AASHTO LRFD Bridge Construction Specifications

Second Edition • 2004

Published by the
American Association of State Highway
and Transportation Officials

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ABBREVIATED TABLE OF CONTENTS

The *AASHTO LRFD Bridge Construction Specifications*, 2nd Edition contains the following 32 sections and an SI appendix:

FOREWORD

The first broadly recognized national standard for the design and construction of bridges in the United States was published in 1931 by the American Association of State Highway Officials (AASHO), the predecessor to AASHTO. With the advent of the automobile and the establishment of highway departments in all of the American states dating back to just before the turn of the century, the design, construction, and maintenance of most U.S. bridges was the responsibility of these departments and, more specifically, the chief bridge engineer within each department. It was natural, therefore, that these engineers, acting collectively as the AASHTO Highway Subcommittee on Bridges and Structures, would become the author and guardian of this first bridge standard.

This first publication was entitled *Standard Specifications for Highway Bridges and Incidental Structures*. It quickly became the *de facto* national standard and, as such, was adopted and used by not only the state highway departments but also other bridge-owning authorities and agencies in the United States and abroad. Rather early on, the last three words of the original title were dropped and it has been reissued in consecutive editions at approximately four-year intervals ever since as *Standard Specifications for Highway Bridges*, with the final 17th edition appearing in 2002.

The body of knowledge related to the design of highway bridges has grown enormously since 1931 and continues to do so. Theory and practice have evolved greatly, reflecting advances through research in understanding the properties of materials, in improved materials, in more rational and accurate analysis of structural behavior, in the advent of computers and rapidly advancing computer technology, in the study of external events representing particular hazards to bridges such as seismic events and stream scour, and in many other areas. The pace of advances in these areas has, if anything, stepped up in recent years. To accommodate this growth in bridge engineering knowledge, the Subcommittee on Bridges and Structures has been granted authority under AASHTO's governing documents to approve and issue Bridge Interims each year, not only with respect to the Standard Specifications but also to incrementally modify and enhance the twenty-odd additional documents on bridges and structures engineering that are under its guidance and sponsorship.

In 1986, the Subcommittee submitted a request to the AASHTO Standing Committee on Research to undertake an assessment of U.S. bridge design specifications, to review foreign design specifications and codes, to consider design philosophies alternative to those underlying the Standard Specifications, and to render recommendations based on these investigations. This work was accomplished under the National Cooperative Highway Research Program (NCHRP), an applied research program directed by the AASHTO Standing Committee on Research and administered on behalf of AASHTO by the Transportation Research Board (TRB). The work was completed in 1987, and, as might be expected with a standard incrementally adjusted over the years, the Standard Specifications were judged to include discernible gaps, inconsistencies, and even some conflicts. Beyond this, the specification did not reflect or incorporate the most recently developing design philosophy, load-and-resistance factor design (LRFD), a philosophy which has been gaining ground in other areas of structural engineering and in other parts of the world such as Canada and Europe.

From its inception until the early 1970s, the sole design philosophy embedded within the Standard Specifications was one known as working stress design (WSD). WSD establishes allowable stresses as a fraction or percentage of a given material's load-carrying capacity and requires that calculated design stresses not exceed those allowable stresses. Beginning in the early 1970s, WSD began to be adjusted to reflect the variable predictability of certain load types, such as vehicular loads and wind forces, through adjusting design factors, a design philosophy referred to as load factor design (LFD). Both WSD and LFD are reflected in the current edition of the Standard Specifications.

A further philosophical extension results from considering the variability in the properties of structural elements, in similar fashion to load variabilities. While considered to a limited extent in LFD, the design philosophy of load-and-resistance factor design (LRFD) takes variability in the behavior of structural elements into account in an explicit manner. LRFD relies on extensive use of statistical methods, but sets forth the results in a manner readily usable by bridge designers and analysts.

