

# AASHTO LRFD BRIDGE



## DESIGN SPECIFICATIONS

Customary U.S. Units • 2012

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**AASHTO**  
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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 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](http://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 933538, Atlanta, GA 31193-3538. 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 Manual for Bridge Element Inspection*. 2011.

*AASHTO Guide Specifications for Horizontally Curved Steel Girder Highway Bridges with Design Examples for I-Girder and Box-Girder Bridges*. 2003. Archived.

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

*AASHTO LRFD Bridge Construction Specifications*. 2010.

*AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings*. 2009.

*AASHTO LRFD Movable Highway Bridge Design Specifications*. 2007.

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

*Bridge Security Guidelines*, 2011.

*Bridge Welding Code: AASHTO/AWS D1.5M/D1.5:2010, an American National Standard*. 2010.

*Construction Handbook for Bridge Temporary Works*. 1995.

*Guide Design Specifications for Bridge Temporary Works*. 1995.

*Guide for Painting Steel Structures*. 1997. Archived.

*Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges*. 2003. Archived but download available.

*Guide Specifications and Commentary for Vessel Collision Design of Highway Bridges*. 2009.

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

*Guide Specifications for Aluminum Highway Bridges*. 1991. Archived.

*Guide Specifications for Bridge Railings*. 1989. Archived.

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

*Guide Specifications for Fatigue Evaluation of Existing Steel Bridges*. 1990. Archived but download available.

*Guide Specifications for Highway Bridge Fabrication with HPS 70W (HPS 485W) Steel*. 2003.

*Guide Specifications for Seismic Isolation Design*. 2010.

*Guide Specifications for Strength Design of Truss Bridges (Load Factor Design)*. 1986. Archived but download available.

*Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges*. 1989. Archived but download available.

*Guide Specifications for Structural Design of Sound Barriers*. 1989. Archived but download available.

*Guide Specifications for the Design of Stress-Laminated Wood Decks*. 1991. Archived but download available.

*Guidelines for Bridge Management Systems*. 1993. Archived but download available.

*LRFD Guide Specifications for Design of Pedestrian Bridges*. 2009.

*The Manual for Bridge Evaluation*. 2011.

*Movable Bridge Inspection, Evaluation, and Maintenance Manual*. 1998.

*Standard Specifications for Movable Highway Bridges*. 1988. Archived but download available.

*Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*. 2009.

*Technical Manual for Design and Construction of Road Tunnels—Civil Elements*. 2010.

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

*AASHTO Maintenance Manual: The Maintenance and Management of Roadways and Bridges*. 2007.

*Guide Specifications for Cathodic Protection of Concrete Bridge Decks*. 1994. Archived but download available.

*Guide Specifications for Concrete Overlay of Pavements and Bridge Decks*. 1990. Archived but download available.

*Guide Specifications for Polymer Concrete Bridge Deck Overlays*. 1995. Archived but download available.

*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. Archived but download available.

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](http://bookstore.transportation.org):

*Design Drawing Presentation Guidelines, G 1.2*. 2003.

*Guidelines for Design Constructability, G 12.1*. 2003.

*Guidelines for Design Details, G 1.4*. 2006.

*Guidelines for Steel Girder Bridge Analysis, G 13.1*. 2011.

*Guide Specification for Application of Coating Systems with Zinc-Rich Primers to Steel Bridges, S 8.1*. 2006.

*Recommendations for the Qualification of Structural Bolting Inspectors, G 4.2*. 2006.

*Sample Owners Quality Assurance Manual, G 4.4*. 2006.

*Shop Detail Drawing Presentation Guidelines, G 1.3*. 2003.

*Shop Detail Drawing Review/Approval Guidelines, G 1.1*. 2000.

*Steel Bridge Bearing Design and Detailing Guidelines, 1st Edition, G 9.1*. 2004.

*Steel Bridge Erection Guide Specification, S 10.1. 2007.*

*Steel Bridge Fabrication Guide Specification, S 2.1. 2008.*

*Steel Bridge Fabrication QC/QA Guide Specification, S 4.1. 2002.*

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. Derthick; 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.

## **PREFACE AND ABBREVIATED TABLE OF CONTENTS**

The *AASHTO LRFD Bridge Design Specifications*, Sixth Edition contains the following 15 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
  15. Design of Sound Barriers
- Index

Detailed Tables of Contents precede each section. The last article of each section is a list of references displayed alphabetically by author.

Figures, tables, and equations are denoted by their home article number and an extension, for example 1.2.3.4.5-1 wherever they are cited. In early editions, when they were referenced in their home article or its commentary, these objects were identified only by the extension. For example, in Article 1.2.3.4.5, Eq. 1.2.3.4.5-2 would simply have been called “Eq. 2.” The same convention applies to figures and tables. Starting with this edition, these objects are identified by their whole nomenclature throughout the text, even within their home articles. This change was to increase the speed and accuracy of electronic production (i.e., CDs and downloadable files) with regard to linking citations to objects.

Please note that the AASHTO materials standards (starting with M or T) cited throughout the LRFD Specifications can be found in *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, adopted by the AASHTO Highway Subcommittee on Materials. The individual standards are also available as downloads on the AASHTO Bookstore, <https://bookstore.transportation.org>. Unless otherwise indicated, these citations refer to the current edition. ASTM materials specifications are also cited and have been updated to reflect ASTM’s revised coding system, e.g., spaces removed between the letter and number.

# CHANGED AND DELETED ARTICLES, 2012

## SUMMARY OF AFFECTED SECTIONS

The revisions included in the *AASHTO LRFD Bridge Design Specifications*, Sixth Edition affect the following sections:

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
9. Decks and Deck Systems
10. Foundations
11. Abutments, Piers, and Walls
12. Buried Structures and Tunnel Liners
13. Railings
14. Joints and Bearings
15. Design of Sound Barriers

## SECTION 2 REVISIONS

### Changed Articles

The following Articles in Section 2 contain changes or additions to the specifications, the commentary, or both:

2.5.2.6.3

### Deleted Articles

No Articles were deleted from Section 2.

## SECTION 3 REVISIONS

### Changed Articles

The following Articles in Section 3 contain changes or additions to the specifications, the commentary, or both:

3.3.2	3.6.1.2.5	3.8.1.1	3.10.9.2	3.16
3.4.1	3.6.1.4.1	3.8.1.2.1	3.11.5.10	
3.4.4	3.6.5.1	3.10.2.1	3.15	

### Deleted Articles

No Articles were deleted from Section 3.

## SECTION 4 REVISIONS

### Changed Articles

The following Articles in Section 4 contain changes or additions to the specifications, the commentary, or both:

4.2	4.6.1.2.2	4.6.2.2.3c	4.6.3.2.4
4.6.1.1	4.6.1.2.3	4.6.2.5	4.7.6
4.6.1.2.1	4.6.2.1.8	4.6.2.6.4	4.9



### **Deleted Articles**

No Articles were deleted from Section 4.

### **SECTION 5 REVISIONS**

#### **Changed Articles**

The following Articles in Section 5 contain changes or additions to the specifications, the commentary, or both:

5.2	5.7.3.3.2	5.9.4.2.2	5.10.4.3.1c	5.13.2.2
5.3	5.8.1.5	5.10.4.3	5.10.4.3.1d	5.14.2.3.2
5.4.2.6	5.9	5.10.4.3.1	5.10.4.3.2	5.14.2.3.4a
5.5.3.1	5.9.1.1	5.10.4.3.1a	5.10.5	5.14.2.3.4b
5.5.4.2.1	5.9.1.6	5.10.4.3.1b	5.10.9.3.7	5.15

#### **Deleted Articles**

5.9.4.3

### **SECTION 6 REVISIONS**

#### **Changed Articles**

The following Articles in Section 6 contain changes or additions to the specifications, the commentary, or both:

6.3	6.6.1.3.2	6.10.11.1.3	6.14.3.3	6.16.2
6.5.4.2	6.7.3	6.11.1.1	6.14.3.4	6.16.3
6.5.5	6.7.4.1	6.11.5	6.14.3.2.1	6.16.4
6.6.1.2.1	6.9.4.2.2	6.11.8.2.2	6.14.3.2.2	6.16.4.1
6.6.1.2.3	6.9.4.4	6.11.11.2	6.14.3.2.3	6.16.4.2
6.6.1.2.4	6.10.1.7	6.12.2.2.1	6.14.4.2	6.16.4.3
6.6.1.2.5	6.10.6.2.3	6.14.3	6.16	6.16.4.4
6.6.1.3.1	6.10.10	6.14.3.1	6.16.1	6.17

#### **Deleted Articles**

6.14.3.4                      6.14.3.5

### **SECTION 7 REVISIONS**

#### **Changed Articles**

The following Articles in Section 7 contain changes or additions to the specifications, the commentary, or both:

7.6.1.2.1

#### **Deleted Articles**

No Articles were deleted from Section 7.

## SECTION 9 REVISIONS

### Changed Articles

The following Articles in Section 9 contain changes or additions to the specifications, the commentary, or both:

9.8.3.4	9.8.3.4.3a	9.8.3.6.2	9.8.3.6.2d	9.8.3.7.4
9.8.3.4.1	9.8.3.4.3b	9.8.3.6.2a	9.8.3.7.1	9.10
9.8.3.4.2	9.8.3.4.3c	9.8.3.6.2b	9.8.3.7.2	
9.8.3.4.3	9.8.3.4.4	9.8.3.6.2c	9.8.3.7.3	

### Deleted Articles

9.8.3.5	9.8.3.5.2
9.8.3.5.1	9.8.3.5.3

## SECTION 10 REVISIONS

### Changed Articles

The following Articles in Section 10 contain changes or additions to the specifications, the commentary, or both:

10.6.3.3	10.8.3.6.3
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### Deleted Articles

No Articles were deleted from Section 10.

## SECTION 11 REVISIONS

### Changed Articles

The following Articles in Section 11 contain changes or additions to the specifications, the commentary, or both:

11.3.1	11.6.5	11.8.6.1	11.10.6.4.3b	A11.1
11.4.1	11.6.5.1	11.8.6.2	11.10.6.4.4b	A11.2
11.5.3	11.6.5.2	11.8.6.3	11.10.7	A11.3
11.5.4	11.6.5.2.1	11.8.6.4	11.10.7.1	A11.3.1
11.5.4.1	11.6.5.2.2	11.9.6	11.10.7.2	A11.3.2
11.5.4.2	11.6.5.3	11.10.1	11.10.7.3	A11.3.3
11.5.5	11.6.5.4	11.10.2.1	11.10.7.4	A11.4
11.5.6	11.6.5.5	11.10.4.2	11.10.10.1	A11.5
11.5.7	11.6.5.6	11.10.6.3.2	11.11.6	A11.6
11.5.8	11.8.1	11.10.6.4.2a	11.12	
11.6.3.3	11.8.6	11.10.6.4.2b	A11	

### Deleted Articles

No Articles were deleted from Section 11.

## **SECTION 12 REVISIONS**

### **Changed Articles**

The following Articles in Section 12 contain changes or additions to the specifications, the commentary, or both:

12.3	12.7.2.2	12.8.9.2.2	12.8.9.4
12.5.5	12.7.2.5	12.8.9.3.1	12.8.9.5
12.6.6.3	12.8.9.1	12.8.9.3.2	12.14.5.6

### **Deleted Articles**

No Articles were deleted from Section 12.

## **SECTION 13 REVISIONS**

### **Changed Articles**

The following Articles in Section 13 contain changes or additions to the specifications, the commentary, or both:

A13.4.3.1

### **Deleted Articles**

No Articles were deleted from Section 13.

## **SECTION 14 REVISIONS**

### **Changed Articles**

The following Articles in Section 14 contain changes or additions to the specifications, the commentary, or both:

14.3	14.7.5.3.3	14.7.6.1	14.7.6.3.3	14.7.6.3.5b
14.6.3.2	14.7.5.3.6	14.7.6.3.2	14.7.6.3.5a	14.7.6.3.6

### **Deleted Articles**

14.7.6.3.5d

## **SECTION 15**

Section 15 is completely new.

AASHTO Publications Staff  
January 2012

SECTION 1: INTRODUCTION

TABLE OF CONTENTS

1.1—SCOPE OF THE SPECIFICATIONS ..... 1-1

1.2—DEFINITIONS..... 1-2

1.3—DESIGN PHILOSOPHY ..... 1-3

    1.3.1—General..... 1-3

    1.3.2—Limit States ..... 1-3

        1.3.2.1—General..... 1-3

        1.3.2.2—Service Limit State..... 1-4

        1.3.2.3—Fatigue and Fracture Limit State..... 1-4

        1.3.2.4—Strength Limit State ..... 1-4

        1.3.2.5—Extreme Event Limit States ..... 1-5

    1.3.3—Ductility ..... 1-5

    1.3.4—Redundancy ..... 1-6

    1.3.5—Operational Importance..... 1-7

1.4—REFERENCES..... 1-7

SECTION 2: GENERAL DESIGN AND LOCATION FEATURES

TABLE OF CONTENTS

2.1—SCOPE ..... 2-1

2.2—DEFINITIONS ..... 2-1

2.3—LOCATION FEATURES ..... 2-3

    2.3.1—Route Location ..... 2-3

        2.3.1.1—General ..... 2-3

        2.3.1.2—Waterway and Floodplain Crossings ..... 2-3

    2.3.2—Bridge Site Arrangement ..... 2-4

        2.3.2.1—General ..... 2-4

        2.3.2.2—Traffic Safety ..... 2-4

            2.3.2.2.1—Protection of Structures ..... 2-4

            2.3.2.2.2—Protection of Users ..... 2-5

            2.3.2.2.3—Geometric Standards ..... 2-5

            2.3.2.2.4—Road Surfaces ..... 2-5

            2.3.2.2.5—Vessel Collisions ..... 2-5

    2.3.3—Clearances ..... 2-6

        2.3.3.1—Navigational ..... 2-6

        2.3.3.2—Highway Vertical ..... 2-6

        2.3.3.3—Highway Horizontal ..... 2-6

        2.3.3.4—Railroad Overpass ..... 2-6

    2.3.4—Environment ..... 2-7

2.4—FOUNDATION INVESTIGATION ..... 2-7

    2.4.1—General ..... 2-7

    2.4.2—Topographic Studies ..... 2-7

2.5—DESIGN OBJECTIVES ..... 2-7

    2.5.1—Safety ..... 2-7

    2.5.2—Serviceability ..... 2-8

        2.5.2.1—Durability ..... 2-8

            2.5.2.1.1—Materials ..... 2-8

            2.5.2.1.2—Self-Protecting Measures ..... 2-8

        2.5.2.2—Inspectability ..... 2-9

        2.5.2.3—Maintainability ..... 2-9

        2.5.2.4—Rideability ..... 2-9

        2.5.2.5—Utilities ..... 2-9

        2.5.2.6—Deformations ..... 2-10

            2.5.2.6.1—General ..... 2-10

            2.5.2.6.2—Criteria for Deflection ..... 2-11

            2.5.2.6.3—Optional Criteria for Span-to-Depth Ratios ..... 2-13

        2.5.2.7—Consideration of Future Widening ..... 2-14

            2.5.2.7.1—Exterior Beams on Multibeam Bridges ..... 2-14

2.5.2.7.2—Substructure .....	2-14
2.5.3—Constructibility .....	2-14
2.5.4—Economy .....	2-15
2.5.4.1—General .....	2-15
2.5.4.2—Alternative Plans .....	2-15
2.5.5—Bridge Aesthetics .....	2-16
2.6—HYDROLOGY AND HYDRAULICS .....	2-17
2.6.1—General .....	2-17
2.6.2—Site Data .....	2-18
2.6.3—Hydrologic Analysis .....	2-18
2.6.4—Hydraulic Analysis .....	2-19
2.6.4.1—General .....	2-19
2.6.4.2—Stream Stability .....	2-19
2.6.4.3—Bridge Waterway .....	2-20
2.6.4.4—Bridge Foundations .....	2-20
2.6.4.4.1—General .....	2-20
2.6.4.4.2—Bridge Scour .....	2-21
2.6.4.5—Roadway Approaches to Bridge .....	2-23
2.6.5—Culvert Location, Length, and Waterway Area .....	2-23
2.6.6—Roadway Drainage .....	2-24
2.6.6.1—General .....	2-24
2.6.6.2—Design Storm .....	2-24
2.6.6.3—Type, Size, and Number of Drains .....	2-24
2.6.6.4—Discharge from Deck Drains .....	2-25
2.6.6.5—Drainage of Structures .....	2-25
2.7—BRIDGE SECURITY .....	2-25
2.7.1—General .....	2-25
2.7.2—Design Demand .....	2-26
2.8—REFERENCES .....	2-26

SECTION 3: LOADS AND LOAD FACTORS

TABLE OF CONTENTS

3.1—SCOPE ..... 3-1

3.2—DEFINITIONS ..... 3-1

3.3—NOTATION ..... 3-3

    3.3.1—General ..... 3-3

    3.3.2—Load and Load Designation ..... 3-7

3.4—LOAD FACTORS AND COMBINATIONS ..... 3-8

    3.4.1—Load Factors and Load Combinations ..... 3-8

    3.4.2—Load Factors for Construction Loads ..... 3-15

        3.4.2.1—Evaluation at the Strength Limit State ..... 3-15

        3.4.2.2—Evaluation of Deflection at the Service Limit State ..... 3-15

    3.4.3—Load Factors for Jacking and Post-Tensioning Forces ..... 3-16

        3.4.3.1—Jacking Forces ..... 3-16

        3.4.3.2—Force for Post-Tensioning Anchorage Zones ..... 3-16

    3.4.4—Load Factors for Orthotropic Decks ..... 3-16

3.5—PERMANENT LOADS ..... 3-16

    3.5.1—Dead Loads: *DC*, *DW*, and *EV* ..... 3-16

    3.5.2—Earth Loads: *EH*, *ES*, and *DD* ..... 3-17

3.6—LIVE LOADS ..... 3-17

    3.6.1—Gravity Loads: *LL* and *PL* ..... 3-17

        3.6.1.1—Vehicular Live Load ..... 3-17

            3.6.1.1.1—Number of Design Lanes ..... 3-17

            3.6.1.1.2—Multiple Presence of Live Load ..... 3-18

        3.6.1.2—Design Vehicular Live Load ..... 3-19

            3.6.1.2.1—General ..... 3-19

            3.6.1.2.2—Design Truck ..... 3-23

            3.6.1.2.3—Design Tandem ..... 3-24

            3.6.1.2.4—Design Lane Load ..... 3-24

            3.6.1.2.5—Tire Contact Area ..... 3-24

            3.6.1.2.6—Distribution of Wheel Loads through Earth Fills ..... 3-25

        3.6.1.3—Application of Design Vehicular Live Loads ..... 3-25

            3.6.1.3.1—General ..... 3-25

            3.6.1.3.2—Loading for Optional Live Load Deflection Evaluation ..... 3-26

            3.6.1.3.3—Design Loads for Decks, Deck Systems, and the Top Slabs of Box Culverts ..... 3-27

