.11—REFERENCES 8-32
APPENDIX A8—GENERAL LOAD-TESTING PROCEDURES 8-34
A8.1—GENERAL 8-34
A8.2—STEP 1: DEFINITION OF OBJECTIVES AND DELIVERABLES 8-34
A8.3—STEP 2: EXECUTION AND VALIDATION OF LOAD TEST 8-35
A8.4—STEP 3: DEVELOPMENT OF ANALYTICAL APPROACH 8-35
A8.5—STEP 4: REFINEMENT OF ANALYTICAL MODEL 8-35
A8.6—STEP 5: DETERMINATION OF FINAL LOAD RATING AND REPORTING 8-35

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

TABLE OF CONTENTS

Example	Bridge Summary			Rating Live Loads	Limit States for Evaluation	Rating Methods	Page
	Span	Type	Rated Members				
A1	Simple Span 65 ft	Composite Steel Stringer Bridge (Interior and Exterior Stringers)	Interior and Exterior Stringer	Design	Strength I Service II Fatigue	LRFR	A-1
				Legal	Strength I Service II	ASR and LFR	A-37
				Permit	Strength II Service II		
A2	Simple Span 26 ft	Reinforced Concrete T-Beam Bridge	Interior Beam	Design	Strength I	LRFR	A-51
				Legal	Strength I	ASR and LFR	A-67
				Permit	Strength II Service I		
A3	Simple Span 80 ft	Prestressed Concrete I-Girder Bridge	Interior Girder	Design	Strength I Service III	LRFR	A-81
				Permit	Strength II Service I		
A4	Simple Span 17 ft 10 in.	Timber Stringer Bridge	Interior Stringer	Design	Strength I	LRFR	A-157
				Legal	Strength I	ASR and LFR	A-165
A5	Four-Span Continuous 112 ft 140 ft 140 ft 112 ft	Welded Steel Plate Girder Bridge	Interior Girder	Design	Strength I Service II	LRFR	A-173
				Legal			
				Permit	Strength II		
A6	Single Span 175 ft	Steel Through Pratt Truss Bridge	Top Chord, Bottom Chord, Diagonal, Vertical	Design	Strength I	LRFR	A-199
A7	Simple Span 21 ft 6 in.	Reinforced Concrete Slab Bridge	Interior and Exterior Strips	Design	Strength I	LRFR	A-215
				Legal	Strength I		
A8	Simple Span 94 ft $8^{1}/_{4}$ in.	Two-Girder Steel Bridge	Intermediate Floorbeam and Main Girder	Design	Strength I Service II	LRFR	A-225
A9	Simple Span 70 ft	Prestressed Concrete Adjacent Box-Beam Bridge	Interior Beam	Design	Strength I Service III	LRFR	A-245
				Permit	Strength II Service I		
A10	Rigid Frame 31.5 ft	Reinforced Concrete Box Culvert	Roof Slab, Walls, and Floor	Design	Strength I	LRFR	A-259
				Legal			
A11	Single span 420.0 ft	Through Truss	Gusset Plates	Legal	Strength I	LRFR	A-281
						ASR and LFR	A-299

continued on next page

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

Example	Bridge Summary			Rating Live Loads	Limit States for Evaluation	Rating Methods	Page
	Span	Type	Rated Members				
A12	Suspended Span 504 ft	Through Truss	Lower Gusset Plate	Design	Strength I	LRFR	A-307
A13	Simple Span 456 ft	Deck Truss	Upper Gusset Plate	Design	Strength I	LRFR	A-331
A14	Simple Span 240 ft	Deck Truss	Lower Gusset Plate	Design	Strength I	LRFR	A-365

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A1—SIMPLE SPAN COMPOSITE STEEL STRINGER BRIDGE A-1
PART A—LOAD AND RESISTANCE FACTOR RATING METHOD A-1
A1A.1—EVALUATION OF AN INTERIOR STRINGER A-1
A1A.1.1—Bridge Data A-1
A1A.1.2—Section Properties A-2
A1A.1.2.1—Noncomposite Section Properties A-2
A1A.1.2.2—Composite Section Properties A-2
A1A.1.2.3—Summary of Section Properties at Midspan A-4
A1A.1.2.3a—Steel Section Only A-4
A1A.1.2.3b—Composite Section—Short Term, $n = 9.2$ A-4
A1A.1.2.3c—Composite Section—Long Term, $3n = 27.6$ A-4
A1A.1.3—Dead-Load Analysis—Interior Stringer A-4
A1A.1.3.1—Components and Attachments, *DC* A-4
A1A.1.3.1a—Noncomposite Dead Loads, DC_1 . . . . . A-4
A1A.1.3.1b—Composite Dead Loads, DC_2 . . . . . A-5
A1A.1.3.2—Wearing Surface A-5
A1A.1.4—Live Load Analysis—Interior Stringer (LRFD Design Table 4.6.2.2.1-1) A-5
A1A.1.4.1—Compute Live Load Distribution Factors (Type (a) cross section) (LRFD Design Table 4.6.2.2.1-1) A-5
A1A.1.4.1a—Distribution Factor for Moment, g_m (LRFD Design Table 4.6.2.2.2b-1) A-6
A1A.1.4.1b—Distribution Factor for Shear, g_v (LRFD Design 4.6.2.2.3a) A-6
A1A.1.4.2—Compute Maximum Live Load Effects A-7
A1A.1.4.2a—Maximum Design Live Load (HL-93) Moment at Midspan A-7
A1A.1.4.2b—Maximum Design Live Load Shear at Beam Ends A-7
A1A.1.4.2c—Distributed Live Load Moments and Shears A-8
A1A.1.5—Compute Nominal Resistance of Section at Midspan (LRFD Design Appendix D6.1) A-8
A1A.1.5.1—Classify Section (LRFD Design 6.10.7 and Figure C6.4.5-1) A-9
A1A.1.5.1a—Check Web Slenderness (LRFD Design 6.10.6.2.2) A-9
A1A.1.5.1b—Check Ductility Requirement (LRFD Design 6.10.7.1.2) A-9
A1A.1.5.2—Plastic Moment, M_p A-10
A1A.1.5.3—Nominal Shear Resistance, V_n (LRFD Design 6.10.9.2) A-10
A1A.1.5.4—Demand Summary for Interior Stringer A-11
A1A.1.6—General Load-Rating Equation A-11
A1A.1.7—Evaluation Factors (for Strength Limit States) A-11
A1A.1.8—Design Load Rating (6A.4.3) A-11
A1A.1.8.1—Strength I Limit State (6A.6.4.1) A-11
A1A.1.8.1a—Inventory Level A-12
A1A.1.8.1b—Operating Level A-12
A1A.1.8.2—Service II Limit State (6A.6.4.1) A-12
A1A.1.8.2a—Inventory Level A-13
A1A.1.8.2b—Operating Level A-13
A1A.1.8.3—Fatigue Limit State (6A.6.4.1) A-14
A1A.1.8.3a—Load Distribution for Fatigue A-14