With the advent of these specifications, bridge engineers had a choice of two standards to guide their designs, the long-standing AASHTO *Standard Specifications for Highway Bridges*, and the alternative, newly adopted *AASHTO LRFD Bridge Design Specifications*, and its companions, *AASHTO LRFD Bridge Construction Specifications* and *AASHTO LRFD Movable Highway Bridge Design Specifications*. Subsequently, the Federal Highway Administration (FHWA) and the states have established a goal that LRFD standards be incorporated in all new bridge designs after 2007.

Interim Specifications are usually published in the middle of the calendar year, and a revised edition of this book is generally published every four years. The Interim Specifications have the same status as AASHTO standards, but are tentative revisions approved by at least two-thirds of the Subcommittee. These revisions are voted on by the AASHTO

member departments prior to the publication of each new edition of this book and, if approved by at least two-thirds of the members, they are included in the new edition as standards of the Association. AASHTO members are the 50 State Highway or Transportation Departments, the District of Columbia, and Puerto Rico. Each member has one vote. The U.S. Department of Transportation is a nonvoting member.

Annual Interim Specifications are generally used by the States after their adoption by the Subcommittee. Orders for these annual Interim Specifications may be placed by visiting our web site, bookstore.transportation.org; calling the AASHTO Publication Sales Office toll free (within the U.S. and Canada), 1-800-231-3475; or mailing to P.O. Box 96716, Washington, DC 20906-6716. A free copy of the current publication catalog can be downloaded from our website or requested from the Publications Sales Office.

Attention is also directed to the following publications prepared and published by the Subcommittee on Bridges and Structures:

AASHTO Guide for Commonly Recognized (CoRe) Structural Elements. 1998.

AASHTO Guide Specifications for Horizontally Curved Steel Girder Highway Bridges with Design Examples for I-Girder and Box-Girder Bridges. 2002.

AASHTO Guide Specifications—Thermal Effects in Concrete Bridge Superstructures. 1989.

AASHTO LRFD Bridge Construction. 1998.

AASHTO LRFD Movable Highway Bridge Design. 1998.

Bridge Data Exchange (BDX) Technical Data Guide. 1995.

Bridge Welding Code: AASHTO/AWS-D1.5M/D1.5: 2002, an American National Standard. 2002.

Construction Handbook for Bridge Temporary Works. 1995.

Guide Design Specifications for Bridge Temporary Works. 1995.

Guide for Painting Steel Structures. 1997.

Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges. 2003.

Guide Specifications and Commentary for Vessel Collision Design of Highway Bridges. 1991.

Guide Specifications for Alternate Load Factor Design Procedures for Steel Beam Bridges Using Braced Compact Sections. 1991.

Guide Specifications for Aluminum Highway Bridges. 1991.

Guide Specifications for Bridge Railings. 1989.

Guide Specifications for Design and Construction of Segmental Concrete Bridges. 1999.

Guide Specifications for Design of Pedestrian Bridges. 1997.

Guide Specifications for Fatigue Evaluation of Existing Steel Bridges. 1990.

Guide Specifications for Highway Bridge Fabrication with HPS070W Steel. 2000.

Guide Specifications for Seismic Isolation Design. 1999.

Guide Specifications for Strength Design of Truss Bridges (Load Factor Design). 1986.

Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges. 1989.

Guide Specifications for Structural Design of Sound Barriers. 1989.

Guide Specifications for the Design of Stress-Laminated Wood Decks. 1991.

Guidelines for Bridge Management Systems. 1993.

Manual for Condition Evaluation of Bridges. 2000.

Movable Bridge Inspection, Evaluation and Maintenance Manual. 1998.

Standard Specifications for Movable Highway Bridges. 1988.

Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. 2001.

Additional bridges and structures publications prepared and published by other AASHTO committees and task forces are as follows:

Guide Specifications for Cathodic Protection of Concrete Bridge Decks. 1994.

Guide Specifications for Polymer Concrete Bridge Deck Overlays. 1995.

Guide Specifications for Shotcrete Repair of Highway Bridges. 1998.

Inspector's Guide for Shotcrete Repair of Bridges. 1999.

Manual for Corrosion Protection of Concrete Components in Bridges. 1992.

Two Parts: Guide Specifications for Concrete Overlay Pavements and Bridge Decks. 1990.