            3.6.1.3.4—Deck Overhang Load ..... 3-28

        3.6.1.4—Fatigue Load ..... 3-28

            3.6.1.4.1—Magnitude and Configuration ..... 3-28

            3.6.1.4.2—Frequency ..... 3-28

            3.6.1.4.3—Load Distribution for Fatigue ..... 3-29

                3.6.1.4.3a—Refined Methods ..... 3-29

                3.6.1.4.3b—Approximate Methods ..... 3-29

3.6.1.5—Rail Transit Load .....	3-30
3.6.1.6—Pedestrian Loads .....	3-30
3.6.1.7—Loads on Railings.....	3-30
3.6.2—Dynamic Load Allowance: <i>IM</i> .....	3-30
3.6.2.1—General.....	3-30
3.6.2.2—Buried Components.....	3-31
3.6.2.3—Wood Components.....	3-32
3.6.3—Centrifugal Forces: <i>CE</i> .....	3-32
3.6.4—Braking Force: <i>BR</i> .....	3-32
3.6.5—Vehicular Collision Force: <i>CT</i> .....	3-35
3.6.5.1—Protection of Structures.....	3-35
3.6.5.2—Vehicle Collision with Barriers.....	3-36
3.7—WATER LOADS: <i>WA</i> .....	3-37
3.7.1—Static Pressure .....	3-37
3.7.2—Buoyancy .....	3-37
3.7.3—Stream Pressure .....	3-37
3.7.3.1—Longitudinal .....	3-37
3.7.3.2—Lateral .....	3-38
3.7.4—Wave Load .....	3-39
3.7.5—Change in Foundations Due to Limit State for Scour.....	3-39
3.8—WIND LOAD: <i>WL</i> AND <i>WS</i> .....	3-39
3.8.1—Horizontal Wind Pressure .....	3-39
3.8.1.1—General.....	3-39
3.8.1.2—Wind Pressure on Structures: <i>WS</i> .....	3-41
3.8.1.2.1—General.....	3-41
3.8.1.2.2—Loads from Superstructures .....	3-41
3.8.1.2.3—Forces Applied Directly to the Substructure .....	3-42
3.8.1.3—Wind Pressure on Vehicles: <i>WL</i> .....	3-42
3.8.2—Vertical Wind Pressure.....	3-43
3.8.3—Aeroelastic Instability .....	3-43
3.8.3.1—General.....	3-43
3.8.3.2—Aeroelastic Phenomena .....	3-44
3.8.3.3—Control of Dynamic Responses.....	3-44
3.8.3.4—Wind Tunnel Tests.....	3-44
3.9—ICE LOADS: <i>IC</i> .....	3-44
3.9.1—General .....	3-44
3.9.2—Dynamic Ice Forces on Piers.....	3-46
3.9.2.1—Effective Ice Strength.....	3-46
3.9.2.2—Crushing and Flexing .....	3-47
3.9.2.3—Small Streams.....	3-48
3.9.2.4—Combination of Longitudinal and Transverse Forces .....	3-49
3.9.2.4.1—Piers Parallel to Flow .....	3-49
3.9.2.4.2—Piers Skewed to Flow.....	3-49



3.9.2.5—Slender and Flexible Piers .....	3-50
3.9.3—Static Ice Loads on Piers .....	3-50
3.9.4—Hanging Dams and Ice Jams .....	3-50
3.9.5—Vertical Forces Due to Ice Adhesion .....	3-50
3.9.6—Ice Accretion and Snow Loads on Superstructures .....	3-51
3.10—EARTHQUAKE EFFECTS: <i>EQ</i> .....	3-52
3.10.1—General .....	3-52
3.10.2—Seismic Hazard .....	3-54
3.10.2.1—General Procedure .....	3-54
3.10.2.2—Site Specific Procedure .....	3-83
3.10.3—Site Effects .....	3-84
3.10.3.1—Site Class Definitions .....	3-84
3.10.3.2—Site Factors .....	3-88
3.10.4—Seismic Hazard Characterization .....	3-89
3.10.4.1—Design Response Spectrum .....	3-89
3.10.4.2—Elastic Seismic Response Coefficient .....	3-90
3.10.5—Operational Classification .....	3-90
3.10.6—Seismic Performance Zones .....	3-91
3.10.7—Response Modification Factors .....	3-91
3.10.7.1—General .....	3-91
3.10.7.2—Application .....	3-92
3.10.8—Combination of Seismic Force Effects .....	3-92
3.10.9—Calculation of Design Forces .....	3-93
3.10.9.1—General .....	3-93
3.10.9.2—Seismic Zone 1 .....	3-93
3.10.9.3—Seismic Zone 2 .....	3-93
3.10.9.4—Seismic Zones 3 and 4 .....	3-94
3.10.9.4.1—General .....	3-94
3.10.9.4.2—Modified Design Forces .....	3-94
3.10.9.4.3—Inelastic Hinging Forces .....	3-94
3.10.9.4.3a—General .....	3-94
3.10.9.4.3b—Single Columns and Piers .....	3-95
3.10.9.4.3c—Piers with Two or More Columns .....	3-96
3.10.9.4.3d—Column and Pile Bent Design Forces .....	3-97
3.10.9.4.3e—Pier Design Forces .....	3-97
3.10.9.4.3f—Foundation Design Forces .....	3-97
3.10.9.5—Longitudinal Restrainers .....	3-98
3.10.9.6—Hold-Down Devices .....	3-98
3.10.10—Requirements for Temporary Bridges and Stage Construction .....	3-98
3.11—EARTH PRESSURE: <i>EH, ES, LS, AND DD</i> .....	3-99
3.11.1—General .....	3-99
3.11.2—Compaction .....	3-100
3.11.3—Presence of Water .....	3-100
3.11.4—Effect of Earthquake .....	3-101

3.11.5—Earth Pressure: <i>EH</i> .....	3-101
3.11.5.1—Lateral Earth Pressure .....	3-101
3.11.5.2—At-Rest Lateral Earth Pressure Coefficient, $k_o$ .....	3-102
3.11.5.3—Active Lateral Earth Pressure Coefficient, $k_a$ .....	3-103
3.11.5.4—Passive Lateral Earth Pressure Coefficient, $k_p$ .....	3-105
3.11.5.5—Equivalent-Fluid Method of Estimating Rankine Lateral Earth Pressures .....	3-107
3.11.5.6—Lateral Earth Pressures for Nongravity Cantilevered Walls .....	3-109
3.11.5.7—Apparent Earth Pressure ( <i>AEP</i> ) for Anchored Walls .....	3-113
3.11.5.7.1—Cohesionless Soils .....	3-113
3.11.5.7.2—Cohesive Soils .....	3-114
3.11.5.7.2a—Stiff to Hard .....	3-115
3.11.5.7.2b—Soft to Medium Stiff .....	3-115
3.11.5.8—Lateral Earth Pressures for Mechanically Stabilized Earth Walls .....	3-116
3.11.5.8.1—General .....	3-116
3.11.5.8.2—Internal Stability .....	3-118
3.11.5.9—Lateral Earth Pressures for Prefabricated Modular Walls .....	3-118
3.11.6—Surcharge Loads: <i>ES</i> and <i>LS</i> .....	3-123
3.11.6.1—Uniform Surcharge Loads ( <i>ES</i> ) .....	3-123
3.11.6.2—Point, Line, and Strip Loads ( <i>ES</i> ): Walls Restrained from Movement .....	3-124
3.11.6.3—Strip Loads ( <i>ES</i> ): Flexible Walls .....	3-127
3.11.6.4—Live Load Surcharge ( <i>LS</i> ) .....	3-129
3.11.6.5—Reduction of Surcharge .....	3-130
3.11.7—Reduction Due to Earth Pressure .....	3-131
3.11.8—Downdrag .....	3-131
3.12—FORCE EFFECTS DUE TO SUPERIMPOSED DEFORMATIONS: <i>TU</i> , <i>TG</i> , <i>SH</i> , <i>CR</i> , <i>SE</i> , <i>PS</i> .....	3-133
3.12.1—General .....	3-133
3.12.2—Uniform Temperature .....	3-133
3.12.2.1—Temperature Range for Procedure A .....	3-133
3.12.2.2—Temperature Range for Procedure B .....	3-134
3.12.2.3—Design Thermal Movements .....	3-136
3.12.3—Temperature Gradient .....	3-136
3.12.4—Differential Shrinkage .....	3-137
3.12.5—Creep .....	3-137
3.12.6—Settlement .....	3-138
3.12.7—Secondary Forces from Post-Tensioning, <i>PS</i> .....	3-138
3.13—FRICTION FORCES: <i>FR</i> .....	3-138
3.14—VESSEL COLLISION: <i>CV</i> .....	3-138
3.14.1—General .....	3-138
3.14.2—Owner’s Responsibility .....	3-140
3.14.3—Operational Classification .....	3-140
3.14.4—Design Vessel .....	3-140
3.14.5—Annual Frequency of Collapse .....	3-141
3.14.5.1—Vessel Frequency Distribution .....	3-142

3.14.5.2—Probability of Aberrancy.....	3-143
3.14.5.2.1—General .....	3-143
3.14.5.2.2—Statistical Method .....	3-143
3.14.5.2.3—Approximate Method.....	3-143
3.14.5.3—Geometric Probability.....	3-146
3.14.5.4—Probability of Collapse .....	3-147
3.14.5.5 Protection Factor.....	3-147
3.14.6—Design Collision Velocity.....	3-150
3.14.7—Vessel Collision Energy.....	3-150
3.14.8—Ship Collision Force on Pier .....	3-151
3.14.9—Ship Bow Damage Length .....	3-153
3.14.10—Ship Collision Force on Superstructure.....	3-153
3.14.10.1—Collision with Bow .....	3-153
3.14.10.2—Collision with Deck House .....	3-153
3.14.10.3—Collision with Mast.....	3-154
3.14.11—Barge Collision Force on Pier.....	3-154
3.14.12—Barge Bow Damage Length.....	3-155
3.14.13—Damage at the Extreme Limit State .....	3-155
3.14.14—Application of Impact Force .....	3-156
3.14.14.1—Substructure Design.....	3-156
3.14.14.2—Superstructure Design.....	3-157
3.14.15—Protection of Substructures .....	3-157
3.14.16—Security Considerations .....	3-158
3.15—BLAST LOADING .....	3-159
3.15.1—Introduction.....	3-159
3.16—REFERENCES.....	3-159
APPENDIX A3—SEISMIC DESIGN FLOWCHARTS.....	3-167
APPENDIX B3—OVERSTRENGTH RESISTANCE .....	3-169

## SECTION 4: STRUCTURAL ANALYSIS AND EVALUATION

### TABLE OF CONTENTS

4.1—SCOPE.....	4-1
4.2—DEFINITIONS.....	4-2
4.3—NOTATION.....	4-6
4.4—ACCEPTABLE METHODS OF STRUCTURAL ANALYSIS.....	4-9
4.5—MATHEMATICAL MODELING.....	4-10
4.5.1—General.....	4-10
4.5.2—Structural Material Behavior.....	4-11
4.5.2.1—Elastic Versus Inelastic Behavior.....	4-11
4.5.2.2—Elastic Behavior.....	4-11
4.5.2.3—Inelastic Behavior.....	4-11
4.5.3—Geometry.....	4-12
4.5.3.1—Small Deflection Theory.....	4-12
4.5.3.2—Large Deflection Theory.....	4-12
4.5.3.2.1—General.....	4-12
4.5.3.2.2—Approximate Methods.....	4-13
4.5.3.2.2a—General.....	4-13
4.5.3.2.2b—Moment Magnification—Beam Columns.....	4-14
4.5.3.2.2c—Moment Magnification—Arches.....	4-15
4.5.3.2.3—Refined Methods.....	4-16
4.5.4—Modeling Boundary Conditions.....	4-16
4.5.5—Equivalent Members.....	4-16
4.6—STATIC ANALYSIS.....	4-17
4.6.1—Influence of Plan Geometry.....	4-17
4.6.1.1—Plan Aspect Ratio.....	4-17
4.6.1.2—Structures Curved in Plan.....	4-17
4.6.1.2.1—General.....	4-17
4.6.1.2.2—Single-Girder Torsionally Stiff Superstructures.....	4-18
4.6.1.2.3—Concrete Box Girder Bridges.....	4-18
4.6.1.2.4—Steel Multiple-Beam Superstructures.....	4-20
4.6.1.2.4a—General.....	4-20
4.6.1.2.4b—I-Girders.....	4-20
4.6.1.2.4c—Closed Box and Tub Girders.....	4-21
4.6.2—Approximate Methods of Analysis.....	4-22
4.6.2.1—Decks.....	4-22
4.6.2.1.1—General.....	4-22
4.6.2.1.2—Applicability.....	4-22
4.6.2.1.3—Width of Equivalent Interior Strips.....	4-23
4.6.2.1.4—Width of Equivalent Strips at Edges of Slabs.....	4-25
4.6.2.1.4a—General.....	4-25
4.6.2.1.4b—Longitudinal Edges.....	4-25
4.6.2.1.4c—Transverse Edges.....	4-25

4.6.2.1.5—Distribution of Wheel Loads.....	4-26
4.6.2.1.6—Calculation of Force Effects .....	4-26
4.6.2.1.7—Cross-Sectional Frame Action .....	4-27
4.6.2.1.8—Live Load Force Effects for Fully and Partially Filled Grids and for Unfilled Grid Decks Composite with Reinforced Concrete Slabs .....	4-27
4.6.2.1.9—Inelastic Analysis .....	4-29
4.6.2.2—Beam-Slab Bridges .....	4-29
4.6.2.2.1—Application .....	4-29
4.6.2.2.2—Distribution Factor Method for Moment and Shear.....	4-35
4.6.2.2.2a—Interior Beams with Wood Decks .....	4-35
4.6.2.2.2b—Interior Beams with Concrete Decks .....	4-35
4.6.2.2.2c—Interior Beams with Corrugated Steel Decks .....	4-38
4.6.2.2.2d—Exterior Beams .....	4-39
4.6.2.2.2e—Skewed Bridges .....	4-40
4.6.2.2.2f—Flexural Moments and Shear in Transverse Floorbeams.....	4-41
4.6.2.2.3—Distribution Factor Method for Shear .....	4-42
4.6.2.2.3a—Interior Beams.....	4-42
4.6.2.2.3b—Exterior Beams .....	4-44
4.6.2.2.3c—Skewed Bridges .....	4-46
4.6.2.2.4—Curved Steel Bridges .....	4-46
4.6.2.2.5—Special Loads with Other Traffic.....	4-47
4.6.2.3—Equivalent Strip Widths for Slab-Type Bridges.....	4-48
4.6.2.4—Truss and Arch Bridges.....	4-49
4.6.2.5—Effective Length Factor, $K$ .....	4-49
4.6.2.6—Effective Flange Width .....	4-54
4.6.2.6.1—General.....	4-54
4.6.2.6.2—Segmental Concrete Box Beams and Single-Cell, Cast-in-Place Box Beams .....	4-55
4.6.2.6.3—Cast-in-Place Multicell Superstructures.....	4-59
4.6.2.6.4—Orthotropic Steel Decks.....	4-59
4.6.2.6.5—Transverse Floorbeams and Integral Bent Caps.....	4-61
4.6.2.7—Lateral Wind Load Distribution in Multibeam Bridges .....	4-62
4.6.2.7.1—I-Sections .....	4-62
4.6.2.7.2—Box Sections .....	4-63
4.6.2.7.3—Construction.....	4-63
4.6.2.8—Seismic Lateral Load Distribution .....	4-63
4.6.2.8.1—Applicability .....	4-63
4.6.2.8.2—Design Criteria.....	4-64
4.6.2.8.3—Load Distribution.....	4-64
4.6.2.9—Analysis of Segmental Concrete Bridges.....	4-65
4.6.2.9.1—General.....	4-65
4.6.2.9.2—Strut-and-Tie Models .....	4-65
4.6.2.9.3—Effective Flange Width.....	4-65
4.6.2.9.4—Transverse Analysis.....	4-66
4.6.2.9.5—Longitudinal Analysis.....	4-66
4.6.2.9.5a—General.....	4-66
4.6.2.9.5b—Erection Analysis.....	4-66

4.6.2.9.5c—Analysis of the Final Structural System.....	4-66
4.6.2.10—Equivalent Strip Widths for Box Culverts.....	4-67
4.6.2.10.1—General.....	4-67
4.6.2.10.2—Case 1: Traffic Travels Parallel to Span.....	4-67
4.6.2.10.3—Case 2: Traffic Travels Perpendicular to Span.....	4-67
4.6.2.10.4—Precast Box Culverts.....	4-68
4.6.3—Refined Methods of Analysis.....	4-68
4.6.3.1—General.....	4-68
4.6.3.2—Decks.....	4-69
4.6.3.2.1—General.....	4-69
4.6.3.2.2—Isotropic Plate Model.....	4-69
4.6.3.2.3—Orthotropic Plate Model.....	4-70
4.6.3.2.4—Refined Orthotropic Deck Model.....	4-70
4.6.3.3—Beam-Slab Bridges.....	4-70
4.6.3.3.1—General.....	4-70
4.6.3.3.2—Curved Steel Bridges.....	4-71
4.6.3.4—Cellular and Box Bridges.....	4-72
4.6.3.5—Truss Bridges.....	4-72
4.6.3.6—Arch Bridges.....	4-73
4.6.3.7—Cable-Stayed Bridges.....	4-73
4.6.3.8—Suspension Bridges.....	4-74
4.6.4—Redistribution of Negative Moments in Continuous Beam Bridges.....	4-74
4.6.4.1—General.....	4-74
4.6.4.2—Refined Method.....	4-75
4.6.4.3—Approximate Procedure.....	4-75
4.6.5—Stability.....	4-75
4.6.6—Analysis for Temperature Gradient.....	4-75
4.7—DYNAMIC ANALYSIS.....	4-77
4.7.1—Basic Requirements of Structural Dynamics.....	4-77
4.7.1.1—General.....	4-77
4.7.1.2—Distribution of Masses.....	4-77
4.7.1.3—Stiffness.....	4-78
4.7.1.4—Damping.....	4-78
4.7.1.5—Natural Frequencies.....	4-78
4.7.2—Elastic Dynamic Responses.....	4-79
4.7.2.1—Vehicle-Induced Vibration.....	4-79
4.7.2.2—Wind-Induced Vibration.....	4-79
4.7.2.2.1—Wind Velocities.....	4-79
4.7.2.2.2—Dynamic Effects.....	4-79
4.7.2.2.3—Design Considerations.....	4-79
4.7.3—Inelastic Dynamic Responses.....	4-80
4.7.3.1—General.....	4-80
4.7.3.2—Plastic Hinges and Yield Lines.....	4-80
4.7.4—Analysis for Earthquake Loads.....	4-80
4.7.4.1—General.....	4-80

4.7.4.2—Single-Span Bridges.....	4-80
4.7.4.3—Multispan Bridges.....	4-81
4.7.4.3.1—Selection of Method.....	4-81
4.7.4.3.2—Single-Mode Methods of Analysis.....	4-82
4.7.4.3.2a—General.....	4-82
4.7.4.3.2b—Single-Mode Spectral Method.....	4-82
4.7.4.3.2c—Uniform Load Method.....	4-83
4.7.4.3.3—Multimode Spectral Method.....	4-85
4.7.4.3.4—Time-History Method.....	4-85
4.7.4.3.4a—General.....	4-85
4.7.4.3.4b—Acceleration Time Histories.....	4-85
4.7.4.4—Minimum Support Length Requirements.....	4-88
4.7.4.5 $P$ - $\Delta$ Requirements.....	4-89
4.7.5—Analysis for Collision Loads.....	4-90
4.7.6—Analysis of Blast Effects.....	4-90
4.8—ANALYSIS BY PHYSICAL MODELS.....	4-90
4.8.1—Scale Model Testing.....	4-90
4.8.2—Bridge Testing.....	4-90
4.9—REFERENCES.....	4-91
APPENDIX A4—DECK SLAB DESIGN TABLE.....	4-97