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A1A.1.8.3b—Calculation of Finite Fatigue Life A-15
A1A.1.8.3c—Calculation of Fatigue Serviceability Index A-16
A1A.1.9—Legal Load Rating A-17
A1A.1.9.1—Live Load: AASHTO Legal Loads—"Routine Commercial Traffic"—Type 3, 3S2, 3-3 (rate for all three) A-18
A1A.1.9.2—Live Load: AASHTO Legal Loads—Specialized Hauling Vehicles and Notional Rating Load—SU4, SU5, SU6, SU7, and NRL A-18
A1A.1.9.3—Strength I Limit State A-18
A1A.1.9.4—Service II Limit State A-19
A1A.1.9.5—Summary A-19
A1A.1.10—Permit Load Rating A-20
A1A.1.10.1—Strength II Limit State A-20
A1A.1.10.2—Service II Limit State (Optional) A-21
A1A.2—EVALUATION OF AN EXTERIOR STRINGER A-21
A1A.2.1—Section Properties A-21
A1A.2.1.1—Noncomposite Section Properties A-21
A1A.2.1.2—Composite Section Properties A-22
A1A.2.1.3—Summary of Section Properties at Midspan A-23
A1A.2.1.3a—Steel Section Only A-23
A1A.2.1.3b—Composite Section—Short Term, $n = 9.2$ A-23
A1A.2.1.3c— Composite Section—Long Term, $3n = 27.6$ A-23
A1A.2.2—Dead Load Analysis—Exterior Stringer A-23
A1A.2.2.1—Components and Attachments, *DC* A-23
A1A.2.2.1a—Noncomposite Dead Loads, DC_1 . . . . . A-23
A1A.2.2.1b—Composite Dead Loads, DC_2 . . . . . A-24
A1A.2.2.2—Wearing Surface A-24
A1A.2.3—Live Load Analysis—Exterior Stringer A-24
A1A.2.3.1—Compute Live Load Distribution Factors (Type (a) cross section) A-24
A1A.2.3.1a—Distribution Factor for Moment, g_m (LRFD Design Table 4.6.2.2.2d-1) A-24
A1A.2.3.1b—Distribution Factor for Shear, *gv* (LRFD Design Table 4.6.2.2.3b-1) A-25
A1A.2.3.1c—Special Analysis for Exterior Girders with Diaphragms or Cross Frames (LRFD Design 4.6.2.2.2d) A-25
A1A.2.3.1d—Summary of Distribution Factors for the Exterior Girders A-26
A1A.2.3.2—Compute Maximum Live Load Effects for HL-93 . . . . . A-26
A1A.2.3.2a—Distributed Live Load Moments and Shears A-26
A1A.2.4—Compute Nominal Resistance of Section at Midspan A-26
A1A.2.4.1—Classify Section (LRFD Design 6.10.7 and Appendix C6 Figure C6.4.5-1) A-27
A1A.2.4.1a—Check Web Slenderness A-27
A1A.2.4.1b—Check Ductility Requirement (LRFD Design 6.10.7.1.2) A-27
A1A.2.4.2—Plastic Moment, M_p A-28
A1A.2.4.3—Nominal Shear Resistance, V_n (LRFD Design 6.10.9.2) A-28
A1A.2.4.4—Demand Summary for Exterior Stringer A-28
A1A.2.5—General Load-Rating Equation A-28
A1A.2.6—Evaluation Factors (for Strength Limit States) A-29

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A1A.2.7—Design Load Rating (6A.4.3) . . . A-29
A1A.2.7.1—Strength I Limit State (6A.6.4.1) . . . A-29
A1A.2.7.1a—Inventory Level . . . A-29
A1A.2.7.1b—Operating Level . . . A-29
A1A.2.7.2—Service II Limit State (6A.6.4.1) . . . A-30
A1A.2.7.2a—Inventory Level . . . A-30
A1A.2.7.2b—Operating Level . . . A-30
A1A.2.7.3—Fatigue Limit State . . . A-31
A1A.2.8—Legal Load Rating (6A.6.4.2) . . . A-31
A1A.2.8.1—Live Load Demand . . . A-31
A1A.2.8.1a—Live Load: AASHTO Legal Loads—Routine Commercial Traffic—Types 3, 3S2, and 3-3 . . . A-31
A1A.2.8.1b—Live Load: AASHTO Legal Loads—Specialized Hauling Vehicles (SHVs) and Notional Rating Load—SU4, SU5, SU6, SU7, and NRL . . . A-31
A1A.2.8.2—Strength I Limit State . . . A-32
A1A.2.8.3—Service II Limit State . . . A-32
A1A.2.8.4—Summary (6A.4.4.4) . . . A-32
A1A.2.9—Permit Load Rating (6A.6.4.2) . . . A-33
A1A.2.9.1—Strength II Limit State . . . A-33
A1A.2.9.2—Service II Limit State (Optional) . . . A-34
A1A.3—SUMMARY OF RATING FACTORS FOR LOAD AND RESISTANCE FACTOR RATING METHOD . . . A-35
PART B—ALLOWABLE STRESS AND LOAD FACTOR RATING METHODS . . . A-37
A1B.1—EVALUATION OF AN INTERIOR STRINGER . . . A-37
A1B.1.1—Bridge Data . . . A-37
A1B.1.2—Section Properties . . . A-37
A1B.1.2.1—Noncomposite Section Properties . . . A-37
A1B.1.2.2—Composite Section Properties . . . A-38
A1B.1.3—Dead Load Analysis—Interior Stringer . . . A-40
A1B.1.3.1—Dead Loads (Includes an Allowance of Six Percent of Steel Weight for Connections) . . . A-40
A1B.1.3.2—Superimposed Dead Loads (AASHTO 3.23.2.3.1.1) . . . A-40
A1B.1.4—Live Load Analysis—Interior Stringer . . . A-40
A1B.1.5—Allowable Stress Rating (6B.3.1, 6B.4.2, and 6B.5.2) . . . A-41
A1B.1.5.1—Impact (Use Standard AASHTO) (6B.6.4, AASHTO 3.8.2.1) . . . A-41
A1B.1.5.2—Distribution (Use Standard AASHTO) (6B.6.3, AASHTO 3.23.2.2, and Table 3.23.1) . . . A-41
A1B.1.5.3—Inventory Level (Bottom Tension Controls) (6B.5.2.1, Table 6B.5.2.1-1) . . . A-41
A1B.1.5.4—Operating Level (6B.5.2.1, Table 6B.5.2.1-2) . . . A-42
A1B.1.5.5—Summary of Ratings for Allowable Stress Rating Method . . . A-43
A1B.1.6—Load Factor Rating (6B.3.2, 6B.4.3, and 6B.5.3) . . . A-43
A1B.1.6.1—Impact (Use Standard AASHTO) (6B.6.4) . . . A-43
A1B.1.6.2—Distribution (Use Standard AASHTO) (6B.6.3) . . . A-43
A1B.1.6.3—Capacity of Section, MR (6B.5.3.1) . . . A-43
A1B.1.6.4—Inventory Level (6B.4.1 and 6B.5.3) . . . A-45
A1B.1.6.5—Operating Level (6B.4.3) . . . A-45

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A1B.1.6.6—Check Serviceability Criteria A-46
A1B.1.6.6a—At Inventory Level (Bottom Steel in Tension Controls) A-46
A1B.1.6.6b—At Operating Level A-46
A1B.1.6.7—Summary of Ratings for Load Factor Rating Method A-46
A1B.1.7—Load Factor Rating—Rate for Single-Unit Formula B Loads A-46
PART C—SUMMARY A-49
A1C.1—SUMMARY OF ALL RATINGS FOR EXAMPLE A1 . . . . A-49
A1C.2—REFERENCES A-50
A2—REINFORCED CONCRETE T-BEAM BRIDGE: EVALUATION OF AN INTERIOR BEAM . A-51
PART A—LOAD AND RESISTANCE FACTOR RATING METHOD A-51
A2A.1—BRIDGE DATA A-51
A2A.2—DEAD-LOAD ANALYSIS—INTERIOR BEAM A-51
A2A.2.1—Components and Attachments, *DC* A-51
A2A.2.2—Wearing Surface, *DW* A-51
A2A.3—LIVE-LOAD ANALYSIS—INTERIOR BEAM A-52
A2A.3.1—Compute Live-Load Distribution Factor A-52
A2A.3.1.1—Distribution Factor for Moment, g_m (LRFD Design Table 4.6.2.2.2b-1) A-53
A2A.3.1.2—Distribution Factor for Shear, g_v (LRFD Design Table 4.6.2.2.3a-1) A-53
A2A.3.2—Compute Maximum Live Load Effects A-53
A2A.3.2.1—Maximum Design Live Load (HL-93) Moment at Midspan A-53
A2A.3.2.2—Maximum Design Live Load Shear (HL-93) at Critical Section A-54
A2A.3.2.3—Distributed Live Load Moments A-54
A2A.4—COMPUTE NOMINAL FLEXURAL RESISTANCE A-54
A2A.4.1—Compute Effective Flange Width, b_e (LRFD Design 4.6.2.6.1) A-54
A2A.4.2—Compute Distance to Neutral Axis, *c* A-54
A2A.5—MAXIMUM REINFORCEMENT (6A.5.5) A-55
A2A.6—MINIMUM REINFORCEMENT (6A.5.6) A-55
A2A.7—COMPUTE NOMINAL SHEAR RESISTANCE A-56
A2A.8—SUMMARY FOR INTERIOR CONCRETE T-BEAM A-58
A2A.9—GENERAL LOAD RATING EQUATION A-58
A2A.10—EVALUATION FACTORS (FOR STRENGTH LIMIT STATES) A-58
A2A.11—DESIGN LOAD RATING (6A.4.3) A-58
A2A.11.1—Strength I Limit State A-58
A2A.11.2—Inventory Level (6A.5.4.1) A-59
A2A.11.3—Operating Level A-59
A2A.12—LEGAL LOAD RATING (6A.5.4.2) A-59
A2A.12.1—Strength I Limit State (6A.5.4.2.1) A-60
A2A.12.2—Summary A-61
A2A.13—PERMIT LOAD RATING (6A.4.5) A-61
A2A.13.1—Strength II Limit State (6A.5.4.2.1) A-62
A2A.13.2—Service I Limit State (Optional) (6A.5.4.2.2b) A-62
A2A.13.2.1—Simplified Check Using $0.75M_n$ (C6A.5.4.2.2b) A-63
A2A.13.2.2—Refined Check Using $0.9f_y$ A-63

