

AASHTO
LRFD Bridge Design Specifications

Customary U.S. Units
Second Edition

1998



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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 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 16th Edition appearing in 1996.

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 the authority under AASHTO's governing documents to approve and issue Bridge Interims each year, not only with respect to *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, review foreign design specifications and codes, consider design philosophies alternative to those underlying *Standard Specifications*, and to render recommendations based on these investigations. This work was accomplished under the National Cooperative Highway Research Program, an applied research program directed by the AASHTO Standing Committee on Research and administered on behalf of AASHTO by the Transportation Research Board. 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 *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 *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.

The principal recommendation of the assessment completed in 1987, therefore, was the development of an entirely new LRFD bridge design standard. A multi-year, exceptionally comprehensive NCHRP project to accomplish this goal was subsequently approved by the AASHTO Standing Committee on Research. Once underway, NCHRP Project 12-33 took five years to complete, and resulted in this document, the *AASHTO LRFD Bridge Design Specifications*. Under the frequent review of the AASHTO Highway Subcommittee on Bridges and Structures and its twenty Technical Committees, the specifications were developed by a team of more than 50 members, including some of the best bridge engineering talent in the U.S. and elsewhere, guided by a distinguished project panel. The effort included the incorporation of state-of-the-art knowledge, and the cooperation and input of industry groups. It has passed through five successive drafts, painstaking reviews, and it has been systematically tested in trial designs in bridge design division of fourteen AASHTO member departments, as well as informally tested in many others. It represents a major step forward in improved bridge design and more accurate analysis methods, which will lead to bridges exhibiting superior serviceability, enhanced long-term maintainability, and more uniform levels of safety.

A discussion of the evolution of the specifications and commentary, including the genesis of the NCHRP project, the research participants, the review process for the specifications, and selected major technical advances in the specifications, is presented in *NCHRP Research Results Digest 198* (available from the Transportation Research Board).

With the advent of these specifications, bridge engineers now have a choice of two standards to guide their designs, the long-standing *AASHTO Standard Specifications for Highway Bridges*, and these alternative, newly adopted *AASHTO LRFD Bridge Design Specifications*, and its companion *AASHTO LRFD Bridge Construction Specifications*.

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Preface

The *AASHTO LRFD Bridge Design Specifications* has the following 14 sections and an Index:

1. Introduction
2. General Design and Location Features
3. Loads and Load Factors
4. Structural Analysis and Evaluation
5. Concrete Structures
6. Steel Structures
7. Aluminum Structures
8. Wood Structures
9. Decks and Deck Systems
10. Foundations
11. Abutments, Piers and Walls
12. Buried Structures and Tunnel Liners
13. Railings
14. Joints and Bearings

Tables of Contents precede each section. References are listed following each section.

Equations, figures and tables are denoted by their home article number and an extension, for example 1.2.3.4.5-1, but when they are referenced in their home article or its commentary they are identified only by the extension. For example, in Article 1.2.3.4.5, Equation 1.2.3.4.5-2 would simply be called "Equation 2." When this equation is referenced anywhere else other than its home article, it is identified by its whole nomenclature, in other words, "Equation 1.2.3.4.5-2." The same convention applies to tables and figures.

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