## SECTION 5: CONCRETE STRUCTURES

### TABLE OF CONTENTS

5.1—SCOPE.....	5-1
5.2—DEFINITIONS.....	5-1
5.3—NOTATION.....	5-5
5.4—MATERIAL PROPERTIES .....	5-12
5.4.1—General.....	5-12
5.4.2—Normal Weight and Structural Lightweight Concrete .....	5-13
5.4.2.1—Compressive Strength.....	5-13
5.4.2.2—Coefficient of Thermal Expansion.....	5-15
5.4.2.3—Shrinkage and Creep.....	5-15
5.4.2.3.1—General .....	5-15
5.4.2.3.2—Creep .....	5-15
5.4.2.3.3—Shrinkage.....	5-17
5.4.2.4—Modulus of Elasticity.....	5-18
5.4.2.5—Poisson’s Ratio .....	5-18
5.4.2.6—Modulus of Rupture.....	5-18
5.4.2.7—Tensile Strength.....	5-19
5.4.3—Reinforcing Steel .....	5-19
5.4.3.1—General .....	5-19
5.4.3.2—Modulus of Elasticity.....	5-20
5.4.3.3—Special Applications .....	5-20
5.4.4—Prestressing Steel .....	5-20
5.4.4.1—General .....	5-20
5.4.4.2—Modulus of Elasticity.....	5-21
5.4.5—Post-Tensioning Anchorages and Couplers .....	5-21
5.4.6—Ducts.....	5-22
5.4.6.1—General .....	5-22
5.4.6.2—Size of Ducts.....	5-22
5.4.6.3—Ducts at Deviation Saddles.....	5-23
5.5—LIMIT STATES.....	5-23
5.5.1—General.....	5-23
5.5.2—Service Limit State.....	5-23
5.5.3—Fatigue Limit State.....	5-23
5.5.3.1—General .....	5-23
5.5.3.2—Reinforcing Bars.....	5-24
5.5.3.3—Prestressing Tendons .....	5-25
5.5.3.4—Welded or Mechanical Splices of Reinforcement.....	5-25
5.5.4—Strength Limit State .....	5-26
5.5.4.1—General .....	5-26
5.5.4.2—Resistance Factors .....	5-26
5.5.4.2.1—Conventional Construction .....	5-26
5.5.4.2.2—Segmental Construction.....	5-28



5.5.4.2.3—Special Requirements for Seismic Zones 2, 3, and 4 .....	5-28
5.5.4.3—Stability .....	5-29
5.5.5—Extreme Event Limit State .....	5-29
5.6—DESIGN CONSIDERATIONS .....	5-29
5.6.1—General .....	5-29
5.6.2—Effects of Imposed Deformation .....	5-29
5.6.3—Strut-and-Tie Model .....	5-29
5.6.3.1—General .....	5-29
5.6.3.2—Structural Modeling .....	5-30
5.6.3.3—Proportioning of Compressive Struts .....	5-31
5.6.3.3.1—Strength of Unreinforced Strut .....	5-31
5.6.3.3.2—Effective Cross-Sectional Area of Strut .....	5-32
5.6.3.3.3—Limiting Compressive Stress in Strut .....	5-33
5.6.3.3.4—Reinforced Strut .....	5-33
5.6.3.4—Proportioning of Tension Ties .....	5-33
5.6.3.4.1—Strength of Tie .....	5-33
5.6.3.4.2—Anchorage of Tie .....	5-34
5.6.3.5—Proportioning of Node Regions .....	5-34
5.6.3.6—Crack Control Reinforcement .....	5-34
5.7—DESIGN FOR FLEXURAL AND AXIAL FORCE EFFECTS .....	5-35
5.7.1—Assumptions for Service and Fatigue Limit States .....	5-35
5.7.2—Assumptions for Strength and Extreme Event Limit States .....	5-36
5.7.2.1—General .....	5-36
5.7.2.2—Rectangular Stress Distribution .....	5-38
5.7.3—Flexural Members .....	5-39
5.7.3.1—Stress in Prestressing Steel at Nominal Flexural Resistance .....	5-39
5.7.3.1.1—Components with Bonded Tendons .....	5-39
5.7.3.1.2—Components with Unbonded Tendons .....	5-40
5.7.3.1.3—Components with Both Bonded and Unbonded Tendons .....	5-40
5.7.3.1.3a—Detailed Analysis .....	5-40
5.7.3.1.3b—Simplified Analysis .....	5-41
5.7.3.2—Flexural Resistance .....	5-41
5.7.3.2.1—Factored Flexural Resistance .....	5-41
5.7.3.2.2—Flanged Sections .....	5-41
5.7.3.2.3—Rectangular Sections .....	5-42
5.7.3.2.4—Other Cross-Sections .....	5-43
5.7.3.2.5—Strain Compatibility Approach .....	5-43
5.7.3.3—Limits for Reinforcement .....	5-43
5.7.3.3.1—Maximum Reinforcement .....	5-43
5.7.3.3.2—Minimum Reinforcement .....	5-43
5.7.3.4—Control of Cracking by Distribution of Reinforcement .....	5-45
5.7.3.5—Moment Redistribution .....	5-47
5.7.3.6—Deformations .....	5-47
5.7.3.6.1—General .....	5-47
5.7.3.6.2—Deflection and Camber .....	5-47

5.7.3.6.3—Axial Deformation .....	5-48
5.7.4—Compression Members .....	5-48
5.7.4.1—General .....	5-48
5.7.4.2—Limits for Reinforcement.....	5-49
5.7.4.3—Approximate Evaluation of Slenderness Effects .....	5-50
5.7.4.4—Factored Axial Resistance .....	5-51
5.7.4.5—Biaxial Flexure .....	5-52
5.7.4.6—Spirals and Ties .....	5-53
5.7.4.7—Hollow Rectangular Compression Members .....	5-53
5.7.4.7.1—Wall Slenderness Ratio.....	5-53
5.7.4.7.2—Limitations on the Use of the Rectangular Stress Block Method .....	5-54
5.7.4.7.2a—General .....	5-54
5.7.4.7.2b—Refined Method for Adjusting Maximum Usable Strain Limit.....	5-54
5.7.4.7.2c—Approximate Method for Adjusting Factored Resistance.....	5-55
5.7.5—Bearing.....	5-55
5.7.6—Tension Members .....	5-56
5.7.6.1—Factored Tension Resistance .....	5-56
5.7.6.2—Resistance to Combinations of Tension and Flexure.....	5-56
5.8—SHEAR AND TORSION.....	5-56
5.8.1—Design Procedures .....	5-56
5.8.1.1—Flexural Regions.....	5-56
5.8.1.2—Regions Near Discontinuities .....	5-57
5.8.1.3—Interface Regions.....	5-57
5.8.1.4—Slabs and Footings.....	5-57
5.8.1.5—Webs of Curved Post-Tensioned Box Girder Bridges .....	5-57
5.8.2—General Requirements.....	5-57
5.8.2.1—General .....	5-57
5.8.2.2—Modifications for Lightweight Concrete .....	5-59
5.8.2.3—Transfer and Development Lengths.....	5-60
5.8.2.4—Regions Requiring Transverse Reinforcement .....	5-60
5.8.2.5—Minimum Transverse Reinforcement .....	5-60
5.8.2.6—Types of Transverse Reinforcement .....	5-61
5.8.2.7—Maximum Spacing of Transverse Reinforcement .....	5-62
5.8.2.8—Design and Detailing Requirements .....	5-62
5.8.2.9—Shear Stress on Concrete .....	5-63
5.8.3—Sectional Design Model.....	5-64
5.8.3.1—General .....	5-64
5.8.3.2—Sections Near Supports.....	5-65
5.8.3.3—Nominal Shear Resistance .....	5-67
5.8.3.4—Procedures for Determining Shear Resistance.....	5-68
5.8.3.4.1—Simplified Procedure for Nonprestressed Sections.....	5-69
5.8.3.4.2—General Procedure .....	5-69
5.8.3.4.3—Simplified Procedure for Prestressed and Nonprestressed Sections.....	5-73
5.8.3.5—Longitudinal Reinforcement.....	5-75
5.8.3.6—Sections Subjected to Combined Shear and Torsion .....	5-77

5.8.3.6.1—Transverse Reinforcement .....	5-77
5.8.3.6.2—Torsional Resistance .....	5-77
5.8.3.6.3—Longitudinal Reinforcement .....	5-77
5.8.4—Interface Shear Transfer—Shear Friction .....	5-78
5.8.4.1—General .....	5-78
5.8.4.2—Computation of the Factored Interface Shear Force, $V_{ui}$ , for Girder/Slab Bridges .....	5-80
5.8.4.3—Cohesion and Friction Factors .....	5-82
5.8.4.4—Minimum Area of Interface Shear Reinforcement .....	5-83
5.8.5—Principal Stresses in Webs of Segmental Concrete Bridges .....	5-84
5.8.6—Shear and Torsion for Segmental Box Girder Bridges .....	5-85
5.8.6.1—General .....	5-85
5.8.6.2—Loading .....	5-85
5.8.6.3—Regions Requiring Consideration of Torsional Effects .....	5-86
5.8.6.4—Torsional Reinforcement .....	5-87
5.8.6.5—Nominal Shear Resistance .....	5-88
5.8.6.6—Reinforcement Details .....	5-89
5.9—PRESTRESSING .....	5-90
5.9.1—General Design Considerations .....	5-90
5.9.1.1—General .....	5-90
5.9.1.2—Specified Concrete Strengths .....	5-91
5.9.1.3—Buckling .....	5-91
5.9.1.4—Section Properties .....	5-91
5.9.1.5—Crack Control .....	5-91
5.9.1.6—Tendons with Angle Points or Curves .....	5-91
5.9.2—Stresses Due to Imposed Deformation .....	5-92
5.9.3—Stress Limitations for Prestressing Tendons .....	5-92
5.9.4—Stress Limits for Concrete .....	5-93
5.9.4.1—For Temporary Stresses before Losses—Fully Prestressed Components .....	5-93
5.9.4.1.1—Compression Stresses .....	5-93
5.9.4.1.2—Tension Stresses .....	5-93
5.9.4.2—For Stresses at Service Limit State after Losses—Fully Prestressed Components .....	5-95
5.9.4.2.1—Compression Stresses .....	5-95
5.9.4.2.2—Tension Stresses .....	5-97
5.9.5—Loss of Prestress .....	5-98
5.9.5.1—Total Loss of Prestress .....	5-98
5.9.5.2—Instantaneous Losses .....	5-98
5.9.5.2.1—Anchorage Set .....	5-98
5.9.5.2.2—Friction .....	5-99
5.9.5.2.2a—Pretensioned Construction .....	5-99
5.9.5.2.2b—Post-Tensioned Construction .....	5-99
5.9.5.2.3—Elastic Shortening .....	5-101
5.9.5.2.3a—Pretensioned Members .....	5-101
5.9.5.2.3b—Post-Tensioned Members .....	5-102
5.9.5.2.3c—Combined Pretensioning and Post-Tensioning .....	5-103
5.9.5.3—Approximate Estimate of Time-Dependent Losses .....	5-103

5.9.5.4—Refined Estimates of Time-Dependent Losses .....	5-104
5.9.5.4.1—General .....	5-104
5.9.5.4.2—Losses: Time of Transfer to Time of Deck Placement .....	5-105
5.9.5.4.2a—Shrinkage of Girder Concrete .....	5-105
5.9.5.4.2b—Creep of Girder Concrete .....	5-106
5.9.5.4.2c—Relaxation of Prestressing Strands .....	5-106
5.9.5.4.3—Losses: Time of Deck Placement to Final Time .....	5-107
5.9.5.4.3a—Shrinkage of Girder Concrete .....	5-107
5.9.5.4.3b—Creep of Girder Concrete .....	5-108
5.9.5.4.3c—Relaxation of Prestressing Strands .....	5-108
5.9.5.4.3d—Shrinkage of Deck Concrete .....	5-108
5.9.5.4.4—Precast Pretensioned Girders without Composite Topping .....	5-109
5.9.5.4.5—Post-Tensioned Nonsegmental Girders .....	5-109
5.9.5.5—Losses for Deflection Calculations .....	5-109
5.10—DETAILS OF REINFORCEMENT .....	5-110
5.10.1—Concrete Cover .....	5-110
5.10.2—Hooks and Bends .....	5-110
5.10.2.1—Standard Hooks .....	5-110
5.10.2.2—Seismic Hooks .....	5-110
5.10.2.3—Minimum Bend Diameters .....	5-110
5.10.3—Spacing of Reinforcement .....	5-111
5.10.3.1 Minimum Spacing of Reinforcing Bars .....	5-111
5.10.3.1.1—Cast-in-Place Concrete .....	5-111
5.10.3.1.2—Precast Concrete .....	5-111
5.10.3.1.3—Multilayers .....	5-111
5.10.3.1.4—Splices .....	5-112
5.10.3.1.5—Bundled Bars .....	5-112
5.10.3.2—Maximum Spacing of Reinforcing Bars .....	5-112
5.10.3.3—Minimum Spacing of Prestressing Tendons and Ducts .....	5-112
5.10.3.3.1—Pretensioning Strand .....	5-112
5.10.3.3.2—Post-Tensioning Ducts—Girders Straight in Plan .....	5-113
5.10.3.3.3—Post-Tensioning Ducts—Girders Curved in Plan .....	5-113
5.10.3.4—Maximum Spacing of Prestressing Tendons and Ducts in Slabs .....	5-113
5.10.3.5—Couplers in Post-Tensioning Tendons .....	5-114
5.10.4—Tendon Confinement .....	5-114
5.10.4.1—General .....	5-114
5.10.4.2—Wobble Effect in Slabs .....	5-114
5.10.4.3—Effects of Curved Tendons .....	5-114
5.10.4.3.1—Design for In-Plane Force Effects .....	5-115
5.10.4.3.1a—In-Plane Force Effects .....	5-115
5.10.4.3.1b— Shear Resistance to Pull-out .....	5-116
5.10.4.3.1c— Cracking of Cover Concrete .....	5-117
5.10.4.3.1d—Regional Bending .....	5-118
5.10.4.3.2—Out-of-Plane Force Effects .....	5-118
5.10.5—External Tendon Supports .....	5-119

5.10.6—Transverse Reinforcement for Compression Members .....	5-119
5.10.6.1—General .....	5-119
5.10.6.2—Spirals .....	5-119
5.10.6.3—Ties .....	5-120
5.10.7—Transverse Reinforcement for Flexural Members .....	5-121
5.10.8—Shrinkage and Temperature Reinforcement .....	5-121
5.10.9—Post-Tensioned Anchorage Zones .....	5-122
5.10.9.1—General .....	5-122
5.10.9.2—General Zone and Local Zone .....	5-123
5.10.9.2.1—General .....	5-123
5.10.9.2.2—General Zone .....	5-124
5.10.9.2.3—Local Zone .....	5-124
5.10.9.2.4—Responsibilities .....	5-125
5.10.9.3—Design of the General Zone .....	5-125
5.10.9.3.1—Design Methods .....	5-125
5.10.9.3.2—Design Principles .....	5-126
5.10.9.3.3—Special Anchorage Devices .....	5-129
5.10.9.3.4—Intermediate Anchorages .....	5-129
5.10.9.3.4a—General .....	5-129
5.10.9.3.4b—Tie-Backs .....	5-130
5.10.9.3.4c—Blister and Rib Reinforcement .....	5-130
5.10.9.3.5—Diaphragms .....	5-131
5.10.9.3.6—Multiple Slab Anchorages .....	5-131
5.10.9.3.7—Deviation Saddles .....	5-132
5.10.9.4—Application of the Strut-and-Tie Model to the Design of General Zone .....	5-132
5.10.9.4.1—General .....	5-132
5.10.9.4.2—Nodes .....	5-134
5.10.9.4.3—Struts .....	5-136
5.10.9.4.4—Ties .....	5-136
5.10.9.5—Elastic Stress Analysis .....	5-136
5.10.9.6—Approximate Stress Analyses and Design .....	5-137
5.10.9.6.1—Limitations of Application .....	5-137
5.10.9.6.2—Compressive Stresses .....	5-138
5.10.9.6.3—Bursting Forces .....	5-140
5.10.9.6.4—Edge Tension Forces .....	5-141
5.10.9.7—Design of Local Zones .....	5-142
5.10.9.7.1—Dimensions of Local Zone .....	5-142
5.10.9.7.2—Bearing Resistance .....	5-143
5.10.9.7.3—Special Anchorage Devices .....	5-144
5.10.10—Pretensioned Anchorage Zones .....	5-144
5.10.10.1—Splitting Resistance .....	5-144
5.10.10.2—Confinement Reinforcement .....	5-146
5.10.11—Provisions for Seismic Design .....	5-147
5.10.11.1—General .....	5-147
5.10.11.2—Seismic Zone 1 .....	5-148
5.10.11.3—Seismic Zone 2 .....	5-148

5.10.11.4—Seismic Zones 3 and 4 .....	5-149
5.10.11.4.1—Column Requirements .....	5-149
5.10.11.4.1a—Longitudinal Reinforcement .....	5-149
5.10.11.4.1b—Flexural Resistance .....	5-149
5.10.11.4.1c—Column Shear and Transverse Reinforcement .....	5-150
5.10.11.4.1d—Transverse Reinforcement for Confinement at Plastic Hinges .....	5-151
5.10.11.4.1e—Spacing of Transverse Reinforcement for Confinement .....	5-153
5.10.11.4.1f—Splices .....	5-153
5.10.11.4.2—Requirements for Wall-Type Piers .....	5-154
5.10.11.4.3—Column Connections .....	5-155
5.10.11.4.4—Construction Joints in Piers and Columns .....	5-155
5.10.12—Reinforcement for Hollow Rectangular Compression Members .....	5-156
5.10.12.1—General .....	5-156
5.10.12.2—Spacing of Reinforcement .....	5-156
5.10.12.3—Ties .....	5-156
5.10.12.4—Splices .....	5-156
5.10.12.5—Hoops .....	5-157
5.11—DEVELOPMENT AND SPLICES OF REINFORCEMENT .....	5-157
5.11.1—General .....	5-157
5.11.1.1—Basic Requirements .....	5-157
5.11.1.2—Flexural Reinforcement .....	5-157
5.11.1.2.1—General .....	5-157
5.11.1.2.2—Positive Moment Reinforcement .....	5-158
5.11.1.2.3—Negative Moment Reinforcement .....	5-159
5.11.1.2.4—Moment Resisting Joints .....	5-159
5.11.2—Development of Reinforcement .....	5-160
5.11.2.1—Deformed Bars and Deformed Wire in Tension .....	5-160
5.11.2.1.1—Tension Development Length .....	5-160
5.11.2.1.2—Modification Factors which Increase $\ell_d$ .....	5-161
5.11.2.1.3—Modification Factors which Decrease $\ell_d$ .....	5-161
5.11.2.2—Deformed Bars in Compression .....	5-162
5.11.2.2.1—Compressive Development Length .....	5-162
5.11.2.2.2—Modification Factors .....	5-162
5.11.2.3—Bundled Bars .....	5-162
5.11.2.4—Standard Hooks in Tension .....	5-163
5.11.2.4.1—Basic Hook Development Length .....	5-163
5.11.2.4.2—Modification Factors .....	5-163
5.11.2.4.3—Hooked-Bar Tie Requirements .....	5-164
5.11.2.5—Welded Wire Fabric .....	5-164
5.11.2.5.1—Deformed Wire Fabric .....	5-164
5.11.2.5.2—Plain Wire Fabric .....	5-165
5.11.2.6—Shear Reinforcement .....	5-165
5.11.2.6.1—General .....	5-165
5.11.2.6.2—Anchorage of Deformed Reinforcement .....	5-166
5.11.2.6.3—Anchorage of Wire Fabric Reinforcement .....	5-166