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A2A.14—SUMMARY OF RATING FACTORS FOR LOAD AND RESISTANCE FACTOR RATING METHOD A-65
PART B—ALLOWABLE STRESS AND LOAD FACTOR RATING METHODS A-67
A2B.1—BRIDGE DATA A-67
A2B.2—SECTION PROPERTIES A-67
A2B.3—DEAD-LOAD ANALYSIS—INTERIOR BEAM A-67
A2B.4—LIVE-LOAD ANALYSIS—INTERIOR BEAM A-68
A2B.5—ALLOWABLE STRESS RATING (6B.3.1, 6B.4.2, AND 6B.5.2) A-68
A2B.5.1—Impact (Use standard AASHTO) (6B.6.4, AASHTO 3.8.2.1) A-68
A2B.5.2—Distribution (Use standard AASHTO) (6B.6.3, AASHTO 3.23.2.2 and Table 3.23.1) A-68
A2B.5.3—Inventory Level (6B.4.2, 6B.5.2.4) A-68
A2B.5.4—Operating Level (6B.5.2) A-71
A2B.6—LOAD CAPACITY BASED ON ALLOWABLE STRESS A-71
A2B.7—CAPACITY (ALTERNATE APPROACH) A-72
A2B.8—ALLOWABLE STRESS RATING—RATE FOR AASHTO LEGAL LOADS A-73
A2B.9—SUMMARY OF RATINGS FOR ALLOWABLE STRESS RATING METHOD A-75
A2B.10—LOAD FACTOR RATING (6B.3.2, 6B.4.3, 6B.5.3) A-75
A2B.10.1—Impact (Use standard AASHTO) (6B.6.4, AASHTO 3.8.2.1) A-75
A2B.10.2—Distribution (Use standard AASHTO) (6B.6.3, AASHTO 3.23.2.2 and Table 3.23.1) A-75
A2B.10.3—Capacity of Section (6B.5.3.2) A-75
A2B.10.4—Inventory Level (6B.4.1, 6B.5.3) A-76
A2B.10.5—Operating Level (6B.4.1, 6B.5.3) A-76
A2B.10.6—Summary of Ratings for Load Factor Rating Method A-77
A2B.10.7—Load Factor Rating—Rate for AASHTO Legal Loads A-77
A2B.10.8—Load Factor Rating—Rate for Single-Unit Formula B Loads A-78
PART C—SUMMARY A-79
A2C.1—SUMMARY OF ALL RATINGS FOR EXAMPLE A2 . . . . . A-79
A2C.2—REFERENCES A-80
A3—SIMPLE SPAN PRESTRESSED CONCRETE: I-GIRDER BRIDGE EVALUATION OF AN INTERIOR A-GIRDER (LRFR ONLY) A-81
A3.1—BRIDGE DATA A-81
A3.2—SECTION PROPERTIES INTERIOR GIRDER A-83
A3.2.1—Non-Composite Section Properties A-83
A3.2.2—Composite Section Properties A-84
A3.3—DEAD LOAD—INTERIOR GIRDER A-85
A3.3.1—Components and Attachments, *DC* A-85
A3.3.1.1—Non-Composite Dead Loads, DC_1 . . . . . A-85
A3.3.1.2—Composite Dead Loads, DC_2 . . . . . A-86
A3.3.2—Wearing Surface, *DW* A-86
A3.4—LIVE LOAD DISTRIBUTION—INTERIOR STRINGER A-86
A3.4.1—Compute Live Load Distribution Factors [Type (k) Cross Section] A-86
A3.4.1.1—Longitudinal Stiffness Parameter, K_g A-86
A3.4.1.2—Distribution Factor for Moment, g_m (LRFD-8 Design Table 4.6.2.2.2b-1) A-87
A3.4.1.3—Distribution Factor for Shear, g_v (LRFD-8 Design 4.6.2.2.3a) A-87

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A3.5—COMPUTE DEMANDS A-88
A3.5.1—Dead Load Demands A-88
A3.5.1.1—Non-Composite Dead Loads, DC_1 . . . . . A-88
A3.5.1.1.1—Midspan Location A-88
A3.5.1.1.2—20 ft from Support Location A-88
A3.5.1.1.3—Critical Shear Distance (5.391 ft) from Support Location A-89
A3.5.1.2—Composite Dead Load Demands (DC_2) A-89
A3.5.1.2.1—Midspan Location A-89
A3.5.1.2.2—20 ft from Support Location A-89
A3.5.1.2.3—Critical Shear Distance (5.391 ft) from Support Location A-89
A3.5.1.3—Wearing Surface Load Demands (DW) A-89
A3.5.1.3.1—Midspan Location A-89
A3.5.1.3.2—20 ft from Support Location A-89
A3.5.1.3.3—Critical Shear Distance (5.391 ft) from Support Location A-90
A3.5.1.4—Dead Load Demand Summary A-90
A3.5.2—Live Load Demands A-90
A3.5.2.1—Dynamic Load Allowances A-90
A3.5.2.2—Maximum Demands at Midspan Location A-90
A3.5.2.2.1—Maximum Moment and Concurrent Shear Demand for HL-93 Loading A-90
A3.5.2.2.2—Maximum Shear and Concurrent Moment Demand for HL-93 Loading A-92
A3.5.2.2.3—Summary of Maximum Live Load Demands from Live Loads A-93
A3.5.2.3—Maximum Demands at 5.391 ft Distance from the Support A-94
A3.5.2.3.1—Maximum Moment and Concurrent Shear Demand for HL-93 Loading A-94
A3.5.2.3.2—Maximum Shear and Concurrent Moment Demand for HL-93 Loading A-95
A3.5.2.3.3—Summary of Maximum Live Load Demands from Live Loads at 5.391 ft from Support A-97
A3.5.2.4—Summary of Maximum Live Load Demands from Live Loads at 20 ft from Support . . . A-97
A3.6—DETERMINE THE AREA AND CENTROID OF PRESTRESSING STRANDS A-98
A3.6.1—At Midspan Location A-98
A3.6.2—At 20 ft from Support Location A-98
A3.6.3—At 5.391 ft from Support Location A-99
A3.7—DETERMINE EFFECTIVE PRESTRESS, f_{pe} A-99
A3.7.1—Loss Due to Elastic Shortening and/or External Loads, Δf_{pES} A-99
A3.7.2—Approximate Lump Sum Estimate of Time-Dependent Losses, Δf_{pLT} A-100
A3.7.3—Total Prestress Losses, Δf_{pT} A-101
A3.8—COMPUTE NOMINAL FLEXURAL RESISTANCE OF SECTIONS A-101
A3.8.1—Compute the Nominal Flexural Resistance of the Section at Midspan A-101
A3.8.1.1—Maximum Reinforcement A-102
A3.8.1.2—Minumum Reinforcement A-102
A3.8.2—Compute the Nominal Flexural Resistance of the Section 20 ft from the Support A-104
A3.8.2.1—Maximum Reinforcement A-106
A3.8.2.2—Minumum Reinforcement A-107
A3.8.3—Compute the Nominal Flexural Resistance of the Section at 5.391 ft from the Support A-107
A3.8.3.1—Maximum Reinforcement A-109