AASHTO Maintenance Manual: The Maintenance and Management of Roadways and Bridges. 1999.

The following bridges and structures titles are the result of the AASHTO–NSBA Steel Bridge Collaboration and are available for free download from the AASHTO Web site, bookstore.transportation.org:

Design Drawing Presentation Guidelines. 2003.

Guidelines for Design Constructability. 2003.

Guide Specification for Coating Systems with Inorganic Zinc-Rich Primer. 2003.

Shop Detail Drawing Presentation Guidelines. 2003.

Shop Detail Drawing Review/Approval Guidelines. 2003.

Steel Bridge Fabrication Guide Specification. 2003.

Steel Bridge Fabrication QC/QA Guide Specification. 2003.

The following have served as chairmen of the Subcommittee on Bridges and Structures since its inception in 1921: Messrs. E. F. Kelley, who pioneered the work of the Subcommittee; Albin L. Gemeny; R. B. McMinn; Raymond Archiband; G. S. Paxson; E. M. Johnson; Ward Goodman; Charles Matlock; Joseph S. Jones; Sidney Poleynard; Jack Freidenrich; Henry W. Derrick; Robert C. Cassano; Clellon Loveall; James E. Siebels; David Pope; Tom Lulay; and Malcolm T. Kerley. The Subcommittee expresses its sincere appreciation of the work of these men and of those active members of the past, whose names, because of retirement, are no longer on the roll.

The Subcommittee would also like to thank Mr. John M. Kulicki, Ph.D., and his associates at Modjeski and Masters for their valuable assistance in the preparation of the LRFD Specifications.

Suggestions for the improvement of the LRFD Specifications are welcomed, just as they were for the Standard Specifications before them. They should be sent to the Chairman, Subcommittee on Bridges and Structures, AASHTO, 444 North Capitol Street, N.W., Suite 249, Washington, DC 20001. Inquiries as to intent or application of the Specifications should be sent to the same address.

AASHTO Highway Subcommittee on Bridges and Structures
December 2004

PREFACE

Dual Units

The *AASHTO LRFD Bridge Construction Specifications*, 2nd Edition has been converted to dual units. Customary U.S. units are the primary units. SI units appear in parentheses throughout the text. Appendix A at the end of the book lists the SI versions of all equations, figures, and tables which are unit-specific.

References

As previously initiated in the *AASHTO LRFD Design Specifications*, 3rd Edition, a reference list appears at the end of each section for the reader's convenience. If a standard is available as a stand-alone publication—for example, the ACI standards—the title is *italicized* in the text and listed in the references. If a standard is available as part of a larger publication—for example, the AASHTO materials specifications—the standard's title is not italicized and the larger publication—in this case, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, 24th Edition—is listed in the references.

Technical Changes

A new and practical feature starting with this edition of LRFD Construction is a listing the balloted items approved and included in this publication, which immediately follows this preface. Please note that gaps in the item numbers reflect ballot items which affect other bridge titles and which therefore have been omitted from this listing. Where one ballot item refers to both LRFD Design and LRFD Construction, the full text of the ballot item has been preserved. Article numbers have been set in **boldface** type for ease of reference.

Preface Table 1 Sections and Articles Containing Balloted Technical Changes.