5.11.2.6.4—Closed Stirrups.....	5-167
5.11.3—Development by Mechanical Anchorages.....	5-167
5.11.4—Development of Prestressing Strand.....	5-167
5.11.4.1—General.....	5-167
5.11.4.2—Bonded Strand.....	5-168
5.11.4.3—Partially Debonded Strands.....	5-169
5.11.5—Splices of Bar Reinforcement.....	5-170
5.11.5.1—Detailing.....	5-170
5.11.5.2—General Requirements.....	5-170
5.11.5.2.1—Lap Splices.....	5-170
5.11.5.2.2—Mechanical Connections.....	5-171
5.11.5.2.3—Welded Splices.....	5-171
5.11.5.3—Splices of Reinforcement in Tension.....	5-171
5.11.5.3.1—Lap Splices in Tension.....	5-171
5.11.5.3.2—Mechanical Connections or Welded Splices in Tension.....	5-172
5.11.5.4—Splices in Tension Tie Members.....	5-172
5.11.5.5—Splices of Bars in Compression.....	5-172
5.11.5.5.1—Lap Splices in Compression.....	5-172
5.11.5.5.2—Mechanical Connections or Welded Splices in Compression.....	5-173
5.11.5.5.3—End-Bearing Splices.....	5-173
5.11.6—Splices of Welded Wire Fabric.....	5-173
5.11.6.1—Splices of Welded Deformed Wire Fabric in Tension.....	5-173
5.11.6.2—Splices of Welded Smooth Wire Fabric in Tension.....	5-173
5.12—DURABILITY.....	5-174
5.12.1—General.....	5-174
5.12.2—Alkali-Silica Reactive Aggregates.....	5-175
5.12.3—Concrete Cover.....	5-175
5.12.4—Protective Coatings.....	5-176
5.12.5—Protection for Prestressing Tendons.....	5-176
5.13—SPECIFIC MEMBERS.....	5-177
5.13.1—Deck Slabs.....	5-177
5.13.2—Diaphragms, Deep Beams, Brackets, Corbels, and Beam Ledges.....	5-177
5.13.2.1—General.....	5-177
5.13.2.2—Diaphragms.....	5-177
5.13.2.3—Detailing Requirements for Deep Beams.....	5-178
5.13.2.4—Brackets and Corbels.....	5-179
5.13.2.4.1—General.....	5-179
5.13.2.4.2—Alternative to Strut-and-Tie Model.....	5-181
5.13.2.5—Beam Ledges.....	5-182
5.13.2.5.1—General.....	5-182
5.13.2.5.2—Design for Shear.....	5-183
5.13.2.5.3—Design for Flexure and Horizontal Force.....	5-184
5.13.2.5.4—Design for Punching Shear.....	5-184
5.13.2.5.5—Design of Hanger Reinforcement.....	5-185
5.13.2.5.6—Design for Bearing.....	5-186

5.13.3—Footings .....	5-187
5.13.3.1—General.....	5-187
5.13.3.2—Loads and Reactions.....	5-187
5.13.3.3—Resistance Factors .....	5-187
5.13.3.4—Moment in Footings.....	5-187
5.13.3.5—Distribution of Moment Reinforcement.....	5-188
5.13.3.6—Shear in Slabs and Footings.....	5-188
5.13.3.6.1—Critical Sections for Shear.....	5-188
5.13.3.6.2—One-Way Action.....	5-189
5.13.3.6.3—Two-Way Action.....	5-189
5.13.3.7—Development of Reinforcement.....	5-190
5.13.3.8—Transfer of Force at Base of Column.....	5-190
5.13.4—Concrete Piles .....	5-191
5.13.4.1—General.....	5-191
5.13.4.2—Splices.....	5-191
5.13.4.3—Precast Reinforced Piles .....	5-192
5.13.4.3.1—Pile Dimensions.....	5-192
5.13.4.3.2—Reinforcing Steel.....	5-192
5.13.4.4—Precast Prestressed Piles.....	5-192
5.13.4.4.1—Pile Dimensions.....	5-192
5.13.4.4.2—Concrete Quality.....	5-192
5.13.4.4.3—Reinforcement .....	5-193
5.13.4.5—Cast-in-Place Piles.....	5-193
5.13.4.5.1—Pile Dimensions.....	5-194
5.13.4.5.2—Reinforcing Steel.....	5-194
5.13.4.6—Seismic Requirements .....	5-194
5.13.4.6.1—Zone 1.....	5-194
5.13.4.6.2—Zone 2.....	5-194
5.13.4.6.2a—General.....	5-194
5.13.4.6.2b—Cast-in-Place Piles.....	5-195
5.13.4.6.2c—Precast Reinforced Piles.....	5-195
5.13.4.6.2d—Precast Prestressed Piles.....	5-195
5.13.4.6.3—Zones 3 and 4.....	5-195
5.13.4.6.3a—General.....	5-195
5.13.4.6.3b—Confinement Length.....	5-195
5.13.4.6.3c—Volumetric Ratio for Confinement.....	5-196
5.13.4.6.3d—Cast-in-Place Piles.....	5-196
5.13.4.6.3e—Precast Piles.....	5-196
5.14—PROVISIONS FOR STRUCTURE TYPES.....	5-196
5.14.1—Beams and Girders.....	5-196
5.14.1.1—General.....	5-196
5.14.1.2—Precast Beams.....	5-197
5.14.1.2.1—Preservice Conditions.....	5-197
5.14.1.2.2—Extreme Dimensions.....	5-197
5.14.1.2.3—Lifting Devices .....	5-197



5.14.1.2.4—Detail Design .....	5-197
5.14.1.2.5—Concrete Strength.....	5-198
5.14.1.3—Spliced Precast Girders .....	5-198
5.14.1.3.1—General.....	5-198
5.14.1.3.2—Joints between Segments .....	5-199
5.14.1.3.2a—General.....	5-199
5.14.1.3.2b—Details of Closure Joints.....	5-199
5.14.1.3.2c—Details of Match-Cast Joints.....	5-200
5.14.1.3.2d—Joint Design.....	5-200
5.14.1.3.3—Girder Segment Design.....	5-200
5.14.1.3.4—Post-Tensioning .....	5-201
5.14.1.4—Bridges Composed of Simple Span Precast Girders Made Continuous.....	5-201
5.14.1.4.1—General.....	5-201
5.14.1.4.2—Restraint Moments.....	5-202
5.14.1.4.3—Material Properties.....	5-203
5.14.1.4.4—Age of Girder When Continuity Is Established .....	5-203
5.14.1.4.5—Degree of Continuity at Various Limit States.....	5-204
5.14.1.4.6—Service Limit State.....	5-205
5.14.1.4.7—Strength Limit State .....	5-206
5.14.1.4.8—Negative Moment Connections.....	5-206
5.14.1.4.9—Positive Moment Connections .....	5-206
5.14.1.4.9a—General.....	5-206
5.14.1.4.9b—Positive Moment Connection Using Mild Reinforcement.....	5-207
5.14.1.4.9c—Positive Moment Connection Using Prestressing Strand.....	5-208
5.14.1.4.9d—Details of Positive Moment Connection .....	5-208
5.14.1.4.10—Continuity Diaphragms.....	5-209
5.14.1.5—Cast-in-Place Girders and Box and T-Beams .....	5-210
5.14.1.5.1—Flange and Web Thickness .....	5-210
5.14.1.5.1a—Top Flange .....	5-210
5.14.1.5.1b—Bottom Flange .....	5-210
5.14.1.5.1c—Web.....	5-210
5.14.1.5.2—Reinforcement.....	5-210
5.14.1.5.2a—Deck Slab Reinforcement Cast-in-Place in T-Beams and Box Girders.....	5-210
5.14.1.5.2b—Bottom Slab Reinforcement in Cast-in-Place Box Girders.....	5-211
5.14.2—Segmental Construction .....	5-211
5.14.2.1—General.....	5-211
5.14.2.2—Analysis of Segmental Bridges.....	5-212
5.14.2.2.1—General.....	5-212
5.14.2.2.2—Construction Analysis.....	5-212
5.14.2.2.3—Analysis of the Final Structural System.....	5-212
5.14.2.3—Design.....	5-213
5.14.2.3.1—Loads.....	5-213
5.14.2.3.2—Construction Loads.....	5-213
5.14.2.3.3—Construction Load Combinations at the Service Limit State.....	5-214
5.14.2.3.4—Construction Load Combinations at Strength Limit States.....	5-217
5.14.2.3.4a—Superstructures.....	5-217

5.14.2.3.4b—Substructures .....	5-217
5.14.2.3.5—Thermal Effects During Construction.....	5-217
5.14.2.3.6—Creep and Shrinkage.....	5-217
5.14.2.3.7—Prestress Losses .....	5-218
5.14.2.3.8—Provisional Post-Tensioning Ducts and Anchorages .....	5-219
5.14.2.3.8a—General.....	5-219
5.14.2.3.8b—Bridges with Internal Ducts.....	5-219
5.14.2.3.8c—Provision for Future Dead Load or Deflection Adjustment.....	5-219
5.14.2.3.9—Plan Presentation .....	5-219
5.14.2.3.10—Box Girder Cross-Section Dimensions and Details.....	5-220
5.14.2.3.10a—Minimum Flange Thickness .....	5-220
5.14.2.3.10b—Minimum Web Thickness .....	5-220
5.14.2.3.10c—Length of Top Flange Cantilever.....	5-221
5.14.2.3.10d—Overall Cross-Section Dimensions.....	5-221
5.14.2.3.10e—Overlays.....	5-222
5.14.2.3.11—Seismic Design .....	5-222
5.14.2.4—Types of Segmental Bridges.....	5-223
5.14.2.4.1—General .....	5-223
5.14.2.4.2—Details for Precast Construction .....	5-223
5.14.2.4.3—Details for Cast-in-Place Construction .....	5-225
5.14.2.4.4—Cantilever Construction.....	5-225
5.14.2.4.5—Span-by-Span Construction.....	5-225
5.14.2.4.6—Incrementally Launched Construction.....	5-226
5.14.2.4.6a—General.....	5-226
5.14.2.4.6b—Force Effects Due to Construction Tolerances.....	5-226
5.14.2.4.6c—Design Details.....	5-227
5.14.2.4.6d—Design of Construction Equipment .....	5-228
5.14.2.5—Use of Alternative Construction Methods .....	5-228
5.14.2.6—Segmentally Constructed Bridge Substructures.....	5-230
5.14.2.6.1—General .....	5-230
5.14.2.6.2—Construction Load Combinations.....	5-230
5.14.2.6.3—Longitudinal Reinforcement of Hollow, Rectangular Precast Segmental Piers .....	5-230
5.14.3—Arches .....	5-231
5.14.3.1—General.....	5-231
5.14.3.2—Arch Ribs.....	5-231
5.14.4—Slab Superstructures .....	5-231
5.14.4.1—Cast-in-Place Solid Slab Superstructures.....	5-231
5.14.4.2—Cast-in-Place Voids Slab Superstructures .....	5-232
5.14.4.2.1—Cross-Section Dimensions.....	5-232
5.14.4.2.2—Minimum Number of Bearings.....	5-233
5.14.4.2.3—Solid End Sections.....	5-233
5.14.4.2.4—General Design Requirements .....	5-233
5.14.4.2.5—Compressive Zones in Negative Moment Area.....	5-234
5.14.4.2.6—Drainage of Voids.....	5-234
5.14.4.3—Precast Deck Bridges.....	5-234
5.14.4.3.1—General .....	5-234

5.14.4.3.2—Shear Transfer Joints.....	5-235
5.14.4.3.3—Shear-Flexure Transfer Joints.....	5-235
5.14.4.3.3a—General.....	5-235
5.14.4.3.3b—Design.....	5-235
5.14.4.3.3c—Post-Tensioning.....	5-235
5.14.4.3.3d—Longitudinal Construction Joints.....	5-235
5.14.4.3.3e—Cast-in-Place Closure Joint.....	5-236
5.14.4.3.3f—Structural Overlay.....	5-236
5.14.5—Additional Provisions for Culverts.....	5-236
5.14.5.1—General.....	5-236
5.14.5.2—Design for Flexure.....	5-236
5.14.5.3—Design for Shear in Slabs of Box Culverts.....	5-236
5.15—REFERENCES.....	5-237
APPENDIX A5—BASIC STEPS FOR CONCRETE BRIDGES.....	5-247
A5.1—GENERAL.....	5-247
A5.2—GENERAL CONSIDERATIONS.....	5-247
A5.3—BEAM AND GIRDER SUPERSTRUCTURE DESIGN.....	5-247
A5.4—SLAB BRIDGES.....	5-248
A5.5—SUBSTRUCTURE DESIGN.....	5-249
APPENDIX B5—GENERAL PROCEDURE FOR SHEAR DESIGN WITH TABLES.....	5-251
B5.1—BACKGROUND.....	5-251
B5.2—SECTIONAL DESIGN MODEL—GENERAL PROCEDURE.....	5-251
APPENDIX C5—UPPER LIMITS FOR ARTICLES AFFECTED BY CONCRETE COMPRESSIVE STRENGTH.....	5-259

SECTION 6: STEEL STRUCTURES

TABLE OF CONTENTS

6.1—SCOPE ..... 6-1

6.2—DEFINITIONS ..... 6-1

6.3—NOTATION ..... 6-10

6.4—MATERIALS ..... 6-22

    6.4.1—Structural Steels ..... 6-22

    6.4.2—Pins, Rollers, and Rockers ..... 6-25

    6.4.3—Bolts, Nuts, and Washers ..... 6-25

        6.4.3.1—Bolts ..... 6-25

        6.4.3.2—Nuts ..... 6-26

            6.4.3.2.1—Nuts Used with Structural Fasteners ..... 6-26

            6.4.3.2.2—Nuts Used with Anchor Bolts ..... 6-26

        6.4.3.3—Washers ..... 6-26

        6.4.3.4—Alternative Fasteners ..... 6-27

        6.4.3.5—Load Indicator Devices ..... 6-27

    6.4.4—Stud Shear Connectors ..... 6-27

    6.4.5—Weld Metal ..... 6-27

    6.4.6—Cast Metal ..... 6-28

        6.4.6.1—Cast Steel and Ductile Iron ..... 6-28

        6.4.6.2—Malleable Castings ..... 6-28

        6.4.6.3—Cast Iron ..... 6-28

    6.4.7—Stainless Steel ..... 6-28

    6.4.8—Cables ..... 6-28

        6.4.8.1—Bright Wire ..... 6-28

        6.4.8.2—Galvanized Wire ..... 6-28

        6.4.8.3—Epoxy-Coated Wire ..... 6-29

        6.4.8.4—Bridge Strand ..... 6-29

6.5—LIMIT STATES ..... 6-29

    6.5.1—General ..... 6-29

    6.5.2—Service Limit State ..... 6-29

    6.5.3—Fatigue and Fracture Limit State ..... 6-29

    6.5.4—Strength Limit State ..... 6-29

        6.5.4.1—General ..... 6-29

        6.5.4.2—Resistance Factors ..... 6-30

    6.5.5—Extreme Event Limit State ..... 6-31

6.6—FATIGUE AND FRACTURE CONSIDERATIONS ..... 6-31

    6.6.1—Fatigue ..... 6-31

        6.6.1.1—General ..... 6-31

        6.6.1.2—Load-Induced Fatigue ..... 6-32

            6.6.1.2.1—Application ..... 6-32

            6.6.1.2.2—Design Criteria ..... 6-33

6.6.1.2.3—Detail Categories.....	6-34
6.6.1.2.4—Detailing to Reduce Constraint.....	6-48
6.6.1.2.5—Fatigue Resistance.....	6-48
6.6.1.3—Distortion-Induced Fatigue.....	6-51
6.6.1.3.1—Transverse Connection Plates.....	6-52
6.6.1.3.2—Lateral Connection Plates.....	6-52
6.6.1.3.3—Orthotropic Decks.....	6-53
6.6.2—Fracture.....	6-53
6.7—GENERAL DIMENSION AND DETAIL REQUIREMENTS.....	6-57
6.7.1—Effective Length of Span.....	6-57
6.7.2—Dead Load Camber.....	6-57
6.7.3—Minimum Thickness of Steel.....	6-59
6.7.4—Diaphragms and Cross-Frames.....	6-59
6.7.4.1—General.....	6-59
6.7.4.2—I-Section Members.....	6-60
6.7.4.3—Box Section Members.....	6-62
6.7.4.4—Trusses and Arches.....	6-64
6.7.5—Lateral Bracing.....	6-65
6.7.5.1—General.....	6-65
6.7.5.2—I-Section Members.....	6-65
6.7.5.3—Tub Section Members.....	6-66
6.7.5.4—Trusses.....	6-68
6.7.6—Pins.....	6-68
6.7.6.1—Location.....	6-68
6.7.6.2—Resistance.....	6-69
6.7.6.2.1—Combined Flexure and Shear.....	6-69
6.7.6.2.2—Bearing.....	6-69
6.7.6.3—Minimum Size Pin for Eyebars.....	6-69
6.7.6.4—Pins and Pin Nuts.....	6-70
6.7.7—Heat-Curved Rolled Beams and Welded Plate Girders.....	6-70
6.7.7.1—Scope.....	6-70
6.7.7.2—Minimum Radius of Curvature.....	6-70
6.7.7.3—Camber.....	6-71
6.8—TENSION MEMBERS.....	6-71
6.8.1—General.....	6-71
6.8.2—Tensile Resistance.....	6-72
6.8.2.1—General.....	6-72
6.8.2.2—Reduction Factor, $U$ .....	6-73
6.8.2.3—Combined Tension and Flexure.....	6-76
6.8.3—Net Area.....	6-77
6.8.4—Limiting Slenderness Ratio.....	6-77
6.8.5—Builtup Members.....	6-78
6.8.5.1—General.....	6-78
6.8.5.2—Perforated Plates.....	6-78
6.8.6—Eyebars.....	6-78

6.8.6.1—Factored Resistance .....	6-78
6.8.6.2—Proportions.....	6-78
6.8.6.3—Packing .....	6-79
6.8.7—Pin-Connected Plates .....	6-79
6.8.7.1—General.....	6-79
6.8.7.2—Pin Plates .....	6-79
6.8.7.3—Proportions.....	6-80
6.8.7.4—Packing .....	6-80
6.9—COMPRESSION MEMBERS .....	6-80
6.9.1—General.....	6-80
6.9.2—Compressive Resistance.....	6-81
6.9.2.1—Axial Compression .....	6-81
6.9.2.2—Combined Axial Compression and Flexure .....	6-81
6.9.3—Limiting Slenderness Ratio .....	6-82
6.9.4—Noncomposite Members .....	6-82
6.9.4.1—Nominal Compressive Resistance.....	6-82
6.9.4.1.1—General .....	6-82
6.9.4.1.2—Elastic Flexural Buckling Resistance.....	6-86
6.9.4.1.3—Elastic Torsional Buckling and Flexural-Torsional Buckling Resistance.....	6-86
6.9.4.2—Nonslender and Slender Member Elements .....	6-88
6.9.4.2.1—Nonslender Member Elements.....	6-88
6.9.4.3—Built-up Members .....	6-93
6.9.4.3.1—General .....	6-93
6.9.4.3.2—Perforated Plates .....	6-94
6.9.4.4—Single-Angle Members .....	6-95
6.9.5—Composite Members .....	6-98
6.9.5.1—Nominal Compressive Resistance.....	6-98
6.9.5.2—Limitations .....	6-99
6.9.5.2.1—General .....	6-99
6.9.5.2.2—Concrete-Filled Tubes .....	6-99
6.9.5.2.3—Concrete-Encased Shapes .....	6-99
6.10—I-SECTION FLEXURAL MEMBERS .....	6-100
6.10.1—General.....	6-100
6.10.1.1—Composite Sections.....	6-102
6.10.1.1.1—Stresses .....	6-102
6.10.1.1.1a—Sequence of Loading .....	6-102
6.10.1.1.1b—Stresses for Sections in Positive Flexure .....	6-102
6.10.1.1.1c—Stresses for Sections in Negative Flexure .....	6-103
6.10.1.1.1d—Concrete Deck Stresses .....	6-103
6.10.1.1.1e—Effective Width of Concrete Deck.....	6-103
6.10.1.2—Noncomposite Sections.....	6-103
6.10.1.3—Hybrid Sections.....	6-104
6.10.1.4—Variable Web Depth Members .....	6-104
6.10.1.5—Stiffness .....	6-106