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A3.8.3.2—Minumum Reinforcement A-109
A3.8.4—Summary of Moment Resistance A-109
A3.9—COMPUTE NOMINAL SHEAR RESISTANCE A-109
A3.9.1—Nominal Shear Resistance at the Critical Section near the Support A-112
A3.9.1.1—Establish the Location of the Critical Section near the Support A-112
A3.9.1.1.1—Establish d_v at the Critical Section near the Support A-112
A3.9.1.1.2—Critical Shear Location near the Support A-112
A3.9.1.2—Maximum Shear Demand at the Critical Section near the Support A-112
A3.9.1.3—Compute Nominal Shear Resistance A-113
A3.9.1.3.1—Simplified Approach A-114
A3.9.1.3.2—MCFT General Procedure (GP-Eqn) with ADBC Approach A-115
A3.9.1.3.3—MCFT Appendix B5 (GP-B5) with ADBC Approach A-118
A3.9.1.3.4—MCFT General Procedure (GP-Eqn) with UDBC Approach A-122
A3.9.1.3.5—MCFT Appendix B5 (GP-B5) with UDBC Approach A-123
A3.9.1.4—Shear Capacity Summary Based on HL-93 Demand A-123
A3.9.1.5—Check Longitudinal Reinforcement (LRFD-8 Design 5.7.3.5) for HL-93 Demand A-124
A3.9.1.6—Shear Capacity Summary Based on all Other Trucks A-124
A3.9.2—Compute Nominal Shear Resistance at the Stirrup Change/Quarter Point (20 ft from Support) A-125
A3.9.2.1—Establish d_v A-125
A3.9.2.2—Maximum Shear at the Stirrup Change Location A-126
A3.9.2.3—Compute Nominal Shear Resistance A-126
A3.9.2.3.1—Simplified Approach A-128
A3.9.2.3.2—MCFT General Procedure (GP-Eqn) with ADBC Approach A-128
A3.9.2.3.3—MCFT Appendix B5 with ADBC Approach (Using Interpolated Values from LRFD Design Table B5.2-1) A-129
A3.9.2.4—Shear Capacity Summary Based on HL-93 Demand at Inventory Level A-131
A3.9.2.5—Shear Capacity Summary Based on all Other Trucks A-132
A3.9.3—Compute Nominal Shear Resistance at Midspan A-132
A3.9.3.1—Shear Capacity Summary Based on All Trucks A-133
A3.10—SUMMARY OF DEMANDS AND CAPACITIES A-134
A3.11—LOAD RATING A-135
A3.11.1—Evaluation Factors (for Strength Limit States) A-135
A3.11.2—Design Load Rating (6A.4.3) A-135
A3.11.2.1—Strength I Limit State (6A.6.4.1) A-135
A3.11.2.1.1—Inventory Level A-136
A3.11.2.1.2—Operating Level A-143
A3.11.2.2—Service III Limit State (6A.5.4.1) A-143
A3.11.2.2.1—Inventory Level A-143
A3.11.2.3—Summary of Rating Factors Established for Design Loading A-146
A3.11.3—Legal Load Rating (6A.4.3) A-146
A3.11.3.1—Rating for NRL Loading A-146
A3.11.3.2—Rating Summary for All Legal Loading A-147
A3.11.4—Permit Load Rating (6A.4.3) A-148

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A3.11.4.1—Strength II Level A-148
A3.11.4.2—Service I Limit State (Optional) (6A.5.4.2.2b) A-148
A3.11.4.2.1—Simplified Method Using $0.75M_n$ (C6A.5.4.2.2b) at the Midspan A-148
A3.11.4.2.2—Refined Method Using $0.9f_y$ at the Midspan A-149
A3.11.4.2.3—Simplified Method Using $0.75M_n$ (C6A.5.4.2.2b) at the Stirrup Change Pt A-150
A3.11.4.2.4—Refined Method Using $0.9f_y$ at the Stirrup Change Pt A-150
A3.11.4.2.5—Simplified Method Using $0.75\ M_n$ (C6A.5.4.2.2b) at the Critical Shear Pt A-151
A3.11.4.2.6—Refined Method Using $0.9f_y$ at the Critical Shear Pt A-151
A3.11.5—Rating Summary for Permit Loading A-152
A3.12—CONCLUSION A-152
A3.13—SHEAR RATING CALCULATIONS BASED ON UDBC APPROACH A-152
A4—TIMBER STRINGER BRIDGE: EVALUATION OF AN INTERIOR STRINGER A-157
PART A—LOAD AND RESISTANCE FACTOR RATING METHOD A-157
A4A.1—BRIDGE DATA A-157
A4A.2—DEAD LOAD ANALYSIS—INTERIOR STRINGER IN FLEXURE A-157
A4A.2.1—Components and Attachments, *DC* A-157
A4A.2.2—Wearing Surface A-157
A4A.3—LIVE LOAD ANALYSIS—INTERIOR STRINGER IN FLEXURE A-158
A4A.3.1—Distribution Factor for Moment and Shear A-158
A4A.3.2—Compute Maximum Live Load Effects A-158
A4A.3.2.1—Maximum Design Live Load (HL-93) Moment at Midspan A-158
A4A.3.2.2—Distributed Live-Load Moments A-158
A4A.4—COMPUTE NOMINAL FLEXURAL RESISTANCE A-158
A4A.4.1—LRFD Design A-159
A4A.5—GENERAL LOAD-RATING EQUATION (6A.4.2) A-159
A4A.6—EVALUATION FACTORS (FOR STRENGTH LIMIT STATE) A-159
A4A.7—DESIGN LOAD RATING (6A.4.3) A-159
A4A.7.1—Strength I Limit State (6A.7.4.1) A-159
A4A.7.1.1—Inventory Level A-159
A4A.7.1.2—Operating Level A-160
A4A.7.1.3—Shear (Horizontal Shear) (LRFD Design 8.7) A-160
A4A.7.1.4—Compute Maximum Shear at Critical Section (14 in. = 1.17 ft) A-160
A4A.7.1.4.1—Dead Load Shear A-160
A4A.7.1.4.2—Live Load Shear (HL-93) A-160
A4A.7.1.5—Compute Nominal Shear Resistance A-161
A4A.7.1.5.1—LRFD Design A-161
A4A.7.1.5.2—Inventory Level A-161
A4A.7.1.5.3—Operating Level A-161
A4A.8—LEGAL LOAD RATING (6A.4.4) A-162
A4A.8.1—Strength I Limit State (6A.7.4.2) A-162
A4A.8.1.1—Shear Capacity A-162
A4A.8.2—Summary A-163
A4A.9—SUMMARY OF RATING FACTORS FOR LOAD AND RESISTANCE FACTOR RATING METHOD A-163