Item No.	2003 Ballot Item
4.	T-2 Committee (Bearings) – Revisions to **Article 18.3.4.3.1** of the *AASHTO LRFD Bridge Construction Specifications* (SI Units)
5.	T-4 Committee (Construction) – Revision to Section 8, Concrete Structures, **Article 8.2.2**, *AASHTO LRFD Bridge Construction Specifications*
6.	T-4 Committee (Construction) – Revision to Section 8, Concrete Structures, **Articles 8.3.1, 8.3.5, 8.3.6, 8.3.7 and 8.3.8**, *AASHTO LRFD Bridge Construction Specifications*
7.	T-4 Committee (Construction) – Revision to Section 8, Concrete Structures, **Articles 8.4.1.1, 8.4.1.2, 8.4.3 and 8.4.4**, *AASHTO LRFD Bridge Construction Specifications*
8.	T-4 Committee (Construction) – Revision to Section 8, Concrete Structures, **Articles 8.5.7.1, 8.5.7.3 and 8.5.7.5**, *AASHTO LRFD Bridge Construction Specifications*
9.	T-4 Committee (Construction) – Revision to Section 8, Concrete Structures, **Articles 8.6.4.1, 8.6.6 and 8.6.7**, *AASHTO LRFD Bridge Construction Specifications*
10.	T-4 Committee (Construction) – Revision to Section 8, Concrete Structures, **Articles 8.11.1, 8.11.3.5 and 8.11.4**, *AASHTO LRFD Bridge Construction Specifications*
11.	T-4 Committee (Construction) – Revision to Section 8, Concrete Structures, **Article 8.13.4**, *AASHTO LRFD Bridge Construction Specifications*
12.	T-4 Committee (Construction) – Revision to **Section 19**, Bridge Deck Joint Seals, *AASHTO LRFD Bridge Construction Specifications*

Item No.	2003 Ballot Item
20.	T-10 Committee (Concrete) – Revision to Article C5.4.1 of the *AASHTO LRFD Bridge Design Specifications*, and additions to **Articles 8.3.7 and C8.3.7** of the *AASHTO LRFD Bridge Construction Specifications*
27.	T-10 Committee (Concrete) – Revision to Article 5.10.3.3.2 of the *AASHTO LRFD Bridge Design Specifications*, and **Article 8.13.7.2** of the *AASHTO LRFD Bridge Construction Specifications*
46.	T-14 Committee (Steel) – Revisions to **Section 11** of the *AASHTO LRFD Bridge Construction Specifications*

Unit Abbreviations

Unit abbreviations are now in accordance with AASHTO R 1. Most of the abbreviations commonly used in LRFD Construction are listed below. For others, please consult R 1, particularly Annex A, in Part 1B of *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, 24th Edition.

The only exception to R 1 usage is a period to abbreviate "inch" (in.) in simple and compound units, other than microinch (μin). Also, please note the following:

- There is no difference in abbreviation for singular and plural. This is not the case for unabbreviated units (day, degree, kip, mil, and ton).
- Units containing the multiplication symbol (·) should have a nonbreaking space on either side of the symbol.
- There should be a nonbreaking space between the value and the unit in any measurement regardless of whether or not the unit is abbreviated.
- Most units of time have one-letter abbreviations. Unit abbreviations are always set in roman type, while variables and factors are set in *italic* type. Thus, "2 h" is the abbreviation for "two hours."

Preface Table 2 Frequently-Used Unit Abbreviations in Accordance with AASHTO R 1.

Unit	Abbreviation
cubic foot	ft^3
cubic inch	$in.^3$
cubic meter	m^3
cubic yard	yd^3
day	day (no abbreviation)
degree (angle)	degree (no abbreviation)
degrees Celsius	ºC
degrees Fahrenheit	ºF
foot	ft
foot-kip	ft-kip
foot per hour	ft/h
foot per minute	ft/min
foot per second	ft/s
foot pound	ft · lb
foot pound-force	ft · lbf
foot second	ft · s
gallon	gal
hour	h
Hertz	Hz
inch	in.
joule	J

Unit	Abbreviation
kilometer per hour	km/h
kilonewton	kN
kilopascal	kPa
kip	kip (no abbreviation)
kip per foot	kip/ft
kip per square inch	ksi
kip per square foot	kip/ft^2
liter	L
megapascal	MPa
meter	m
microinch	µin
micron	µm
mil	mil (no abbreviation)
mile	mi
milliliter	mL
minute	min (min. for “minimum”)
newton	N
newton meter	N · m
newton per meter	N/m
ounce	oz
pascal	Pa
pascal second	Pa · s
pound	lb
pound-force	lbf
pound-force foot	lbf · ft
pound-force inch	lbf · in.
pound-force per foot	lbf/ft
pound-force per inch	lbf/in.
pound-force per pound	lbf/lb
pound-force per square foot	psf
pound-force per square inch	psi
pound per cubic foot	lb/ft^3
pound per cubic inch	$lb/in.^3$
pound per cubic yard	lb/yd^3
pound per foot	lb/ft
pound per inch	lb/in.
pound per hour	lb/h
pound per square foot	lb/ft^2
pound per yard	lb/yd
radian	rad
radian per second	rad/s
quart	qt
second	s
square inch	$in.^2$
square foot	ft^2
square meter	m^2
square mile	mi^2
square yard	yd^2
ton	ton (no abbreviation)
year	y