6.10.1.6—Flange Stresses and Member Bending Moments .....	6-106
6.10.1.7—Minimum Negative Flexure Concrete Deck Reinforcement .....	6-108
6.10.1.8—Net Section Fracture.....	6-110
6.10.1.9—Web Bend-Buckling Resistance.....	6-110
6.10.1.9.1—Webs without Longitudinal Stiffeners .....	6-110
6.10.1.9.2—Webs with Longitudinal Stiffeners .....	6-112
6.10.1.10—Flange-Strength Reduction Factors .....	6-113
6.10.1.10.1—Hybrid Factor, $R_h$ .....	6-113
6.10.1.10.2—Web Load-Shedding Factor, $R_b$ .....	6-114
6.10.2—Cross-Section Proportion Limits .....	6-118
6.10.2.1—Web Proportions .....	6-118
6.10.2.1.1—Webs without Longitudinal Stiffeners .....	6-118
6.10.2.1.2—Webs with Longitudinal Stiffeners .....	6-119
6.10.2.2—Flange Proportions .....	6-119
6.10.3—Constructibility.....	6-120
6.10.3.1—General .....	6-120
6.10.3.2—Flexure .....	6-121
6.10.3.2.1—Discretely Braced Flanges in Compression.....	6-121
6.10.3.2.2—Discretely Braced Flanges in Tension.....	6-123
6.10.3.2.3 Continuously Braced Flanges in Tension or Compression .....	6-123
6.10.3.2.4—Concrete Deck.....	6-123
6.10.3.3—Shear .....	6-124
6.10.3.4—Deck Placement.....	6-124
6.10.3.5—Dead Load Deflections.....	6-126
6.10.4—Service Limit State .....	6-127
6.10.4.1—Elastic Deformations.....	6-127
6.10.4.2—Permanent Deformations.....	6-127
6.10.4.2.1—General.....	6-127
6.10.4.2.2—Flexure .....	6-127
6.10.5—Fatigue and Fracture Limit State .....	6-130
6.10.5.1—Fatigue.....	6-130
6.10.5.2—Fracture .....	6-130
6.10.5.3—Special Fatigue Requirement for Webs.....	6-130
6.10.6—Strength Limit State.....	6-131
6.10.6.1—General .....	6-131
6.10.6.2—Flexure .....	6-132
6.10.6.2.1—General.....	6-132
6.10.6.2.2—Composite Sections in Positive Flexure.....	6-132
6.10.6.2.3—Composite Sections in Negative Flexure and Noncomposite Sections .....	6-134
6.10.6.3—Shear .....	6-136
6.10.6.4—Shear Connectors .....	6-136
6.10.7—Flexural Resistance—Composite Sections in Positive Flexure .....	6-136
6.10.7.1—Compact Sections.....	6-136
6.10.7.1.1—General.....	6-136
6.10.7.1.2—Nominal Flexural Resistance .....	6-137
6.10.7.2—Noncompact Sections.....	6-139

6.10.7.2.1—General .....	6-139
6.10.7.2.2—Nominal Flexural Resistance .....	6-140
6.10.7.3—Ductility Requirement.....	6-140
6.10.8—Flexural Resistance—Composite Sections in Negative Flexure and Noncomposite Sections .....	6-141
6.10.8.1—General.....	6-141
6.10.8.1.1—Discretely Braced Flanges in Compression .....	6-141
6.10.8.1.2—Discretely Braced Flanges in Tension .....	6-141
6.10.8.1.3—Continuously Braced Flanges in Tension or Compression .....	6-141
6.10.8.2 Compression-Flange Flexural Resistance .....	6-142
6.10.8.2.1—General .....	6-142
6.10.8.2.2—Local Buckling Resistance.....	6-143
6.10.8.2.3—Lateral Torsional Buckling Resistance .....	6-144
6.10.8.3—Tension-Flange Flexural Resistance .....	6-150
6.10.9—Shear Resistance .....	6-151
6.10.9.1—General.....	6-151
6.10.9.2—Nominal Resistance of Unstiffened Webs .....	6-152
6.10.9.3—Nominal Resistance of Stiffened Webs.....	6-152
6.10.9.3.1—General .....	6-152
6.10.9.3.2—Interior Panels.....	6-153
6.10.9.3.3—End Panels .....	6-154
6.10.10—Shear Connectors .....	6-154
6.10.10.1—General.....	6-154
6.10.10.1.1—Types .....	6-155
6.10.10.1.2—Pitch.....	6-155
6.10.10.1.3—Transverse Spacing .....	6-156
6.10.10.1.4—Cover and Penetration.....	6-157
6.10.10.2—Fatigue Resistance .....	6-157
6.10.10.3—Special Requirements for Points of Permanent Load Contraflexure.....	6-158
6.10.10.4—Strength Limit State .....	6-158
6.10.10.4.1—General .....	6-158
6.10.10.4.2—Nominal Shear Force .....	6-159
6.10.10.4.3—Nominal Shear Resistance .....	6-161
6.10.11—Stiffeners.....	6-161
6.10.11.1—Transverse Stiffeners .....	6-161
6.10.11.1.1—General .....	6-161
6.10.11.1.2—Projecting Width.....	6-162
6.10.11.1.3—Moment of Inertia .....	6-162
6.10.11.2—Bearing Stiffeners .....	6-165
6.10.11.2.1—General .....	6-165
6.10.11.2.2—Projecting Width.....	6-165
6.10.11.2.3—Bearing Resistance.....	6-165
6.10.11.2.4—Axial Resistance of Bearing Stiffeners .....	6-166
6.10.11.2.4a—General.....	6-166
6.10.11.2.4b—Effective Section.....	6-166
6.10.11.3—Longitudinal Stiffeners .....	6-166
6.10.11.3.1—General .....	6-166



6.10.11.3.2—Projecting Width .....	6-169
6.10.11.3.3—Moment of Inertia and Radius of Gyration .....	6-169
6.10.12—Cover Plates .....	6-170
6.10.12.1—General .....	6-170
6.10.12.2—End Requirements .....	6-170
6.10.12.2.1—General .....	6-170
6.10.12.2.2—Welded Ends .....	6-171
6.10.12.2.3—Bolted Ends .....	6-171
6.11—BOX-SECTION FLEXURAL MEMBERS .....	6-171
6.11.1—General .....	6-171
6.11.1.1—Stress Determinations .....	6-173
6.11.1.2—Bearings .....	6-176
6.11.1.3—Flange-to-Web Connections .....	6-176
6.11.1.4—Access and Drainage .....	6-177
6.11.2—Cross-Section Proportion Limits .....	6-177
6.11.2.1—Web Proportions .....	6-177
6.11.2.1.1—General .....	6-177
6.11.2.1.2—Webs without Longitudinal Stiffeners .....	6-178
6.11.2.1.3—Webs with Longitudinal Stiffeners .....	6-178
6.11.2.2—Flange Proportions .....	6-178
6.11.2.3—Special Restrictions on Use of Live Load Distribution Factor for Multiple Box Sections.....	6-178
6.11.3—Constructibility .....	6-179
6.11.3.1—General .....	6-179
6.11.3.2—Flexure .....	6-179
6.11.3.3—Shear .....	6-182
6.11.4—Service Limit State .....	6-182
6.11.5—Fatigue and Fracture Limit State .....	6-183
6.11.6—Strength Limit State.....	6-185
6.11.6.1—General .....	6-185
6.11.6.2—Flexure .....	6-185
6.11.6.2.1—General .....	6-185
6.11.6.2.2—Sections in Positive Flexure .....	6-185
6.11.6.2.3—Sections in Negative Flexure .....	6-186
6.11.6.3—Shear .....	6-186
6.11.6.4—Shear Connectors .....	6-186
6.11.7—Flexural Resistance—Sections in Positive Flexure .....	6-187
6.11.7.1—Compact Sections.....	6-187
6.11.7.1.1—General .....	6-187
6.11.7.1.2—Nominal Flexural Resistance .....	6-187
6.11.7.2—Noncompact Sections .....	6-187
6.11.7.2.1—General .....	6-187
6.11.7.2.2—Nominal Flexural Resistance .....	6-188
6.11.8—Flexural Resistance—Sections in Negative Flexure.....	6-189
6.11.8.1—General .....	6-189
6.11.8.1.1—Box Flanges in Compression .....	6-189

6.11.8.1.2—Continuously Braced Flanges in Tension .....	6-190
6.11.8.2—Flexural Resistance of Box Flanges in Compression.....	6-190
6.11.8.2.1—General .....	6-190
6.11.8.2.2—Unstiffened Flanges .....	6-190
6.11.8.2.3—Longitudinally Stiffened Flanges.....	6-192
6.11.8.3—Tension-Flange Flexural Resistance .....	6-193
6.11.9—Shear Resistance .....	6-194
6.11.10—Shear Connectors .....	6-194
6.11.11—Stiffeners.....	6-195
6.11.11.1—Web Stiffeners .....	6-195
6.11.11.2—Longitudinal Compression-Flange Stiffeners .....	6-196
6.12—MISCELLANEOUS FLEXURAL MEMBERS .....	6-199
6.12.1—General.....	6-199
6.12.1.1—Scope .....	6-199
6.12.1.2—Strength Limit State .....	6-199
6.12.1.2.1—Flexure.....	6-199
6.12.1.2.2—Combined Flexure and Axial Load.....	6-199
6.12.1.2.3—Shear.....	6-200
6.12.1.2.3a—General.....	6-200
6.12.1.2.3b—Square and Rectangular HSS.....	6-200
6.12.1.2.3c—Circular Tubes .....	6-200
6.12.2—Nominal Flexural Resistance .....	6-201
6.12.2.1—General.....	6-201
6.12.2.2—Noncomposite Members .....	6-201
6.12.2.2.1—I- and H-Shaped Members.....	6-201
6.12.2.2.2—Box-Shaped Members.....	6-202
6.12.2.2.3—Circular Tubes .....	6-204
6.12.2.2.4—Tees and Double Angles.....	6-205
6.12.2.2.5—Channels .....	6-207
6.12.2.2.6—Single Angles.....	6-209
6.12.2.2.7—Rectangular Bars and Solid Rounds .....	6-210
6.12.2.3—Composite Members.....	6-211
6.12.2.3.1—Concrete-Encased Shapes.....	6-211
6.12.2.3.2—Concrete-Filled Tubes.....	6-212
6.12.3—Nominal Shear Resistance of Composite Members .....	6-212
6.12.3.1—Concrete-Encased Shapes.....	6-212
6.12.3.2—Concrete-Filled Tubes.....	6-213
6.12.3.2.1—Rectangular Tubes .....	6-213
6.12.3.2.2—Circular Tubes .....	6-213
6.13—CONNECTIONS AND SPLICES.....	6-213
6.13.1—General.....	6-213
6.13.2—Bolted Connections.....	6-214
6.13.2.1—General.....	6-214
6.13.2.1.1—Slip-Critical Connections.....	6-214

6.13.2.1.2—Bearing-Type Connections.....	6-215
6.13.2.2—Factored Resistance.....	6-215
6.13.2.3—Bolts, Nuts, and Washers.....	6-216
6.13.2.3.1—Bolts and Nuts.....	6-216
6.13.2.3.2—Washers.....	6-216
6.13.2.4—Holes.....	6-217
6.13.2.4.1—Type.....	6-217
6.13.2.4.1a—General.....	6-217
6.13.2.4.1b—Oversize Holes.....	6-217
6.13.2.4.1c—Short-Slotted Holes.....	6-217
6.13.2.4.1d—Long-Slotted Holes.....	6-217
6.13.2.4.2—Size.....	6-217
6.13.2.5—Size of Bolts.....	6-218
6.13.2.6—Spacing of Bolts.....	6-218
6.13.2.6.1—Minimum Spacing and Clear Distance.....	6-218
6.13.2.6.2—Maximum Spacing for Sealing Bolts.....	6-218
6.13.2.6.3—Maximum Pitch for Stitch Bolts.....	6-219
6.13.2.6.4—Maximum Pitch for Stitch Bolts at the End of Compression Members.....	6-219
6.13.2.6.5—End Distance.....	6-219
6.13.2.6.6—Edge Distances.....	6-220
6.13.2.7—Shear Resistance.....	6-220
6.13.2.8—Slip Resistance.....	6-221
6.13.2.9—Bearing Resistance at Bolt Holes.....	6-224
6.13.2.10—Tensile Resistance.....	6-225
6.13.2.10.1—General.....	6-225
6.13.2.10.2—Nominal Tensile Resistance.....	6-225
6.13.2.10.3—Fatigue Resistance.....	6-225
6.13.2.10.4—Prying Action.....	6-225
6.13.2.11—Combined Tension and Shear.....	6-226
6.13.2.12—Shear Resistance of Anchor Bolts.....	6-226
6.13.3—Welded Connections.....	6-227
6.13.3.1—General.....	6-227
6.13.3.2—Factored Resistance.....	6-227
6.13.3.2.1—General.....	6-227
6.13.3.2.2—Complete Penetration Groove-Welded Connections.....	6-227
6.13.3.2.2a—Tension and Compression.....	6-227
6.13.3.2.2b—Shear.....	6-227
6.13.3.2.3—Partial Penetration Groove-Welded Connections.....	6-228
6.13.3.2.3a—Tension or Compression.....	6-228
6.13.3.2.3b—Shear.....	6-228
6.13.3.2.4—Fillet-Welded Connections.....	6-228
6.13.3.2.4a—Tension and Compression.....	6-228
6.13.3.2.4b—Shear.....	6-229
6.13.3.3—Effective Area.....	6-229
6.13.3.4—Size of Fillet Welds.....	6-229
6.13.3.5—Minimum Effective Length of Fillet Welds.....	6-230

6.13.3.6—Fillet Weld End Returns.....	6-230
6.13.3.7—Seal Welds .....	6-230
6.13.4—Block Shear Rupture Resistance .....	6-230
6.13.5—Connection Elements .....	6-231
6.13.5.1—General.....	6-231
6.13.5.2—Tension .....	6-231
6.13.5.3—Shear .....	6-232
6.13.6—Splices.....	6-232
6.13.6.1—Bolted Splices .....	6-232
6.13.6.1.1—General .....	6-232
6.13.6.1.2—Tension Members .....	6-232
6.13.6.1.3—Compression Members .....	6-233
6.13.6.1.4—Flexural Members .....	6-233
6.13.6.1.4a—General.....	6-233
6.13.6.1.4b—Web Splices.....	6-234
6.13.6.1.4c—Flange Splices.....	6-238
6.13.6.1.5—Fillers .....	6-241
6.13.6.2—Welded Splices .....	6-242
6.13.7—Rigid Frame Connections.....	6-243
6.13.7.1—General.....	6-243
6.13.7.2—Webs .....	6-243
6.14—PROVISIONS FOR STRUCTURE TYPES .....	6-244
6.14.1—Through-Girder Spans.....	6-244
6.14.2—Trusses .....	6-244
6.14.2.1—General.....	6-244
6.14.2.2—Truss Members .....	6-245
6.14.2.3—Secondary Stresses.....	6-245
6.14.2.4—Diaphragms.....	6-245
6.14.2.5—Camber.....	6-245
6.14.2.6—Working Lines and Gravity Axes .....	6-245
6.14.2.7—Portal and Sway Bracing.....	6-246
6.14.2.7.1—General .....	6-246
6.14.2.7.2—Through-Truss Spans.....	6-246
6.14.2.7.3—Deck Truss Spans .....	6-246
6.14.2.8—Gusset Plates.....	6-246
6.14.2.9—Half Through-Trusses .....	6-247
6.14.2.10—Factored Resistance .....	6-247
6.14.3—Orthotropic Deck Superstructures.....	6-247
6.14.3.1—General.....	6-247
6.14.3.2—Decks in Global Compression.....	6-247
6.14.3.2.1—General .....	6-247
6.14.3.2.2—Local Buckling .....	6-248
6.14.3.2.3—Panel Buckling.....	6-248
6.14.3.3—Effective Width of Deck .....	6-249
6.14.3.4—Superposition of Global and Local Effects .....	6-249

6.14.4—Solid Web Arches .....	6-249
6.14.4.1—Moment Amplification for Deflection.....	6-249
6.14.4.2—Web Slenderness .....	6-249
6.14.4.3—Flange Stability .....	6-250
6.15—PILES .....	6-250
6.15.1—General.....	6-250
6.15.2—Structural Resistance .....	6-250
6.15.3—Compressive Resistance .....	6-252
6.15.3.1—Axial Compression.....	6-252
6.15.3.2—Combined Axial Compression and Flexure.....	6-252
6.15.3.3—Buckling.....	6-252
6.15.4—Maximum Permissible Driving Stresses.....	6-252
6.16—PROVISIONS FOR SEISMIC DESIGN.....	6-252
6.16.1—General.....	6-252
6.16.2—Materials.....	6-254
6.16.3—Design Requirements for Seismic Zone 1 .....	6-254
6.16.4—Design Requirements for Seismic Zones 2, 3, or 4 .....	6-254
6.16.4.1—General .....	6-254
6.16.4.2—Deck .....	6-255
6.16.4.3—Shear Connectors .....	6-256
6.16.4.4—Elastic Superstructures .....	6-259
6.17—REFERENCES.....	6-259
APPENDIX A6—FLEXURAL RESISTANCE OF STRAIGHT COMPOSITE I-SECTIONS IN NEGATIVE FLEXURE AND STRAIGHT NONCOMPOSITE I-SECTIONS WITH COMPACT OR NONCOMPACT WEBS .....	6-271
A6.1—GENERAL .....	6-271
A6.1.1—Sections with Discretely Braced Compression Flanges.....	6-272
A6.1.2—Sections with Discretely Braced Tension Flanges.....	6-273
A6.1.3 Sections with Continuously Braced Compression Flanges .....	6-274
A6.1.4 Sections with Continuously Braced Tension Flanges.....	6-274
A6.2—WEB PLASTIFICATION FACTORS .....	6-274
A6.2.1—Compact Web Sections .....	6-274
A6.2.2—Noncompact Web Sections.....	6-275
A6.3—FLEXURAL RESISTANCE BASED ON THE COMPRESSION FLANGE.....	6-277
A6.3.1—General .....	6-277
A6.3.2—Local Buckling Resistance .....	6-278
A6.3.3—Lateral Torsional Buckling Resistance .....	6-279
A6.4—FLEXURAL RESISTANCE BASED ON TENSION FLANGE YIELDING .....	6-282
APPENDIX B6—MOMENT REDISTRIBUTION FROM INTERIOR-PIER I-SECTIONS IN STRAIGHT CONTINUOUS-SPAN BRIDGES.....	6-283

B6.1—GENERAL .....	6-283
B6.2—SCOPE .....	6-283
B6.2.1—Web Proportions.....	6-284
B6.2.2—Compression Flange Proportions.....	6-284
B6.2.3—Section Transitions.....	6-285
B6.2.4—Compression Flange Bracing .....	6-285
B6.2.5—Shear.....	6-285
B6.2.6—Bearing Stiffeners.....	6-285
B6.3—SERVICE LIMIT STATE .....	6-286
B6.3.1—General .....	6-286
B6.3.2—Flexure .....	6-286
B6.3.2.1—Adjacent to Interior-Pier Sections .....	6-286
B6.3.2.2—At All Other Locations .....	6-286
B6.3.3—Redistribution Moments .....	6-287
B6.3.3.1—At Interior-Pier Sections.....	6-287
B6.3.3.2—At All Other Locations .....	6-287
B6.4—STRENGTH LIMIT STATE.....	6-288
B6.4.1—Flexural Resistance .....	6-288
B6.4.1.1—Adjacent to Interior-Pier Sections .....	6-288
B6.4.1.2—At All Other Locations .....	6-288
B6.4.2—Redistribution Moments .....	6-288
B6.4.2.1—At Interior-Pier Sections.....	6-288
B6.4.2.2—At All Other Sections .....	6-289
B6.5—EFFECTIVE PLASTIC MOMENT .....	6-289
B6.5.1—Interior-Pier Sections with Enhanced Moment-Rotation Characteristics .....	6-289
B6.5.2—All Other Interior-Pier Sections.....	6-290
B6.6—REFINED METHOD .....	6-290
B6.6.1—General .....	6-290
B6.6.2—Nominal Moment-Rotation Curves .....	6-292
APPENDIX C6—BASIC STEPS FOR STEEL BRIDGE SUPERSTRUCTURES .....	6-295
C6.1—GENERAL .....	6-295
C6.2—GENERAL CONSIDERATIONS.....	6-295
C6.3—SUPERSTRUCTURE DESIGN.....	6-295
C6.4—FLOWCHARTS FOR FLEXURAL DESIGN OF I-SECTIONS.....	6-300
C6.4.1—Flowchart for LRFD Article 6.10.3 .....	6-300
C6.4.2—Flowchart for LRFD Article 6.10.4.....	6-301
C6.4.3—Flowchart for LRFD Article 6.10.5 .....	6-302
C6.4.4—Flowchart for LRFD Article 6.10.6.....	6-303
C6.4.5—Flowchart for LRFD Article 6.10.7.....	6-304