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

PART B—ALLOWABLE STRESS RATING METHOD A-165
A4B.1—BRIDGE DATA A-165
A4B.2—SECTION PROPERTIES A-165
A4B.3—DEAD LOAD ANALYSIS—INTERIOR STRINGER A-165
A4B.4—LIVE LOAD ANALYSIS—INTERIOR STRINGER A-165
A4B.5—ALLOWABLE STRESS RATING (6B.3.1, 6B.4.2, 6B.5.2) A-166
A4B.5.1—Impact (Use standard AASHTO) (6B.6.4) A-166
A4B.5.2—Distribution (Use standard AASHTO) (6B.6.3 . . . . . A-166
A4B.5.3—Stresses to be Used (Use NDS, *National Design Specification for Wood Construction*, 2024 Edition) A-166
A4B.5.3.1—Inventory Level Stresses (6B.5.2.7) A-167
A4B.5.3.2—Operating Level Stresses (Use standard AASHTO) (6B.5.2.7) A-167
A4B.5.4—Inventory Level Rating for Flexure A-167
A4B.5.5—Operating Level Rating for Flexure A-167
A4B.5.6—Check Horizontal Shear A-167
A4B.5.7—Inventory Level Rating for Shear A-169
A4B.5.8—Operating Level Rating for Shear A-169
A4B.5.9—Summary of Ratings for Allowable Stress Rating Method A-169
A4B.6—LOAD FACTOR RATING A-170
PART C—SUMMARY A-171
A4C.1—SUMMARY OF ALL RATINGS FOR EXAMPLE A4 . . . . . A-171
A4C.2—REFERENCES A-171
A5—FOUR-SPAN CONTINUOUS STRAIGHT WELDED PLATE GIRDER BRIDGE: EVALUATION OF AN INTERIOR GIRDER A-173
A5.1—BRIDGE DATA A-173
A5.1.1—Girder Bracing A-173
A5.1.2—Girder Section Properties A-173
A5.1.3—Girder Sections A-174
A5.2—DEAD LOAD ANALYSIS—INTERIOR GIRDER A-174
A5.2.1—Components and Attachments, *DC* A-174
A5.2.2—Wearing Surface, *DW* A-174
A5.3—DEAD LOAD EFFECTS A-175
A5.3.1—Maximum Positive Moment at Span 1 (at 0.4*L* = 44.8 ft) A-175
A5.3.2—Maximum Positive Moment at Span 2 (at 0.5*L* = 182 ft) A-176
A5.3.3—Maximum Negative Moment at Pier 2 (252 ft) A-176
A5.3.4—Maximum Shear left of Pier 1 (112 ft) A-176
A5.3.5—Negative Moments at Pier 1 . . . . . A-176
A5.4—LIVE LOAD DISTRIBUTION FACTORS A-176
A5.4.1—Positive Flexure and Shear to the Left of Pier 1 . . . . . A-176
A5.4.1.1—Interior Girder (LRFD Design Table 4.6.2.2.2b-1) A-176
A5.4.2—Negative Flexure A-177
A5.4.2.1—Interior Girder A-178
A5.5—LIVE LOAD EFFECTS A-178

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A5.5.1—Maximum Positive Moment at Span 1 (at 0.4*L*) A-178
A5.5.1.1—Design Live Load (HL-93) A-178
A5.5.1.2—Legal Loads A-178
A5.5.2—Maximum Positive Moment at Span 2 (at 0.5*L*) A-179
A5.5.2.1—Design Live Load (HL-93) A-179
A5.5.2.2—Legal Loads (Use Only Truck Loads) A-179
A5.5.3—Maximum Negative Moment at Pier 2 . . . . A-179
A5.5.3.1—Calculate Maximum Negative Moment at Pier 2 . . . . A-180
A5.5.3.1.1—Design Live Load (HL-93) A-180
A5.5.3.1.2—Legal Loads (Truck Loads and Lane-Type Load) A-181
A5.5.4—Maximum Shear at Pier 1 (Left of Support) A-182
A5.5.4.1—Design Live Load (HL-93) A-182
A5.5.4.2—Legal Loads A-182
A5.6—COMPUTE NOMINAL FLEXURAL RESISTANCE OF SECTION (POSITIVE AND NEGATIVE MOMENT) A-182
A5.6.1—Noncomposite Symmetric Section A-182
A5.6.1.1—Check Web for Noncompact Slenderness Limit A-182
A5.6.2—Regions B and H—Positive Moment Sections with Continuously Braced Compression Flanges A-183
A5.6.2.1—Calculate Plastic Moment, M_p (LRFD Design D6.1) A-183
A5.6.3—Region E—Negative Moment Sections with Discretely Braced Compression Flange (LRFD Design A6.1.1) A-185
A5.6.3.1—Calculate Local Buckling Resistance (LRFD Design A6.3.2) A-185
A5.6.3.2—Calculate Lateral–Torsional Buckling Resistance (LRFD Design A6.3.3) A-186
A5.7—GENERAL LOAD RATING EQUATION (6A.4.2) A-189
A5.8—DESIGN LOAD RATING A-189
A5.8.1—Strength I Limit State A-189
A5.8.1.1—Flexure at Span 1, 0.4*L* A-190
A5.8.1.2—Flexure at Span 2, 0.5*L* A-190
A5.8.1.3—Flexure at Pier 2 . . . . A-190
A5.8.2—Service II Limit State (6A.6.4.1) A-190
A5.8.2.1—At Span 1, 0.4*L* A-191
A5.8.2.2—At Span 2, 0.5*L* A-191
A5.8.2.3—At Pier 2 . . . . A-191
A5.8.3—Legal Load Rating (6A.4.4) A-191
A5.8.3.1—Strength I Limit State (6A.6.4.2.1) A-191
A5.8.3.1.1—Flexure at Span 1, 0.4*L* A-191
A5.8.3.1.2—Flexure at Span 2, 0.5*L* A-192
A5.8.3.1.3—Flexure at Pier 2 . . . . A-192
A5.8.3.2—Service II Limit State (6A.6.4.2.2) A-192
A5.8.3.2.1—At Span 1, 0.4*L* (Type 3-3 Truck Governs) A-192
A5.8.3.2.2—At Span 2, 0.5*L* (Type 3-3 Truck Governs) A-192
A5.8.3.2.3—At Pier 2 (Lane-Type Load Governs) A-192

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A5.9—SHEAR EVALUATION A-193
A5.9.1—Shear Resistance at Pier 1 . . . . . A-193
A5.9.2—Shear Resistance for Interior Panel A-193
A5.10—SHEAR RATING AT PIER 1 . . . . . A-195
A5.10.1—Design Load Rating A-195
A5.10.2—Legal Load Rating (Type 3-3 Governs) A-195
A5.10.3—Permit Load Rating (6A.4.5) A-195
A5.10.3.1—Flexure at Span 1, 0.4*L* A-196
A5.10.3.2—Flexure at Span 2, 0.5*L* A-197
A5.10.3.3—Flexure at Pier 2 . . . . . A-197
A5.11—SUMMARY OF RATING FACTORS A-197
A5.12—REFERENCE A-197
A6—THROUGH PRATT TRUSS BRIDGE: DESIGN LOAD CHECK OF SELECTED TRUSS MEMBERS A-199
A6.1—BRIDGE DATA A-199
A6.2—MEMBER PROPERTIES A-199
A6.3—DEAD LOAD ANALYSIS A-199
A6.4—LIVE LOAD ANALYSIS (DESIGN LOAD CHECK) A-200
A6.4.1—Live Load Distribution Factors A-201
A6.4.1.1—One Lane Loaded (See Figure A6.4.1-1) A-201
A6.4.1.2—Two Lanes Loaded (See Figure A6.4.1-1) A-201
A6.4.1.3—Three Lanes Loaded (See Figure A6.4.1-1) A-201
A6.4.2—Live Load Force Effects (Due to HL-93) A-201
A6.4.2.1—Member TC4 (See Figure A6.3-1) A-201
A6.4.2.2—Member BC4 . . . . . A-203
A6.4.2.3—Member D1 . . . . . A-203
A6.4.2.4—Member V1 . . . . . A-203
A6.5—COMPUTE NOMINAL RESISTANCE OF MEMBERS A-203
A6.5.1—Top Chord TC4 (Compression Member) A-203
A6.5.2—Bottom Chord Member BC4 (Tension Member A-206
A6.5.2.1—Limit State: Yielding over Gross Area (in the Shank of the Eyebar) A-206
A6.5.2.2—Limit State: Fracture at the Eyebar Head A-206
A6.5.3—Diagonal Member D1 . . . . . A-206
A6.5.3.1—Limit State: Yielding over Gross Area (in the Shank of the Eyebar) A-206
A6.5.3.2—Limit State: Fracture at the Eyebar Head A-207
A6.5.4—Vertical Member V1 . . . . . A-207
A6.5.4.1—Limit State: Yielding over Gross Area A-207
A6.5.4.2—Limit State: Fracture at Net Area (at Rivet Holes) A-208
A6.6—GENERAL LOAD RATING EQUATION A-209
A6.7—EVALUATION FACTORS (FOR STRENGTH LIMIT STATES) A-209
A6.7.1—Resistance Factor, φ A-209
A6.7.2—Condition Factor, φ_c A-209
A6.7.3—System Factor, φ_s A-209