AASHTO Publications Staff
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SECTION 1: STRUCTURE EXCAVATION AND BACKFILL

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SECTION 1

STRUCTURE EXCAVATION AND BACKFILL

1.1 GENERAL

C1.1

Structure excavation shall consist of the removal of all material, of whatever nature, necessary for the construction of foundations for bridges, retaining walls, and other major structures, in accordance with the contract documents or as directed by the Engineer.

If not otherwise provided for in the contract, structure excavation shall include the furnishing of all necessary equipment and the construction and subsequent removal of all cofferdams, shoring, and water control systems which may be necessary for the execution of the work.

If not otherwise specified in the contract documents, it shall also include the placement of all necessary backfill, including any necessary stockpiling of excavated material which is to be used in backfill, and the disposing of excavated material which is not required for backfill, in roadway embankments or as provided for excess and unsuitable material in Subsection 203.02, *AASHTO Guide Specifications for Highway Construction*.

Subsection 203.02 is located in the *AASHTO Guide Specifications for Highway Construction.*

If the contract does not include a separate pay item or items for such work, structure excavation shall include all necessary clearing and grubbing and the removal of existing structures within the area to be excavated.

Classification, if any, of excavation will be indicated in the contract documents and set forth in the proposal.

The removal and disposal of buried natural or man-made objects are included in the class of excavation in which they are located, unless such removal and disposal are included in other items of work. However, in the case of a buried man-made object, the removal and disposal of such object will be paid for as extra work and its volume will not be included in the measured quantity of excavation, if:

- its removal requires the use of methods or equipment not used for other excavation on the project,
- its presence was not indicated in the contract drawings,
- its presence could not have been ascertained by site investigation, including contact with identified utilities within the area, and
- the Contractor so requests in writing prior to its removal.

1.2 WORKING DRAWINGS

Whenever specified in the contract drawings, the Contractor shall provide working drawings, accompanied by calculations where appropriate, of excavation

procedures, embankment construction, and backfilling operations. This plan shall show the details of shoring, bracing, slope treatment, or other protective system proposed for use and shall be accompanied by design calculations and supporting data in sufficient detail to permit an engineering review of the proposed design.

The working drawings for protection from caving shall be submitted sufficiently in advance of proposed use to allow for their review; revision, if needed; and approval without delay to the work.

Working drawings shall be approved by the Engineer prior to performance of the work involved, and such approval shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

1.3 MATERIALS

Material used for backfill shall be free of frozen lumps, wood, or other degradable or hazardous matter and shall be of a grading such that the required compaction can be consistently obtained using the compaction methods selected by the Contractor.

Permeable material for underdrains shall conform to *AASHTO Guide Specifications for Highway Construction*, Subsection 704.01.

C1.3

Subsection 704.01 is located in the *AASHTO Guide Specifications for Highway Construction*.

1.4 CONSTRUCTION

1.4.1 Depth of Footings

The elevation of the bottoms of footings, as shown in the contract documents, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation.

1.4.2 Foundation Preparation and Control of Water

1.4.2.1 General

Where practical, all substructures shall be constructed in open excavation and, where necessary, the excavation shall be shored, braced, or protected by cofferdams constructed in accordance with the requirements contained in Article 3.3, “Cofferdams and Shoring.” When footings can be placed in the dry without the use of cofferdams, backforms may be omitted with the approval of the Engineer and the entire excavation filled with concrete to the required elevation of the top of the footing. The additional concrete required shall be furnished and placed at the expense of the Contractor. Temporary water control systems shall conform to the requirements contained in Article 3.4, “Temporary Water Control Systems.”