C6.4.6—Flowchart for LRFD Article 6.10.8 .....	6-305
C6.4.7—Flowchart for Appendix A6 .....	6-307
C6.4.8—Flowchart for Article D6.4.1 .....	6-309
C6.4.9—Flowchart for Article D6.4.2 .....	6-310
C6.4.10—Moment Gradient Modifier, $C_b$ (Sample Cases) .....	6-311
 APPENDIX D6—FUNDAMENTAL CALCULATIONS FOR FLEXURAL MEMBERS .....	 6-313
D6.1—PLASTIC MOMENT .....	6-313
D6.2—YIELD MOMENT .....	6-315
D6.2.1—Noncomposite Sections .....	6-315
D6.2.2—Composite Sections in Positive Flexure .....	6-316
D6.2.3—Composite Sections in Negative Flexure .....	6-316
D6.2.4—Sections with Cover Plates .....	6-317
D6.3—DEPTH OF THE WEB IN COMPRESSION .....	6-317
D6.3.1—In the Elastic Range ( $D_c$ ) .....	6-317
D6.3.2—At Plastic Moment ( $D_{cp}$ ) .....	6-318
D6.4—LATERAL TORSIONAL BUCKLING EQUATIONS FOR $C_B > 1.0$ , WITH EMPHASIS ON UNBRACED LENGTH REQUIREMENTS FOR DEVELOPMENT OF THE MAXIMUM FLEXURAL RESISTANCE .....	6-319
D6.4.1—By the Provisions of Article 6.10.8.2.3 .....	6-319
D6.4.2—By the Provisions of Article A6.3.3 .....	6-320
D6.5—CONCENTRATED LOADS APPLIED TO WEBS WITHOUT BEARING STIFFENERS .....	6-320
D6.5.1—General .....	6-320
D6.5.2—Web Local Yielding .....	6-321
D6.5.3—Web Crippling .....	6-321

SECTION 7: ALUMINUM STRUCTURES

TABLE OF CONTENTS

7.1—SCOPE..... 7-1

7.2—DEFINITIONS..... 7-1

7.3—NOTATION..... 7-1

7.4—MATERIALS..... 7-3

    7.4.1—General..... 7-3

    7.4.2—Aluminum Sheet, Plate, and Shapes ..... 7-3

        7.4.2.1—Extrusions and Mechanically Fastened Built-Up Members..... 7-3

        7.4.2.2—Welded Built-Up Members..... 7-4

    7.4.3—Material for Pins, Rollers, and Expansion Rockers ..... 7-6

    7.4.4—Fasteners—Rivets and Bolts ..... 7-6

    7.4.5—Weld Metal ..... 7-7

    7.4.6—Aluminum Castings ..... 7-7

    7.4.7—Aluminum Forgings ..... 7-7

7.5—LIMIT STATES..... 7-7

    7.5.1—Service Limit State..... 7-7

        7.5.1.1—Appearance of Buckling ..... 7-7

        7.5.1.2—Effective Width for Calculation of Deflection of Thin Gage Sections ..... 7-8

        7.5.1.3—Web Crippling ..... 7-9

        7.5.1.4—Live Load Deflection ..... 7-9

    7.5.2—Fatigue and Fracture Limit State..... 7-9

    7.5.3—Strength Limit State ..... 7-10

    7.5.4—Resistance Factors..... 7-10

7.6—FATIGUE AND FRACTURE CONSIDERATIONS..... 7-11

    7.6.1—Fatigue ..... 7-11

        7.6.1.1—General ..... 7-11

        7.6.1.2—Load-Induced Fatigue ..... 7-12

            7.6.1.2.1—Application ..... 7-12

            7.6.1.2.2—Design Criteria..... 7-12

            7.6.1.2.3—Detail Categories ..... 7-12

            7.6.1.2.4—Fatigue Resistance ..... 7-16

        7.6.1.3—Distortion-Induced Fatigue..... 7-17

            7.6.1.3.1—Transverse Connection Plates..... 7-18

            7.6.1.3.2—Lateral Connection Plates ..... 7-18

    7.6.2—Fracture ..... 7-18

7.7—DESIGN CONSIDERATIONS ..... 7-18

    7.7.1—Dead Load Camber ..... 7-18

    7.7.2—Welding Requirements ..... 7-18

    7.7.3—Welding Procedures..... 7-18

    7.7.4—Nondestructive Testing ..... 7-19

    7.7.5—Uplift and Slip of Deck Slabs ..... 7-19

    7.7.6—Composite Sections..... 7-19



7.8—GENERAL DIMENSION AND DETAIL REQUIREMENTS .....	7-19
7.8.1—Effective Length of Span .....	7-19
7.8.2—Slenderness Ratios for Tension and Compression Members .....	7-20
7.8.3—Minimum Thickness of Aluminum .....	7-21
7.8.4—Diaphragms and Cross-Frames .....	7-21
7.8.5—Lateral Bracing .....	7-22
7.8.5.1—General .....	7-22
7.8.5.2—Through-Spans .....	7-22
7.8.6—Pins and Pin-Connected Elements .....	7-22
7.9—TENSION MEMBERS .....	7-23
7.9.1—General .....	7-23
7.9.2—Tensile Resistance .....	7-23
7.9.3—Effective Area of Angle and T-Sections .....	7-23
7.9.4—Net Area .....	7-24
7.10—COMPRESSION MEMBERS .....	7-24
7.10.1—General .....	7-24
7.10.2—Compressive Resistance of Columns .....	7-26
7.10.3—Compressive Resistance of Components of Columns—Outstanding Flanges and Legs .....	7-27
7.10.4—Compressive Resistance of Components of Columns, Gross Section—Flat Plates with Both Edges Supported .....	7-28
7.10.4.1—General .....	7-28
7.10.4.2—Effect of Local Buckling of Elements on Column Strength .....	7-29
7.10.5—Compressive Resistance of Components of Columns, Gross Section—Curved Plates Supported on Both Edges, Walls of Round, or Oval Tubes .....	7-29
7.11—FLEXURAL MEMBERS .....	7-30
7.11.1—Tensile Resistance of Flexural Member .....	7-30
7.11.1.1—Net Section .....	7-30
7.11.1.2—Tension in Extreme Fibers of Beams, Structural Shapes Bent about Strong Axis, Rectangular Tubes .....	7-30
7.11.1.3—Tension in Extreme Fibers of Beams, Round, or Oval Tubes .....	7-30
7.11.1.4—Tension in Extreme Fibers of Beams—Shapes Bent about Weak Axis, Rectangular Bars, Plates .....	7-31
7.11.2—Compressive Resistance of Flexural Members .....	7-31
7.11.2.1—Compression in Beams, Extreme Fiber, Gross Section, Single-Web Beams Bent about Strong Axis .....	7-31
7.11.2.2—Compression in Beams, Extreme Fiber, Gross Section, Round or Oval Tubes .....	7-33
7.11.2.3—Compression in Beams, Extreme Fiber, Gross Section, Solid Rectangular Beams .....	7-33
7.11.2.4—Compression in Beams, Extreme Fiber, Gross Section, Rectangular Tubes, and Box Sections .....	7-34
7.11.3—Compressive Resistance of Flexural Members Limited by Plate Slenderness .....	7-35
7.11.3.1—General .....	7-35
7.11.3.2—Compression in Components of Beams with Component under Uniform Compression, Gross Section, Outstanding Flanges .....	7-36
7.11.3.2.1—General .....	7-36
7.11.3.2.2—Effect of Local Buckling of Elements on Resistance .....	7-37
7.11.3.3—Compression in Components of Beams with Component under Uniform Compression, Gross Section, Flat Plates with Both Edges Supported .....	7-37

7.11.3.4—Compression in Components of Beams—Curved Sections .....	7-38
7.11.3.5—Compression in Components of Beams with Component under Bending in Own Plane, Gross Section, Flat Plates with Compression Edge Free, Tension Edge Supported .....	7-38
7.11.3.6—Webs of Beams, Gross Section, Flat Plates with Both Edges Supported .....	7-39
7.11.3.7—Webs of Beams with Longitudinal Stiffener, Both Edges Supported.....	7-40
7.11.4—Shear Resistance .....	7-40
7.11.4.1—Shear—Unstiffened Flat Webs .....	7-40
7.11.4.2—Shear in Webs—Stiffened Flat Webs .....	7-41
7.11.5—Design of Stiffeners .....	7-42
7.11.5.1—Longitudinal Stiffeners for Webs.....	7-42
7.11.5.2—Transverse Stiffeners for Shear in Webs.....	7-43
7.11.5.3—Stiffeners for Outstanding Flanges .....	7-44
7.11.5.4—Bearing Stiffeners .....	7-45
7.12—TORSION .....	7-45
7.12.1—General.....	7-45
7.12.2—Compression Members Subjected to Torsion .....	7-45
7.12.2.1—Members with Double-Axis Symmetry .....	7-46
7.12.2.2—Members with Single-Axis Symmetry.....	7-46
7.12.3—St. Venant Torsion .....	7-46
7.12.3.1—Open Section.....	7-46
7.12.3.2—Box Section.....	7-47
7.12.4—Warping Torsion .....	7-47
7.12.4.1—Open Sections .....	7-47
7.12.4.2—Box Section.....	7-48
7.13—COMBINED FORCE EFFECTS .....	7-48
7.13.1—Combined Compression and Flexure .....	7-48
7.13.2—Combined Shear, Compression, and Flexure .....	7-48
7.13.3—Torsion and Shear in Tubes .....	7-49
7.13.4—Combined Compression and Flexure—Webs .....	7-49
7.14—CONNECTIONS AND SPLICES .....	7-50
7.14.1—General.....	7-50
7.14.2—Bolted Connections.....	7-50
7.14.2.1—Bolts and Nuts .....	7-50
7.14.2.2—Holes.....	7-51
7.14.2.3—Size of Fasteners .....	7-51
7.14.2.4—Spacing of Fasteners .....	7-51
7.14.2.4.1—Minimum Pitch and Clear Distance.....	7-51
7.14.2.4.2—Maximum Pitch for Sealing Fasteners.....	7-51
7.14.2.4.3—Maximum Pitch for Stitch Fasteners .....	7-52
7.14.2.4.4—Stitch Fasteners at the End of Compression Members .....	7-52
7.14.2.4.5—End and Edge Distances .....	7-52
7.14.2.5—Shear Resistance of Fasteners.....	7-52
7.14.2.6—Slip-Critical Connections.....	7-53
7.14.2.7—Bearing Resistance at Fastener Holes .....	7-53
7.14.2.7.1—General .....	7-53

7.14.2.7.2—Bearing Resistance at Rivet and Bolt Holes .....	7-53
7.14.2.7.3—Bearing on Flat Surfaces and Pins .....	7-53
7.14.2.8—Tension.....	7-53
7.14.3—Block Shear or End Rupture.....	7-54
7.14.4—Splices .....	7-54
7.14.4.1—General.....	7-54
7.14.4.2—Tension Members.....	7-54
7.14.4.3—Compression Members .....	7-54
7.14.4.4—Flexural Members .....	7-54
7.14.4.5—Welding.....	7-55
7.15—PROVISIONS FOR STRUCTURE TYPES .....	7-55
7.15.1—Floor System .....	7-55
7.15.2—Lateral Bracing.....	7-55
7.15.3—Beam and Girder Framing.....	7-55
7.15.4—Trusses .....	7-55
7.15.4.1—General.....	7-55
7.15.4.2—Portal and Sway Bracing.....	7-56
7.15.5—Arches .....	7-56
7.16—REFERENCES.....	7-57

SECTION 8: WOOD STRUCTURES

TABLE OF CONTENTS

8.1—SCOPE ..... 8-1

8.2—DEFINITIONS ..... 8-1

8.3—NOTATION ..... 8-4

8.4—MATERIALS ..... 8-5

    8.4.1—Wood Products ..... 8-5

        8.4.1.1—Sawn Lumber ..... 8-5

            8.4.1.1.1—General ..... 8-5

            8.4.1.1.2—Dimensions ..... 8-6

            8.4.1.1.3—Moisture Content ..... 8-6

            8.4.1.1.4—Reference Design Values ..... 8-6

        8.4.1.2—Structural Glued Laminated Timber (Glulam) ..... 8-12

            8.4.1.2.1—General ..... 8-12

            8.4.1.2.2—Dimensions ..... 8-13

            8.4.1.2.3—Reference Design Values ..... 8-14

        8.4.1.3—Tension-Reinforced Glulams ..... 8-18

            8.4.1.3.1—General ..... 8-18

            8.4.1.3.2—Dimensions ..... 8-18

            8.4.1.3.3—Fatigue ..... 8-19

            8.4.1.3.4—Reference Design Values for Tension-Reinforced Glulams ..... 8-19

            8.4.1.3.5—Volume Effect ..... 8-20

            8.4.1.3.6—Preservative Treatment ..... 8-21

        8.4.1.4—Piles ..... 8-21

    8.4.2—Metal Fasteners and Hardware ..... 8-21

        8.4.2.1—General ..... 8-21

        8.4.2.2—Minimum Requirements ..... 8-21

            8.4.2.2.1—Fasteners ..... 8-21

            8.4.2.2.2—Prestressing Bars ..... 8-21

            8.4.2.2.3—Split Ring Connectors ..... 8-22

            8.4.2.2.4—Shear Plate Connectors ..... 8-22

            8.4.2.2.5—Nails and Spikes ..... 8-22

            8.4.2.2.6—Drift Pins and Bolts ..... 8-22

            8.4.2.2.7—Spike Grids ..... 8-22

            8.4.2.2.8—Toothed Metal Plate Connectors ..... 8-22

        8.4.2.3—Corrosion Protection ..... 8-23

            8.4.2.3.1—Metallic Coating ..... 8-23

            8.4.2.3.2—Alternative Coating ..... 8-23

    8.4.3—Preservative Treatment ..... 8-23

        8.4.3.1—Requirement for Treatment ..... 8-23

        8.4.3.2—Treatment Chemicals ..... 8-23

        8.4.3.3—Inspection and Marking ..... 8-24

        8.4.3.4—Fire Retardant Treatment ..... 8-24

    8.4.4—Adjustment Factors for Reference Design Values ..... 8-24

8.4.4.1—General.....	8-24
8.4.4.2—Format Conversion Factor, $C_{KF}$ .....	8-25
8.4.4.3—Wet Service Factor, $C_M$ .....	8-26
8.4.4.4—Size Factor, $C_F$ , for Sawn Lumber .....	8-26
8.4.4.5—Volume Factor, $C_V$ , (Glulam).....	8-27
8.4.4.6—Flat-Use Factor, $C_{fu}$ .....	8-28
8.4.4.7—Incising Factor, $C_i$ .....	8-29
8.4.4.8—Deck Factor, $C_d$ .....	8-29
8.4.4.9—Time Effect Factor, $C_\lambda$ .....	8-30
8.5—LIMIT STATES .....	8-30
8.5.1—Service Limit State .....	8-30
8.5.2—Strength Limit State .....	8-30
8.5.2.1—General.....	8-30
8.5.2.2—Resistance Factors.....	8-31
8.5.2.3—Stability .....	8-31
8.5.3—Extreme Event Limit State .....	8-31
8.6—COMPONENTS IN FLEXURE.....	8-31
8.6.1—General.....	8-31
8.6.2—Rectangular Section.....	8-31
8.6.3—Circular Section.....	8-33
8.7—COMPONENTS UNDER SHEAR .....	8-33
8.8—COMPONENTS IN COMPRESSION .....	8-33
8.8.1—General.....	8-33
8.8.2—Compression Parallel to Grain.....	8-33
8.8.3—Compression Perpendicular to Grain.....	8-34
8.9—COMPONENTS IN TENSION PARALLEL TO GRAIN.....	8-35
8.10—COMPONENTS IN COMBINED FLEXURE AND AXIAL LOADING .....	8-35
8.10.1—Components in Combined Flexure and Tension.....	8-35
8.10.2—Components in Combined Flexure and Compression Parallel to Grain .....	8-36
8.11—BRACING REQUIREMENTS .....	8-36
8.11.1—General.....	8-36
8.11.2—Sawn Wood Beams .....	8-36
8.11.3—Glued Laminated Timber Girders.....	8-37
8.11.4—Bracing of Trusses.....	8-37
8.12—CAMBER REQUIREMENTS .....	8-37
8.12.1—Glued Laminated Timber Girders.....	8-37
8.12.2—Trusses .....	8-37
8.12.3—Stress Laminated Timber Deck Bridge.....	8-37

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8.13—CONNECTION DESIGN .....	8-37
8.14—REFERENCES.....	8-37