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A6.8—DESIGN LOAD RATING (6A.4.3) A-209
A6.8.1—Top Chord TC4 . . . . . A-210
A6.8.2—Bottom Chord BC4 . . . . . A-210
A6.8.3—Diagonal D1 . . . . . A-210
A6.8.4—Vertical V1 . . . . . A-210
A6.9—SUMMARY OF RATING FACTORS A-211
A6.10—RATING OF STEEL COMPRESSION MEMBER (TC4) WITH ECCENTRIC CONNECTIONS A-211
A6.10.1—Cross Section of Top Chord A-212
A6.11—REFERENCES A-214
A7—REINFORCED CONCRETE SLAB BRIDGE DESIGN AND LEGAL LOAD CHECK A-215
A7.1—BRIDGE DATA A-215
A7.2—DEAD LOAD ANALYSIS A-215
A7.2.1—Interior Strip—Unit (One Foot) Width A-215
A7.2.1.1—Components, *DC* A-215
A7.2.1.2—Wearing Surface, *DW* A-215
A7.3—LIVE LOAD ANALYSIS (DESIGN LOAD CHECK) A-215
A7.3.1—One Lane Loaded A-215
A7.3.2—More than One Lane Loaded A-216
A7.3.2.1—Midspan Live Load Force Effects (HL-93) A-218
A7.4—COMPUTE NOMINAL RESISTANCE A-218
A7.5—MAXIMUM REINFORCEMENT (6A.5.5, LRFD DESIGN 5.6.2.1) A-219
A7.6—MINIMUM REINFORCEMENT (6A.5.6, LRFD DESIGN 5.6.3.3) A-219
A7.7—SHEAR A-220
A7.8—GENERAL LOAD-RATING EQUATION (6A.4.2) A-221
A7.9—EVALUATION FACTORS (FOR STRENGTH LIMIT STATES) A-221
A7.9.1—Resistance Factor, φ (LRFD Design 5.5.4.2) A-221
A7.9.2—Condition Factor, φ_c (6A.4.2.3) A-221
A7.9.3—System Factor, φ_s (6A.4.2.4) A-221
A7.10—DESIGN LOAD RATING (6A.4.3) A-221
A7.10.1—Strength I Limit State (6A.5.4.1) A-221
A7.10.1.1—Inventory Level A-221
A7.10.1.2—Operating Level A-221
A7.10.2—Service Limit State A-222
A7.11—LEGAL LOAD RATING (6A.4.4) A-222
A7.11.1—Live Load Demand A-222
A7.11.1.1—AASHTO Legal Loads—Routine Commercial Traffic—Type 3, 3S2, 3-3 (Rate for all 3) A-222
A7.11.1.2— Live Load: AASHTO Legal Loads—Specialized Hauling Vehicles (SHVs) and Notional Rating Load—SU4, SU5, SU6, SU7, and NRL A-222
A7.11.2—Strength I Limit State A-222
A7.11.2.1—For Types 3, 3S2, and 3-3 . . . . . A-222
A7.11.2.2—For Specialized Hauling Vehicles (SHVs) and NRL A-223
A7.11.3—Service Limit State A-223

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A7.11.4—Shear . . . A-223
A7.11.5—Summary . . . A-223
A7.12—SUMMARY OF RATING FACTORS . . . A-224
A7.13—REFERENCE . . . A-224
A8—TWO-GIRDER STEEL BRIDGE: DESIGN LOAD RATING OF GIRDER AND FLOORBEAM . . . A-225
A8.1—BRIDGE DATA . . . A-225
A8.2—RATING OF INTERMEDIATE FLOORBEAM . . . A-225
A8.3—DEAD LOAD FORCE EFFECTS . . . A-225
A8.4—LIVE LOAD (HL-93) FORCE EFFECTS . . . A-227
A8.4.1—Live Load (HL-93) Reactions on Intermediate Floorbeam . . . A-227
A8.4.2—Live Load (HL-93) Maximum Positive Moment . . . A-227
A8.4.3—Live Load (HL-93) Maximum Shear . . . A-228
A8.4.4—Live Load (HL-93) Maximum Negative Moment . . . A-229
A8.5—SUMMARY OF LIVE LOAD (HL-93) FORCE EFFECTS IN FLOORBEAM . . . A-230
A8.6—COMPUTE NOMINAL RESISTANCE OF FLOORBEAM . . . A-231
A8.6.1—Positive Moment Section—Noncomposite Construction . . . A-231
A8.6.2—Negative Moment Section . . . A-233
A8.6.3—Nominal Shear Resistance (unstiffened web) . . . A-235
A8.7—GENERAL LOAD-RATING EQUATION (6A.4.2) . . . A-235
A8.7.1—Evaluation Factors (for Strength Limit States) . . . A-235
A8.7.1.1—Resistance Factor, φ (LRFD Design 6.5.4.2) . . . A-235
A8.7.1.2—Condition Factor, φ_c (6A.4.2.3) . . . A-236
A8.7.1.3—System Factor, φ_s (6A.4.2.4) . . . A-236
A8.7.2—Design Load Rating (6A.4.3) . . . A-236
A8.7.2.1—Strength I Limit State (6A.6.4.1) . . . A-236
A8.7.2.1.1—Flexure at 8.17 ft from West Girder (Max. Positive Live Load Moment) . . . A-236
A8.7.2.1.2—Flexure at East Girder (Max. Negative Moment) . . . A-236
A8.7.2.1.3—Shear at East Girder . . . A-236
A8.7.2.2—Service II Limit State . . . A-236
A8.7.2.2.1—At 8.17 ft from West Girder . . . A-236
A8.7.2.2.2—At East Girder . . . A-237
A8.8—RATING OF EAST GIRDER (G1) . . . A-237
A8.9—DEAD LOAD FORCE EFFECTS . . . A-238
A8.10—LIVE LOAD ANALYSIS . . . A-238
A8.11—COMPUTE NORMINAL FLEXURAL RESISTANCE OF SECTION . . . A-240
A8.11.1—Local Buckling Resistance . . . A-240
A8.11.2—Lateral–Torsional Buckling Resistance (LRFD Design 6.10.8.2.3) . . . A-240
A8.12—GENERAL LOAD-RATING EQUATION (6A.4.2) . . . A-242
A8.12.1—Evaluation Factors (for Strength Limit States) . . . A-242
A8.12.1.1—Resistance Factor, φ . . . A-242
A8.12.1.2—Condition Factor, φ_c . . . A-242
A8.12.1.3—System Factor, φ_s . . . A-242
A8.12.2—Design Load Rating (6A.4.3) . . . A-242