SECTION 9: DECKS AND DECK SYSTEMS

TABLE OF CONTENTS

9.1—SCOPE ..... 9-1

9.2—DEFINITIONS ..... 9-1

9.3—NOTATION ..... 9-4

9.4—GENERAL DESIGN REQUIREMENTS ..... 9-4

    9.4.1—Interface Action ..... 9-4

    9.4.2—Deck Drainage ..... 9-4

    9.4.3—Concrete Appurtenances ..... 9-5

    9.4.4—Edge Supports ..... 9-5

    9.4.5—Stay-in-Place Formwork for Overhangs..... 9-5

9.5—LIMIT STATES ..... 9-5

    9.5.1—General..... 9-5

    9.5.2—Service Limit States ..... 9-5

    9.5.3—Fatigue and Fracture Limit State..... 9-6

    9.5.4—Strength Limit States..... 9-6

    9.5.5—Extreme Event Limit States ..... 9-6

9.6—ANALYSIS..... 9-6

    9.6.1—Methods of Analysis ..... 9-6

    9.6.2—Loading..... 9-6

9.7—CONCRETE DECK SLABS ..... 9-7

    9.7.1—General..... 9-7

        9.7.1.1—Minimum Depth and Cover ..... 9-7

        9.7.1.2—Composite Action ..... 9-7

        9.7.1.3—Skewed Decks..... 9-7

        9.7.1.4—Edge Support ..... 9-8

        9.7.1.5—Design of Cantilever Slabs..... 9-8

    9.7.2—Empirical Design ..... 9-8

        9.7.2.1—General..... 9-8

        9.7.2.2—Application ..... 9-9

        9.7.2.3—Effective Length ..... 9-9

        9.7.2.4—Design Conditions..... 9-10

        9.7.2.5—Reinforcement Requirements..... 9-11

        9.7.2.6—Deck with Stay-in-Place Formwork..... 9-12

    9.7.3—Traditional Design ..... 9-12

        9.7.3.1—General..... 9-12

        9.7.3.2—Distribution Reinforcement..... 9-12

    9.7.4—Stay-in-Place Formwork ..... 9-13

        9.7.4.1—General..... 9-13

        9.7.4.2—Steel Formwork..... 9-13

        9.7.4.3—Concrete Formwork ..... 9-13

            9.7.4.3.1—Depth ..... 9-13

9.7.4.3.2—Reinforcement .....	9-13
9.7.4.3.3—Creep and Shrinkage Control .....	9-14
9.7.4.3.4—Bedding of Panels .....	9-14
9.7.5—Precast Deck Slabs on Girders .....	9-14
9.7.5.1—General .....	9-14
9.7.5.2—Transversely Joined Precast Decks .....	9-14
9.7.5.3—Longitudinally Post-Tensioned Precast Decks .....	9-15
9.7.6—Deck Slabs in Segmental Construction .....	9-15
9.7.6.1—General .....	9-15
9.7.6.2—Joints in Decks .....	9-15
9.8—METAL DECKS .....	9-15
9.8.1—General .....	9-15
9.8.2—Metal Grid Decks .....	9-16
9.8.2.1—General .....	9-16
9.8.2.2—Open Grid Floors .....	9-16
9.8.2.3—Filled and Partially Filled Grid Decks .....	9-17
9.8.2.3.1—General .....	9-17
9.8.2.3.2—Design Requirements .....	9-17
9.8.2.3.3—Fatigue and Fracture Limit State .....	9-18
9.8.2.4—Unfilled Grid Decks Composite with Reinforced Concrete Slabs .....	9-18
9.8.2.4.1—General .....	9-18
9.8.2.4.2—Design .....	9-19
9.8.2.4.3—Fatigue Limit State .....	9-19
9.8.3—Orthotropic Steel Decks .....	9-20
9.8.3.1—General .....	9-20
9.8.3.2—Wheel Load Distribution .....	9-20
9.8.3.3—Wearing Surface .....	9-20
9.8.3.4—Analysis of Orthotropic Decks .....	9-21
9.8.3.4.1—General .....	9-21
9.8.3.4.2—Level 1 Design .....	9-23
9.8.3.4.3—Level 2 Design .....	9-23
9.8.3.4.3a—General .....	9-23
9.8.3.4.3b—Decks with Open Ribs .....	9-24
9.8.3.4.3c—Decks with Closed Ribs .....	9-24
9.8.3.4.4—Level 3 Design .....	9-24
9.8.3.5—Design .....	9-25
9.8.3.5.1—Superposition of Local and Global Effects .....	9-25
9.8.3.5.2—Limit States .....	9-25
9.8.3.5.2a—General .....	9-25
9.8.3.5.2b—Service Limit State .....	9-26
9.8.3.5.2c—Strength Limit State .....	9-26
9.8.3.5.2d—Fatigue Limit State .....	9-26
9.8.3.6—Detailing Requirements .....	9-26
9.8.3.6.1—Minimum Plate Thickness .....	9-26
9.8.3.6.2—Limit States .....	9-27
9.8.3.6.2a—General .....	9-27



9.8.3.6.2b—Service Limit State .....	9-27
9.8.3.6.2c—Strength Limit State .....	9-27
9.8.3.6.2d—Fatigue Limit State .....	9-27
9.8.3.6.3—Welding to Orthotropic Decks .....	9-28
9.8.3.6.4—Deck and Rib Details .....	9-28
9.8.3.7—Detailing Requirements .....	9-29
9.8.3.7.1—Minimum Plate Thickness .....	9-29
9.8.3.7.2—Closed Ribs .....	9-29
9.8.3.7.3—Welding to Orthotropic Decks .....	9-30
9.8.3.7.4—Deck and Rib Details .....	9-30
9.8.4—Orthotropic Aluminum Decks .....	9-31
9.8.4.1—General .....	9-31
9.8.4.2—Approximate Analysis .....	9-31
9.8.4.3—Limit States .....	9-31
9.8.5—Corrugated Metal Decks .....	9-32
9.8.5.1—General .....	9-32
9.8.5.2—Distribution of Wheel Loads .....	9-32
9.8.5.3—Composite Action .....	9-32
9.9—WOOD DECKS AND DECK SYSTEMS .....	9-32
9.9.1—Scope .....	9-32
9.9.2—General .....	9-32
9.9.3—Design Requirements .....	9-32
9.9.3.1—Load Distribution .....	9-32
9.9.3.2—Shear Design .....	9-33
9.9.3.3—Deformation .....	9-33
9.9.3.4—Thermal Expansion .....	9-33
9.9.3.5—Wearing Surfaces .....	9-33
9.9.3.6—Skewed Decks .....	9-33
9.9.4—Glued Laminated Decks .....	9-34
9.9.4.1—General .....	9-34
9.9.4.2—Deck Tie-Downs .....	9-34
9.9.4.3—Interconnected Decks .....	9-34
9.9.4.3.1—Panels Parallel to Traffic .....	9-34
9.9.4.3.2—Panels Perpendicular to Traffic .....	9-34
9.9.4.4—Noninterconnected Decks .....	9-35
9.9.5—Stress Laminated Decks .....	9-35
9.9.5.1—General .....	9-35
9.9.5.2—Nailing .....	9-35
9.9.5.3—Staggered Butt Joints .....	9-36
9.9.5.4—Holes in Laminations .....	9-36
9.9.5.5—Deck Tie-Downs .....	9-36
9.9.5.6—Stressing .....	9-36
9.9.5.6.1—Prestressing System .....	9-36
9.9.5.6.2—Prestressing Materials .....	9-38
9.9.5.6.3—Design Requirements .....	9-39
9.9.5.6.4—Corrosion Protection .....	9-40

9.9.5.6.5—Railings .....	9-40
9.9.6—Spike Laminated Decks .....	9-40
9.9.6.1—General .....	9-40
9.9.6.2—Deck Tie-Downs .....	9-41
9.9.6.3—Panel Decks .....	9-41
9.9.7—Plank Decks .....	9-42
9.9.7.1—General .....	9-42
9.9.7.2—Deck Tie-Downs .....	9-42
9.9.8—Wearing Surfaces for Wood Decks .....	9-42
9.9.8.1—General .....	9-42
9.9.8.2—Plant Mix Asphalt .....	9-42
9.9.8.3—Chip Seal .....	9-43
9.10—REFERENCES .....	9-43

**SECTION 10: FOUNDATIONS**

**TABLE OF CONTENTS**

10.1—SCOPE ..... 10-1

10.2—DEFINITIONS..... 10-1

10.3—NOTATION..... 10-3

10.4—SOIL AND ROCK PROPERTIES..... 10-7

    10.4.1—Informational Needs ..... 10-7

    10.4.2—Subsurface Exploration..... 10-8

    10.4.3—Laboratory Tests ..... 10-11

        10.4.3.1—Soil Tests ..... 10-11

        10.4.3.2—Rock Tests ..... 10-11

    10.4.4—In-Situ Tests..... 10-11

    10.4.5—Geophysical Tests..... 10-12

    10.4.6—Selection of Design Properties..... 10-13

        10.4.6.1—General..... 10-13

        10.4.6.2—Soil Strength ..... 10-15

            10.4.6.2.1—General ..... 10-15

            10.4.6.2.2—Undrained Strength of Cohesive Soils..... 10-15

            10.4.6.2.3—Drained Strength of Cohesive Soils..... 10-16

            10.4.6.2.4—Drained Strength of Granular Soils ..... 10-16

        10.4.6.3—Soil Deformation ..... 10-18

        10.4.6.4—Rock Mass Strength..... 10-21

        10.4.6.5—Rock Mass Deformation ..... 10-25

        10.4.6.6—Erodibility of Rock ..... 10-27

10.5—LIMIT STATES AND RESISTANCE FACTORS ..... 10-27

    10.5.1—General..... 10-27

    10.5.2—Service Limit States..... 10-27

        10.5.2.1—General..... 10-27

        10.5.2.2—Tolerable Movements and Movement Criteria ..... 10-28

        10.5.2.3—Overall Stability..... 10-28

        10.5.2.4—Abutment Transitions ..... 10-29

    10.5.3—Strength Limit States ..... 10-29

        10.5.3.1—General..... 10-29

        10.5.3.2—Spread Footings ..... 10-29

        10.5.3.3—Driven Piles ..... 10-30

        10.5.3.4—Drilled Shafts..... 10-30

        10.5.3.5—Micropiles..... 10-30

    10.5.4—Extreme Events Limit States..... 10-31

        10.5.4.1—Extreme Events Design..... 10-31

        10.5.4.2—Liquefaction Design Requirements..... 10-31

    10.5.5—Resistance Factors..... 10-38

        10.5.5.1—Service Limit States ..... 10-38

        10.5.5.2—Strength Limit States ..... 10-38

10.5.5.2.1—General.....	10-38
10.5.5.2.2—Spread Footings .....	10-39
10.5.5.2.3—Driven Piles.....	10-40
10.5.5.2.4—Drilled Shafts .....	10-47
10.5.5.2.5—Micropiles .....	10-49
10.5.5.3—Extreme Limit States.....	10-50
10.5.5.3.1—General.....	10-50
10.5.5.3.2—Scour .....	10-50
10.5.5.3.3—Other Extreme Limit States .....	10-51
10.6—SPREAD FOOTINGS.....	10-51
10.6.1—General Considerations .....	10-51
10.6.1.1—General.....	10-51
10.6.1.2—Bearing Depth .....	10-51
10.6.1.3—Effective Footing Dimensions.....	10-52
10.6.1.4—Bearing Stress Distributions.....	10-52
10.6.1.5—Anchorage of Inclined Footings.....	10-53
10.6.1.6—Groundwater .....	10-53
10.6.1.7—Uplift.....	10-53
10.6.1.8—Nearby Structures.....	10-53
10.6.2—Service Limit State Design.....	10-53
10.6.2.1—General.....	10-53
10.6.2.2—Tolerable Movements .....	10-53
10.6.2.3—Loads.....	10-54
10.6.2.4—Settlement Analyses .....	10-54
10.6.2.4.1—General.....	10-54
10.6.2.4.2—Settlement of Footings on Cohesionless Soils .....	10-55
10.6.2.4.3—Settlement of Footings on Cohesive Soils .....	10-58
10.6.2.4.4—Settlement of Footings on Rock.....	10-63
10.6.2.5—Overall Stability .....	10-64
10.6.2.6—Bearing Resistance at the Service Limit State.....	10-64
10.6.2.6.1—Presumptive Values for Bearing Resistance .....	10-64
10.6.2.6.2—Semiempirical Procedures for Bearing Resistance .....	10-65
10.6.3—Strength Limit State Design .....	10-66
10.6.3.1—Bearing Resistance of Soil .....	10-66
10.6.3.1.1—General.....	10-66
10.6.3.1.2—Theoretical Estimation .....	10-67
10.6.3.1.2a—Basic Formulation.....	10-67
10.6.3.1.2b—Considerations for Punching Shear.....	10-70
10.6.3.1.2c—Considerations for Footings on Slopes.....	10-71
10.6.3.1.2d—Considerations for Two-Layer Soil Systems—Critical Depth.....	10-73
10.6.3.1.2e—Two-Layered Soil System in Undrained Loading.....	10-74
10.6.3.1.2f—Two-Layered Soil System in Drained Loading .....	10-76
10.6.3.1.3—Semiempirical Procedures .....	10-76
10.6.3.1.4—Plate Load Tests.....	10-77
10.6.3.2—Bearing Resistance of Rock .....	10-77

10.6.3.2.1—General .....	10-77
10.6.3.2.2—Semiempirical Procedures .....	10-78
10.6.3.2.3—Analytic Method .....	10-78
10.6.3.2.4—Load Test .....	10-78
10.6.3.3—Eccentric Load Limitations .....	10-78
10.6.3.4—Failure by Sliding .....	10-79
10.6.4—Extreme Event Limit State Design .....	10-80
10.6.4.1—General .....	10-80
10.6.4.2—Eccentric Load Limitations .....	10-81
10.6.5—Structural Design .....	10-81
10.7—DRIVEN PILES .....	10-81
10.7.1—General .....	10-81
10.7.1.1—Application .....	10-81
10.7.1.2—Minimum Pile Spacing, Clearance, and Embedment into Cap .....	10-81
10.7.1.3—Piles through Embankment Fill .....	10-82
10.7.1.4—Batter Piles .....	10-82
10.7.1.5—Pile Design Requirements .....	10-82
10.7.1.6—Determination of Pile Loads .....	10-83
10.7.1.6.1—General .....	10-83
10.7.1.6.2—Downdrag .....	10-83
10.7.1.6.3—Uplift Due to Expansive Soils .....	10-83
10.7.1.6.4—Nearby Structures .....	10-84
10.7.2—Service Limit State Design .....	10-84
10.7.2.1—General .....	10-84
10.7.2.2—Tolerable Movements .....	10-84
10.7.2.3—Settlement .....	10-84
10.7.2.3.1—Equivalent Footing Analogy .....	10-84
10.7.2.3.2—Pile Groups in Cohesive Soil .....	10-86
10.7.2.4—Horizontal Pile Foundation Movement .....	10-87
10.7.2.5—Settlement Due to Downdrag .....	10-89
10.7.2.6—Lateral Squeeze .....	10-89
10.7.3—Strength Limit State Design .....	10-89
10.7.3.1—General .....	10-89
10.7.3.2—Point Bearing Piles on Rock .....	10-90
10.7.3.2.1—General .....	10-90
10.7.3.2.2—Piles Driven to Soft Rock .....	10-90
10.7.3.2.3—Piles Driven to Hard Rock .....	10-90
10.7.3.3—Pile Length Estimates for Contract Documents .....	10-91
10.7.3.4—Nominal Axial Resistance Change after Pile Driving .....	10-93
10.7.3.4.1—General .....	10-93
10.7.3.4.2—Relaxation .....	10-93
10.7.3.4.3—Setup .....	10-93
10.7.3.5—Groundwater Effects and Buoyancy .....	10-94
10.7.3.6—Scour .....	10-94
10.7.3.7—Downdrag .....	10-95

10.7.3.8—Determination of Nominal Bearing Resistance for Piles .....	10-96
10.7.3.8.1—General .....	10-96
10.7.3.8.2—Static Load Test .....	10-97
10.7.3.8.3—Dynamic Testing .....	10-97
10.7.3.8.4—Wave Equation Analysis .....	10-98
10.7.3.8.5—Dynamic Formula .....	10-99
10.7.3.8.6—Static Analysis .....	10-100
10.7.3.8.6a—General .....	10-100
10.7.3.8.6b— $\alpha$ -Method .....	10-101
10.7.3.8.6c— $\beta$ -Method .....	10-102
10.7.3.8.6d— $\lambda$ -Method .....	10-102
10.7.3.8.6e—Tip Resistance in Cohesive Soils .....	10-103
10.7.3.8.6f—Nordlund/Thurman Method in Cohesionless Soils .....	10-103
10.7.3.8.6g—Using SPT or CPT in Cohesionless Soils .....	10-108
10.7.3.9—Resistance of Pile Groups in Compression .....	10-112
10.7.3.10—Uplift Resistance of Single Piles .....	10-114
10.7.3.11—Uplift Resistance of Pile Groups .....	10-114
10.7.3.12—Nominal Lateral Resistance of Pile Foundations .....	10-116
10.7.3.13—Pile Structural Resistance .....	10-117
10.7.3.13.1—Steel Piles .....	10-117
10.7.3.13.2—Concrete Piles .....	10-117
10.7.3.13.3—Timber Piles .....	10-118
10.7.3.13.4—Buckling and Lateral Stability .....	10-118
10.7.4—Extreme Event Limit State .....	10-118
10.7.5—Corrosion and Deterioration .....	10-119
10.7.6—Determination of Minimum Pile Penetration .....	10-120
10.7.7—Determination of $R_{ndr}$ Used to Establish Contract Driving Criteria for Nominal Bearing Resistance .....	10-121
10.7.8—Drivability Analysis .....	10-121
10.7.9—Probe Piles .....	10-123
10.8—DRILLED SHAFTS .....	10-123
10.8.1—General .....	10-123
10.8.1.1—Scope .....	10-123
10.8.1.2—Shaft Spacing, Clearance, and Embedment into Cap .....	10-124
10.8.1.3—Shaft Diameter and Enlarged Bases .....	10-124
10.8.1.4—Battered Shafts .....	10-124
10.8.1.5—Drilled Shaft Resistance .....	10-125
10.8.1.6—Determination of Shaft Loads .....	10-126
10.8.1.6.1—General .....	10-126
10.8.1.6.2—Downdrag .....	10-126
10.8.1.6.3—Uplift .....	10-126
10.8.2—Service Limit State Design .....	10-126
10.8.2.1—Tolerable Movements .....	10-126
10.8.2.2—Settlement .....	10-126
10.8.2.2.1—General .....	10-126

10.8.2.2.2—Settlement of Single-Drilled Shaft.....	10-127
10.8.2.2.3—Intermediate Geo Materials (IGMs) .....	10-129
10.8.2.2.4—Group Settlement.....	10-130
10.8.2.3—Horizontal Movement of Shafts and Shaft Groups.....	10-130
10.8.2.4—Settlement Due to Downdrag.....	10-130
10.8.2.5—Lateral Squeeze.....	10-130
10.8.3—Strength Limit State Design.....	10-130
10.8.3.1—General.....	10-130
10.8.3.2—Groundwater Table and Buoyancy .....	10-130
10.8.3.3—Scour.....	10-130
10.8.3.4—Downdrag .....	10-130
10.8.3.5—Nominal Axial Compression Resistance of Single Drilled Shafts.....	10-131
10.8.3.5.1—Estimation of Drilled Shaft Resistance in Cohesive Soils.....	10-131
10.8.3.5.1a—General.....	10-131
10.8.3.5.1b—Side Resistance.....	10-132
10.8.3.5.1c—Tip Resistance.....	10-133
10.8.3.5.2—Estimation of Drilled Shaft Resistance in Cohesionless Soils.....	10-134
10.8.3.5.2a—General.....	10-134
10.8.3.5.2b—Side Resistance.....	10-134
10.8.3.5.2c—Tip Resistance.....	10-135
10.8.3.5.3—Shafts in Strong Soil Overlying Weaker Compressible Soil .....	10-136
10.8.3.5.4—Estimation of Drilled Shaft Resistance in Rock .....	10-136
10.8.3.5.4a—General.....	10-136
10.8.3.5.4b—Side Resistance.....	10-137
10.8.3.5.4c—Tip Resistance.....	10-138
10.8.3.5.4d—Combined Side and Tip Resistance .....	10-138
10.8.3.5.5—Estimation of Drilled Shaft Resistance in Intermediate Geo Materials (IGMs) .....	10-139
10.8.3.5.6—Shaft Load Test.....	10-139
10.8.3.6—Shaft Group Resistance.....	10-140
10.8.3.6.1—General .....	10-140
10.8.3.6.2—Cohesive Soil.....	10-140
10.8.3.6.3—Cohesionless Soil.....	10-141
10.8.3.6.4—Shaft Groups in Strong Soil Overlying Weak Soil .....	10-141
10.8.3.7—Uplift Resistance.....	10-142
10.8.3.7.1—General .....	10-142
10.8.3.7.2—Uplift Resistance of Single Drilled Shaft .....	10-142
10.8.3.7.3—Group Uplift Resistance .....	10-143
10.8.3.7.4—Uplift Load Test.....	10-143
10.8.3.8—Nominal Horizontal Resistance of Shaft and Shaft Groups.....	10-143
10.8.3.9—Shaft Structural Resistance .....	10-143
10.8.3.9.1—General .....	10-143
10.8.3.9.2—Buckling and Lateral Stability.....	10-143
10.8.3.9.3—Reinforcement .....	10-143
10.8.3.9.4—Transverse Reinforcement.....	10-144
10.8.3.9.5—Concrete.....	10-144
10.8.3.9.6—Reinforcement into Superstructure.....	10-144