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A8.12.2.1—Flexure . . . A-242
A8.12.2.1.1—Strength I Limit State . . . A-242
A8.12.2.1.2—Service II Limit State . . . A-243
A8.12.2.2—Shear . . . A-243
A8.12.2.2.1—Strength I Limit State . . . A-243
A8.13—SUMMARY OF RATING FACTORS . . . A-244
A8.14—REFERENCE . . . A-244
A9—P/S CONCRETE ADJACENT BOX-BEAM BRIDGE: DESIGN LOAD AND PERMIT LOAD RATING OF AN INTERIOR BEAM . . . A-245
A9.1—BRIDGE DATA . . . A-245
A9.1.1—Section Properties . . . A-245
A9.2—DEAD LOAD ANALYSIS—INTERIOR BEAM . . . A-245
A9.2.1—Components and Attachments, *DC* . . . A-245
A9.2.2—Wearing Surface and Utilities, *DW* . . . A-247
A9.3—LIVE LOAD ANALYSIS—INTERIOR GIRDER . . . A-247
A9.3.1—Compute Live Load Distribution Factors for an Interior Beam (LRFD Design Table 4.6.2.2.2b-1) . . . A-247
A9.3.1.1—Distribution Factor for Moment . . . A-247
A9.3.2—Maximum Live Load (HL-93) Moment at Midspan . . . A-248
A9.4—COMPUTE NOMINAL FLEXURAL RESISTANCE . . . A-248
A9.5—MAXIMUM REINFORCEMENT (C6A.5.5) . . . A-249
A9.6—MINIMUM REINFORCEMENT . . . A-249
A9.6.1—Determine Effective Prestress Force, P_{pe} . . . A-250
A9.6.1.1—Loss Due to Elastic Shortening, Δf_{pES} (LRFD Design 5.9.3.2.3a) . . . A-250
A9.6.1.2—Approximate Lump Sum Estimate of Time-Dependent Losses, Δf_{pLT} (LRFD Design 5.9.3.3) . . . A-251
A9.6.1.3—Total Prestress Losses, Δf_{pT} . . . A-253
A9.7—GENERAL LOAD-RATING EQUATION (6A.4.2) . . . A-253
A9.7.1—Evaluation Factors for Strength Limit States . . . A-253
A9.7.1.1—Resistance Factor, φ . . . A-253
A9.7.1.2—Condition Factor, φ_c . . . A-253
A9.7.1.3—System Factor, φ_s . . . A-254
A9.7.2—Design Load Rating (6A.4.3) . . . A-254
A9.7.2.1—Strength I Limit State (6A.5.4.1) . . . A-254
A9.7.2.1.1—Flexure at Midspan . . . A-254
A9.7.2.2—Service III Limit State for Inventory Level (6A.5.4.1) . . . A-254
A9.7.3—Legal Load Rating (6A.4.4) . . . A-255
A9.7.4—Permit Load Rating (6A.4.5) . . . A-255
A9.7.4.1—Strength II Limit State . . . A-255
A9.7.4.2—Service I Limit State . . . A-256
A9.7.4.2.1—Simplified Check using $0.75M_n$ . . . A-256
A9.7.4.2.2—Refined Check using $0.90f_y$ . . . A-256
A9.8—SUMMARY OF RATING FACTORS . . . A-258

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A9.9—REFERENCE A-258
A10—LRFR RATING OF A REINFORCED CONCRETE BOX CULVERT A-259
A10.1—CULVERT DATA A-259
A10.2—DEAD LOAD ANALYSIS, *DC* (6A.5.12.10.1) A-259
A10.3—WEARING SURFACE, *DW* A-260
A10.4—EARTH LOAD: VERTICAL, *EV* (6A.5.12.10.2A) A-260
A10.5—EARTH LOAD: HORIZONTAL, *EH* (6A.5.12.10.2B) A-260
A10.6—SURCHARGE EARTH LOAD: HORIZONTAL, *ES* (6A.5.12.10.2C) A-261
A10.7—LIVE LOAD ANALYSIS, *LL* (6A.5.12.10.3) A-261
A10.7.1—Design Load: HL-93 Tandem A-263
A10.7.2—Design Load: HL-93 Truck A-263
A10.7.3—Legal Load: Type 3 . . . . . A-263
A10.7.4—Legal Load: SU-4 . . . . . A-263
A10.7.5—Surcharge Live Load, *LS* (6A.5.12.10.3c) A-263
A10.8—STRUCTURAL ANALYSIS OF BOX CULVERT (6A.5.12.3) A-265
A10.9—NOMINAL FLEXURAL RESISTANCE A-267
A10.9.1—Top Slab Center A-267
A10.9.2—Top Slab Corner A-267
A10.9.3—Bottom Slab Center A-268
A10.9.4—Bottom Slab Corner A-268
A10.9.5—Sidewall: Top–Center–Bottom A-268
A10.10—NOMINAL SHEAR RESISTANCE A-269
A10.10.1—Top Slab Corner A-269
A10.10.2—Bottom Slab Corner A-269
A10.10.3—Sidewall Top–Center–Bottom A-270
A10.11—AXIAL THRUST RESISTANCE A-270
A10.12—CALCULATE RATING FACTORS, *RF* A-271
A10.12.1—Load Factors for Culvert Load Rating (Table 6A.5.12.5-1) A-271
A10.12.2—Strength I Limit State: Design Load Rating Factor Calculation for Flexure A-271
A10.12.3—Strength I Limit State: Design Load Rating Factor Calculation for Shear A-273
A10.12.4—Strength I Limit State: Design Load Rating Factor Calculation for Axial Thrust A-275
A10.12.5—Strength I Limit State: Legal Load Rating for Flexure A-276
A10.12.6—Strength I Limit State: Legal Load Rating for Shear A-277
A10.12.7—Strength I Limit State: Legal Load Rating for Axial Thrust A-277
A10.13—RATING SUMMARY A-278
A10.14—CAPACITY CHECK FOR PERMANENT LOADS A-278
A11—THROUGH TRUSS BRIDGE: GUSSET PLATE RATING A-281
A11.1—BRIDGE AND MEMBER DATA A-281
PART A—LOAD AND RESISTANCE FACTOR RATING METHOD A-283
A11A.1—LOAD AND RESISTANCE FACTOR RATING OF GUSSET PLATES A-283
A11A.2—CHECK THE TENSION RESISTANCE OF M1 . . . . . A-283
A11A.3—CHECK THE CHORD SPLICE RESISTANCE A-286
A11A.4—CHECK TENSION RESISTANCE OF M2 . . . . . A-288

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A11A.5—CHECK THE COMPRESSION RESISTANCE OF M3 . . . . . A-290
A11A.6—CHECK THE COMPRESSION RESISTANCE OF M4 . . . . . A-292
A11A.7—CHECK HORIZONTAL SHEAR CAPACITY OF THE GUSSET PLATE A-296
A11A.8—CHECK VERTICAL SHEAR CAPACITY OF THE GUSSET PLATE A-297
A11A.9—SUMMARY OF LRFR LOAD RATING FACTORS A-297
PART B—LOAD FACTOR RATING METHOD A-299
A11B.1—LOAD FACTOR RATING OF GUSSET PLATES A-299
A11B.2—CHECK THE TENSION RESISTANCE OF M1 . . . . . A-299
A11B.3—CHECK THE CHORD SPLICE RESISTANCE A-301
A11B.4—CHECK TENSION RESISTANCE OF M2 . . . . . A-301
A11B.5—CHECK THE COMPRESSION RESISTANCE OF M3 . . . . . A-302
A11B.6—CHECK THE COMPRESSION RESISTANCE OF M4 . . . . . A-303
A11B.7—CHECK HORIZONTAL SHEAR CAPACITY OF THE GUSSET PLATE A-304
A11B.8—CHECK VERTICAL SHEAR CAPACITY OF THE GUSSET PLATE A-305
A11B.9—SUMMARY OF LFR LOAD RATING FACTORS A-305
A12—THROUGH TRUSS BRIDGE: LOWER GUSSET PLATE RATING A-307
A12.1—BRIDGE AND MEMBER DATA A-307
A12.2—LOAD AND RESISTANCE FACTOR RATING OF GUSSET PLATES A-307
A12.3—HORIZONTAL SHEAR RESISTANCE OF THE GUSSET PLATES A-310
A12.4—VERTICAL SHEAR RESISTANCE OF THE GUSSET PLATES A-312
A12.5—CHORD SPLICE RESISTANCE A-313
A12.6—TENSION RESISTANCE OF M2 . . . . . A-313
A12.7—TENSION RESISTANCE OF M3 . . . . . A-315
A12.8—COMPRESSION RESISTANCE OF M4 . . . . . A-317
A12.8.1—Whitmore Section Buckling and Partial Shear Plane Yielding A-317
A12.8.2—Basic Corner Check A-319
A12.8.3—Refined Corner Check A-322
A12.9—FINITE ELEMENT MODEL EVALUATION OF THE GUSSET PLATES A-327
A12.10—SUMMARY OF LOAD RATING FACTORS A-329
A13—DECK TRUSS BRIDGE: UPPER GUSSET PLATE RATING A-331
A13.1—BRIDGE AND MEMBER DATA A-331
A13.2—LOAD AND RESISTANCE FACTOR RATING OF GUSSET PLATES A-331
A13.3—HORIZONTAL SHEAR RESISTANCE OF THE GUSSET PLATES A-335
A13.4—VERTICAL SHEAR RESISTANCE OF THE GUSSET PLATES A-336
A13.5—CHORD SPLICE RESISTANCE A-337
A13.6—TENSION RESISTANCE OF M1 . . . . . A-340
A13.7—COMPRESSION RESISTANCE OF M2 . . . . . A-342
A13.7.1—Whitmore Section Buckling and Partial Shear Plane Yielding A-342
A13.7.2—Basic Corner Check A-344
A13.7.3—Refined Corner Check A-347
A13.7.4—Truncated Whitmore Check A-355
A13.8—TENSION RESISTANCE OF M3 . . . . . A-358
A13.9—TENSION RESISTANCE OF M4 . . . . . A-360

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

A13.10—FINITE ELEMENT MODEL EVALUATION OF THE GUSSET PLATES. A-362
A13.11—SUMMARY OF LOAD RATING FACTORS. A-364
A14—DECK TRUSS BRIDGE: LOWER GUSSET PLATE RATING A-365
A14.1—BRIDGE AND MEMBER DATA. A-365
A14.2—LOAD AND RESISTANCE FACTOR RATING OF GUSSET PLATES. A-365
A14.3—HORIZONTAL SHEAR RESISTANCE OF THE GUSSET PLATES. A-368
A14.4—VERTICAL SHEAR RESISTANCE OF THE GUSSET PLATES. A-369
A14.5—CHORD SPLICE RESISTANCE A-370
A14.6—TENSION RESISTANCE OF M1. . . . . A-373
A14.7—COMPRESSION RESISTANCE OF M2 . . . . . A-375
A14.7.1—Whitmore Section Buckling and Partial Shear Plane Yielding A-375
A14.7.2—Basic Corner Check. A-377
A14.7.3—Refined Corner Check A-382
A14.7.4—Truncated Whitmore Check A-386
A14.8—TENSION RESISTANCE OF M3. . . . . A-389
A14.9—FINITE ELEMENT MODEL EVALUATION OF THE GUSSET PLATES A-390
A14.10—SUMMARY OF LOAD RATING FACTORS A-392
A15—REFERENCE A-392

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

Section 1:

INTRODUCTION

1.1—PURPOSE

The purpose of *The Manual for Bridge Evaluation* (MBE) is to serve as a resource for use in developing specific policy and procedures for the inspection and evaluation of existing in-service highway bridges. The MBE also includes the nationally-recognized guidance for the load rating of highway bridges.

The National Bridge Inspection Standards (NBIS), as found in the Code of Federal Regulations (23 CFR 650 Subpart C), define the regulations for the inspection and evaluation of the nation's bridges.

The MBE is incorporated by reference in the CFR (23 CFR 650 Subpart C) to be used along with other reference documents such as the American Association of State Highway and Transportation Officials (AASHTO) *Manual for Bridge Element Inspection*, the Federal Highway Administration's (FHWA) *Bridge Inspector's Reference Manual* (BIRM), and the latest National Bridge Inventory (NBI) coding guidance document for the inspection and evaluation of the nation's bridges (see Article 1.6).

The NBIS have evolved and been improved over the years since their creation in the early 1970s.

The MBE has also evolved and been revised and improved to reflect best practices as determined by research, state departments of transportation (DOTs), and others. In the future as improved practices and research are developed, the MBE will reflect those improvements.

Throughout this Manual, there are subsections titled in part "Provisions to Support the NBIS Requirements." These subsections were developed to provide specific guidance and best practices that are considered to be required under the regulations.

1.2—SCOPE

The Manual has been divided into eight Sections, with each Section representing a distinct phase of an overall bridge inspection and evaluation program.

- Section 1—Purpose, scope, applicability, inspection and evaluation quality measures, and definition of general interest terms.
- Section 2—Provisions for proper documentation to be included in a bridge file. The bridge file associated with each bridge provides the foundation against which changes in physical condition can be compared.

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

- Section 3—Overview of bridge management systems and their key elements.
- Section 4—Types and frequency of field inspections, as well as specific inspection techniques and procedures.
- Section 5—Various inspection and evaluation testing methods. Conditions at a bridge site or the absence of information from original construction may warrant more elaborate material tests to determine properties for evaluation.
- Section 6—Nationally recognized specification for the load rating of bridges. Includes the Load and Resistance Factor method, the Load Factor method, and the Allowable Stress method.
- Section 7—Provisions for the evaluation of existing bridges for fatigue.
- Section 8—Field-performed load test procedures. Field load testing is a means of supplementing analytical procedures in determining the live-load capacity of a bridge and for improving the confidence in the assumptions.

The successful application of this Manual is directly related to the DOT organizational structure. Such a structure should be both effective and responsive so that the unique characteristics and special problems of individual bridges are considered in developing an appropriate inspection plan and load capacity determination.

1.3—APPLICABILITY

The provisions of this Manual apply to all highway structures that qualify as bridges in accordance with the AASHTO definition of a bridge (see Article 1.5). These provisions may be applied to smaller structures which do not qualify as bridges at the discretion of the DOT.

The NBIS establish minimum requirements for inspection programs and minimum qualifications for bridge inspection personnel. The NBIS apply to all highway bridges that are more than 20 ft in length and located on public roads.

Where conflicts or inconsistencies exist between this Manual and the federal requirements specified in the NBIS, the FHWA coding guidance, or BIRM, the federal requirements shall govern. This Manual does not fully reflect the Specifications for the National Bridge Inventory and the 2022 NBIS.

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

1.4—QUALITY

To maintain the accuracy and consistency of inspections and load ratings, bridge inspection programs need to have appropriate quality control (QC) and quality assurance (QA) measures in place. QC procedures are intended to maintain the quality of the bridge inspections, bridge data, scour evaluations, and load ratings, and are usually performed continuously within the bridge inspection teams or units performing these functions. QC procedures can vary depending on the structural and scour conditions of a bridge with increased level of review commensurate with increased deterioration of bridge conditions. QA procedures are used to verify the adequacy of the quality control procedures to meet or exceed the standards established by the program manager. QA procedures are usually performed independently of the bridge inspection and load rating teams on a sample of their work.

1.4.1—Provisions to Support the NBIS Requirements

A quality control and quality assurance (QC/QA) program is to include periodic field review of inspection teams, periodic bridge inspection refresher training for program managers and team leaders, QC/QA measures for inventory data, and independent review of inspection reports and computations. The program manager is responsible for developing a QC/QA program that generally conforms to the provisions of Article 1.4. Specific details are to be determined by the program manager.

1.4.2—QC/QA Procedures

Typical quality procedures may include the use of checklists to ensure uniformity and completeness, the review of reports and computations by a person other than the originating individual, and the periodic field review of inspection teams and their work. The documented quality control plan may include:

- defined QC roles and responsibilities;
- qualifications for the program manager, bridge inspection personnel, and load rating personnel, including:
  - education,
  - certification or registration,
  - training, and
  - years and type of experience;

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

- procedures for review and validation of inspection reports and data;
- procedures for documenting important bridge inspection information;
- procedures for review validation of load rating and scour calculations and data; and
- procedures for identification and resolution of data issues including errors, omissions, compatibility between items, changes, or any combination thereof.

QA measures include the overall review of the inspection and rating program to ascertain that the results meet or exceed the standards established by the program manager. The documented QA plan may include:

- defined quality assurance roles and responsibilities;
- frequency parameters for review of districts or units and bridges; and
- procedures and sampling parameters for selecting bridges to conduct independent review and check of results, including:
  - condition rating of elements or change in condition rating,
  - load rating and scour evaluations,
  - posting status,
  - deficiency status,
  - critical findings and the status of any follow-up action, and
  - location of bridge.

QA measures provide a validation that QC practices are resulting in accurate and thorough inspections, complete bridge files, accurate and complete load ratings and scour evaluations, and qualified inspectors and load raters. Results from QA reviews are used by the program manager to maintain the quality of the program and make improvements where needed.

1.5—DEFINITIONS AND TERMINOLOGY

AASHTO—American Association of State Highway and Transportation Officials.

As-Built Plans—Plans that show the state of the bridge at the end of construction; usually prepared by the Contractor or the resident Engineer.

ASR—Allowable Stress Rating.

Bias—The ratio of mean to nominal value of a random variable.

© 2026 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.