10.8.3.9.7—Enlarged Bases.....	10-144
10.8.4—Extreme Event Limit State .....	10-144
10.9—MICROPILES .....	10-145
10.9.1—General.....	10-145
10.9.1.1—Scope.....	10-146
10.9.1.2—Minimum Micropile Spacing, Clearance, and Embedment into Cap.....	10-146
10.9.1.3—Micropiles through Embankment Fill .....	10-146
10.9.1.4—Battered Micropiles.....	10-146
10.9.1.5—Micropile Design Requirements .....	10-146
10.9.1.6—Determination of Micropile Loads.....	10-147
10.9.1.6.1—Downdrag .....	10-147
10.9.1.6.2—Uplift Due to Expansive Soils.....	10-147
10.9.1.6.3—Nearby Structures .....	10-147
10.9.2—Service Limit State Design.....	10-147
10.9.2.1—General .....	10-147
10.9.2.2—Tolerable Movements .....	10-147
10.9.2.3—Settlement .....	10-147
10.9.2.3.1—Micropile Groups in Cohesive Soil.....	10-147
10.9.2.3.2—Micropile Groups in Cohesionless Soil.....	10-147
10.9.2.4—Horizontal Micropile Foundation Movement .....	10-147
10.9.2.5—Settlement Due to Downdrag.....	10-147
10.9.2.6—Lateral Squeeze .....	10-147
10.9.3—Strength Limit State Design.....	10-148
10.9.3.1—General.....	10-148
10.9.3.2—Ground Water Table and Bouyancy.....	10-148
10.9.3.3—Scour .....	10-148
10.9.3.4—Downdrag.....	10-148
10.9.3.5—Nominal Axial Compression Resistance of a Single Micropile.....	10-148
10.9.3.5.1—General.....	10-148
10.9.3.5.2—Estimation of Grout-to-Ground Bond Resistance .....	10-149
10.9.3.5.3—Estimation of Micropile Tip Resistance in Rock .....	10-150
10.9.3.5.4—Micropile Load Test.....	10-151
10.9.3.6—Resistance of Micropile Groups in Compression.....	10-151
10.9.3.7—Nominal Uplift Resistance of a Single Micropile .....	10-151
10.9.3.8—Nominal Uplift Resistance of Micropile Groups .....	10-151
10.9.3.9—Nominal Horizontal Resistance of Micropiles and Micropile Groups.....	10-152
10.9.3.10—Structural Resistance.....	10-152
10.9.3.10.1—General.....	10-152
10.9.3.10.2—Axial Compressive Resistance.....	10-152
10.9.3.10.2a—Cased Length .....	10-153
10.9.3.10.2b—Uncased Length .....	10-153
10.9.3.10.3—Axial Tension Resistance.....	10-154
10.9.3.10.3a—Cased Length .....	10-154
10.9.3.10.3b—Uncased Length .....	10-155
10.9.3.10.4—Plunge Length Transfer Load .....	10-155



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10.9.3.10.5—Grout-to-Steel Bond .....	10-156
10.9.3.10.6—Buckling and Lateral Stability .....	10-156
10.9.3.10.7—Reinforcement into Superstructure .....	10-156
10.9.4—Extreme Event Limit State .....	10-156
10.9.5—Corrosion and Deterioration .....	10-156
10.10—REFERENCES .....	10-156
APPENDIX A10—SEISMIC ANALYSIS AND DESIGN OF FOUNDATIONS .....	10-163
A10.1—INVESTIGATION .....	10-163
A10.2—FOUNDATION DESIGN .....	10-163
A10.3—SPECIAL PILE REQUIREMENTS .....	10-167

SECTION 11: WALLS, ABUTMENTS, AND PIERS

TABLE OF CONTENTS

11.1—SCOPE ..... 11-1

11.2—DEFINITIONS..... 11-1

11.3—NOTATION..... 11-2

    11.3.1—General..... 11-2

11.4—SOIL PROPERTIES AND MATERIALS ..... 11-5

    11.4.1—General..... 11-5

    11.4.2—Determination of Soil Properties..... 11-5

11.5—LIMIT STATES AND RESISTANCE FACTORS ..... 11-6

    11.5.1—General..... 11-6

    11.5.2—Service Limit States ..... 11-6

    11.5.3—Strength Limit State ..... 11-7

    11.5.4—Extreme Event Limit State..... 11-7

        11.5.4.1—General Requirements ..... 11-7

        11.5.4.2—Extreme Event I, No Analysis ..... 11-8

    11.5.5—Resistance Requirement..... 11-10

    11.5.6—Load Combinations and Load Factors ..... 11-10

    11.5.7—Resistance Factors—Service and Strength..... 11-13

    11.5.8—Resistance Factors—Extreme Event Limit State ..... 11-16

11.6—ABUTMENTS AND CONVENTIONAL RETAINING WALLS ..... 11-16

    11.6.1—General Considerations ..... 11-16

        11.6.1.1—General..... 11-16

        11.6.1.2—Loading..... 11-17

        11.6.1.3—Integral Abutments ..... 11-18

        11.6.1.4—Wingwalls ..... 11-18

        11.6.1.5—Reinforcement ..... 11-18

            11.6.1.5.1—Conventional Walls and Abutments ..... 11-18

            11.6.1.5.2—Wingwalls..... 11-18

        11.6.1.6—Expansion and Contraction Joints..... 11-18

    11.6.2—Movement and Stability at the Service Limit State..... 11-19

        11.6.2.1—Abutments..... 11-19

        11.6.2.2—Conventional Retaining Walls ..... 11-19

        11.6.2.3—Overall Stability..... 11-19

    11.6.3—Bearing Resistance and Stability at the Strength Limit State..... 11-20

        11.6.3.1—General..... 11-20

        11.6.3.2—Bearing Resistance..... 11-20

        11.6.3.3—Eccentricity Limits..... 11-22

        11.6.3.4—Subsurface Erosion ..... 11-22

        11.6.3.5—Passive Resistance ..... 11-23

        11.6.3.6—Sliding..... 11-23

    11.6.4—Safety against Structural Failure ..... 11-23

    11.6.5—Seismic Design for Abutments and Conventional Retaining Walls..... 11-23

        11.6.5.1—General..... 11-23

        11.6.5.2—Calculation of Seismic Acceleration Coefficients for Wall Design..... 11-26

            11.6.5.2.1—Characterization of Acceleration at Wall Base..... 11-26

            11.6.5.2.2—Estimation of Acceleration Acting on Wall Mass ..... 11-26

11.6.5.3—Calculation of Seismic Active Earth Pressures .....	11-27
11.6.5.4—Calculation of Seismic Earth Pressure for Nonyielding Abutments and Walls .....	11-30
11.6.5.5—Calculation of Seismic Passive Earth Pressure .....	11-31
11.6.5.6—Wall Details for Improved Seismic Performance.....	11-32
11.6.6—Drainage.....	11-33
11.7—PIERS.....	11-33
11.7.1—Load Effects in Piers .....	11-33
11.7.2—Pier Protection.....	11-34
11.7.2.1—Collision.....	11-34
11.7.2.2—Collision Walls.....	11-34
11.7.2.3—Scour.....	11-34
11.7.2.4—Facing.....	11-34
11.8—NONGRAVITY CANTILEVERED WALLS .....	11-34
11.8.1—General.....	11-34
11.8.2—Loading.....	11-34
11.8.3—Movement and Stability at the Service Limit State.....	11-34
11.8.3.1—Movement.....	11-34
11.8.3.2—Overall Stability.....	11-35
11.8.4—Safety against Soil Failure at the Strength Limit State.....	11-35
11.8.4.1—Overall Stability.....	11-35
11.8.5—Safety against Structural Failure.....	11-36
11.8.5.1—Vertical Wall Elements.....	11-36
11.8.5.2—Facing.....	11-36
11.8.6—Seismic Design of Nongravity Cantilever Walls.....	11-38
11.8.6.1—General.....	11-38
11.8.6.2—Seismic Active Lateral Earth Pressure.....	11-38
11.8.6.3—Seismic Passive Lateral Earth Pressure.....	11-40
11.8.6.4—Wall Displacement Analyses to Determine Earth Pressures.....	11-41
11.8.7—Corrosion Protection .....	11-42
11.8.8—Drainage.....	11-43
11.9—ANCHORED WALLS.....	11-43
11.9.1—General.....	11-43
11.9.2—Loading.....	11-44
11.9.3—Movement and Stability at the Service Limit State.....	11-44
11.9.3.1—Movement.....	11-44
11.9.3.2—Overall Stability.....	11-45
11.9.4—Safety against Soil Failure.....	11-45
11.9.4.1—Bearing Resistance.....	11-45
11.9.4.2—Anchor Pullout Capacity.....	11-46
11.9.4.3—Passive Resistance.....	11-49
11.9.5—Safety against Structural Failure.....	11-49
11.9.5.1—Anchors.....	11-49
11.9.5.2—Vertical Wall Elements.....	11-51
11.9.5.3—Facing.....	11-51
11.9.6—Seismic Design.....	11-51
11.9.7—Corrosion Protection .....	11-52

11.9.8—Construction and Installation .....	11-53
11.9.8.1—Anchor Stressing and Testing .....	11-53
11.9.9—Drainage .....	11-54
11.10—MECHANICALLY STABILIZED EARTH WALLS .....	11-54
11.10.1—General .....	11-54
11.10.2—Structure Dimensions .....	11-56
11.10.2.1—Minimum Length of Soil Reinforcement .....	11-57
11.10.2.2—Minimum Front Face Embedment .....	11-58
11.10.2.3—Facing .....	11-58
11.10.2.3.1—Stiff or Rigid Concrete, Steel, and Timber Facings .....	11-59
11.10.2.3.2—Flexible Wall Facings .....	11-59
11.10.2.3.3—Corrosion Issues for MSE Facing .....	11-60
11.10.3—Loading .....	11-60
11.10.4—Movement and Stability at the Service Limit State .....	11-60
11.10.4.1—Settlement .....	11-60
11.10.4.2—Lateral Displacement .....	11-61
11.10.4.3—Overall Stability .....	11-61
11.10.5—Safety against Soil Failure (External Stability) .....	11-62
11.10.5.1—General .....	11-62
11.10.5.2—Loading .....	11-63
11.10.5.3—Sliding .....	11-64
11.10.5.4—Bearing Resistance .....	11-64
11.10.5.5—Overturning .....	11-64
11.10.6—Safety against Structural Failure (Internal Stability) .....	11-65
11.10.6.1—General .....	11-65
11.10.6.2—Loading .....	11-65
11.10.6.2.1—Maximum Reinforcement Loads .....	11-66
11.10.6.2.2—Reinforcement Loads at Connection to Wall Face .....	11-70
11.10.6.3—Reinforcement Pullout .....	11-70
11.10.6.3.1—Boundary between Active and Resistant Zones .....	11-70
11.10.6.3.2—Reinforcement Pullout Design .....	11-72
11.10.6.4—Reinforcement Strength .....	11-74
11.10.6.4.1—General .....	11-74
11.10.6.4.2—Design Life Considerations .....	11-76
11.10.6.4.2a—Steel Reinforcements .....	11-76
11.10.6.4.2b—Geosynthetic Reinforcements .....	11-78
11.10.6.4.3—Design Tensile Resistance .....	11-80
11.10.6.4.3a—Steel Reinforcements .....	11-80
11.10.6.4.3b—Geosynthetic Reinforcements .....	11-80
11.10.6.4.4—Reinforcement/Facing Connection Design Strength .....	11-82
11.10.6.4.4a—Steel Reinforcements .....	11-82
11.10.6.4.4b—Geosynthetic Reinforcements .....	11-82
11.10.7—Seismic Design of MSE Walls .....	11-86
11.10.7.1—External Stability .....	11-86
11.10.7.2—Internal Stability .....	11-87
11.10.7.3—Facing Reinforcement Connections .....	11-91
11.10.7.4—Wall Details for Improved Seismic Performance .....	11-93

11.10.8—Drainage .....	11-94
11.10.9—Subsurface Erosion.....	11-94
11.10.10—Special Loading Conditions .....	11-95
11.10.10.1—Concentrated Dead Loads .....	11-95
11.10.10.2—Traffic Loads and Barriers .....	11-96
11.10.10.3—Hydrostatic Pressures .....	11-98
11.10.10.4—Obstructions in the Reinforced Soil Zone .....	11-98
11.10.11—MSE Abutments .....	11-99
11.11—PREFABRICATED MODULAR WALLS .....	11-101
11.11.1—General .....	11-101
11.11.2—Loading .....	11-102
11.11.3—Movement at the Service Limit State .....	11-102
11.11.4—Safety against Soil Failure.....	11-102
11.11.4.1—General .....	11-102
11.11.4.2—Sliding .....	11-102
11.11.4.3—Bearing Resistance .....	11-102
11.11.4.4—Overturning .....	11-103
11.11.4.5—Subsurface Erosion .....	11-103
11.11.4.6—Overall Stability .....	11-103
11.11.4.7—Passive Resistance and Sliding .....	11-103
11.11.5—Safety against Structural Failure .....	11-103
11.11.5.1—Module Members .....	11-103
11.11.6—Seismic Design for Prefabricated Modular Walls .....	11-104
11.11.7—Abutments .....	11-105
11.11.8—Drainage .....	11-105
11.12—REFERENCES .....	11-105
APPENDIX A11—SEISMIC DESIGN OF RETAINING STRUCTURES .....	11-109
A11.1—GENERAL .....	11-109
A11.2—PERFORMANCE OF WALLS IN PAST EARTHQUAKES.....	11-109
A11.3—CALCULATION OF SEISMIC ACTIVE PRESSURE.....	11-110
A11.3.1—Mononobe-Okabe Method .....	11-110
A11.3.2—Modification of Mononobe-Okabe Method to Consider Cohesion .....	11-112
A11.3.3—Generalized Limit Equilibrium (GLE) Method.....	11-115
A11.4—SEISMIC PASSIVE PRESSURE .....	11-115
A11.5—ESTIMATING WALL SEISMIC ACCELERATION CONSIDERING WAVE SCATTERING AND WALL DISPLACEMENT .....	11-120
A11.5.1—Kavazanjian et al., (1997).....	11-121
A11.5.2—NCHRP Report 611—Anderson et al. (2008).....	11-121
A11.5.3—Bray et al. (2010), and Bray and Travasarou (2009) .....	11-124
A11.6—APPENDIX REFERENCES .....	11-124

SECTION 12: BURIED STRUCTURES AND TUNNEL LINERS

TABLE OF CONTENTS

12.1—SCOPE ..... 12-1

12.2—DEFINITIONS ..... 12-1

12.3—NOTATION ..... 12-1

12.4—SOIL AND MATERIAL PROPERTIES ..... 12-6

    12.4.1—Determination of Soil Properties ..... 12-6

        12.4.1.1—General ..... 12-6

        12.4.1.2—Foundation Soils ..... 12-6

        12.4.1.3—Envelope Backfill Soils ..... 12-6

    12.4.2—Materials ..... 12-7

        12.4.2.1—Aluminum Pipe and Structural Plate Structures ..... 12-7

        12.4.2.2—Concrete ..... 12-7

        12.4.2.3—Precast Concrete Pipe ..... 12-7

        12.4.2.4—Precast Concrete Structures ..... 12-7

        12.4.2.5—Steel Pipe and Structural Plate Structures ..... 12-7

        12.4.2.6—Deep Corrugated Structures ..... 12-8

        12.4.2.7—Steel Reinforcement ..... 12-8

        12.4.2.8—Thermoplastic Pipe ..... 12-8

12.5—LIMIT STATES AND RESISTANCE FACTORS ..... 12-8

    12.5.1—General ..... 12-8

    12.5.2—Service Limit State ..... 12-9

    12.5.3—Strength Limit State ..... 12-9

    12.5.4—Load Modifiers and Load Factors ..... 12-9

    12.5.5—Resistance Factors ..... 12-10

    12.5.6—Flexibility Limits and Construction Stiffness ..... 12-12

        12.5.6.1—Corrugated Metal Pipe and Structural Plate Structures ..... 12-12

        12.5.6.2—Spiral Rib Metal Pipe and Pipe Arches ..... 12-12

        12.5.6.3—Flexibility Limits and Construction Stiffness—Thermoplastic Pipe ..... 12-13

        12.5.6.4—Steel Tunnel Liner Plate ..... 12-13

12.6—GENERAL DESIGN FEATURES ..... 12-13

    12.6.1—Loading ..... 12-13

    12.6.2—Service Limit State ..... 12-14

        12.6.2.1—Tolerable Movement ..... 12-14

        12.6.2.2—Settlement ..... 12-14

            12.6.2.2.1—General ..... 12-14

            12.6.2.2.2—Longitudinal Differential Settlement ..... 12-14

            12.6.2.2.3—Differential Settlement between Structure and Backfill ..... 12-14

            12.6.2.2.4—Footing Settlement ..... 12-14

            12.6.2.2.5—Unbalanced Loading ..... 12-15

        12.6.2.3—Uplift ..... 12-18

    12.6.3—Safety against Soil Failure ..... 12-18

        12.6.3.1—Bearing Resistance and Stability ..... 12-18

12.6.3.2—Corner Backfill for Metal Pipe Arches .....	12-19
12.6.4—Hydraulic Design .....	12-19
12.6.5—Scour .....	12-19
12.6.6—Soil Envelope .....	12-19
12.6.6.1—Trench Installations .....	12-19
12.6.6.2—Embankment Installations .....	12-19
12.6.6.3—Minimum Cover .....	12-20
12.6.7—Minimum Spacing between Multiple Lines of Pipe .....	12-21
12.6.8—End Treatment .....	12-22
12.6.8.1—General .....	12-22
12.6.8.2—Flexible Culverts Constructed on Skew .....	12-22
12.6.9—Corrosive and Abrasive Conditions .....	12-23
12.7—METAL PIPE, PIPE ARCH, AND ARCH STRUCTURES .....	12-24
12.7.1—General .....	12-24
12.7.2—Safety against Structural Failure .....	12-24
12.7.2.1—Section Properties .....	12-24
12.7.2.2—Thrust .....	12-24
12.7.2.3—Wall Resistance .....	12-25
12.7.2.4—Resistance to Buckling .....	12-25
12.7.2.5—Seam Resistance .....	12-25
12.7.2.6—Handling and Installation Requirements .....	12-25
12.7.3—Smooth Lined Pipe .....	12-26
12.7.4—Stiffening Elements for Structural Plate Structures .....	12-26
12.7.5—Construction and Installation .....	12-26
12.8—LONG-SPAN STRUCTURAL PLATE STRUCTURES .....	12-26
12.8.1—General .....	12-26
12.8.2—Service Limit State .....	12-27
12.8.3—Safety against Structural Failure .....	12-27
12.8.3.1—Section Properties .....	12-27
12.8.3.1.1—Cross-Section .....	12-27
12.8.3.1.2—Shape Control .....	12-28
12.8.3.1.3—Mechanical and Chemical Requirements .....	12-28
12.8.3.2—Thrust .....	12-29
12.8.3.3—Wall Area .....	12-29
12.8.3.4—Seam Strength .....	12-29
12.8.3.5—Acceptable Special Features .....	12-29
12.8.3.5.1—Continuous Longitudinal Stiffeners .....	12-29
12.8.3.5.2—Reinforcing Ribs .....	12-29
12.8.4—Safety against Structural Failure—Foundation Design .....	12-29
12.8.4.1—Settlement Limits .....	12-29
12.8.4.2—Footing Reactions in Arch Structures .....	12-30
12.8.4.3—Footing Design .....	12-31
12.8.5—Safety against Structural Failure—Soil Envelope Design .....	12-31
12.8.5.1—General .....	12-31
12.8.5.2—Construction Requirements .....	12-31

12.8.5.3—Service Requirements .....	12-32
12.8.6—Safety against Structural Failure—End Treatment Design .....	12-33
12.8.6.1—General.....	12-33
12.8.6.2—Standard Shell End Types.....	12-33
12.8.6.3—Balanced Support.....	12-35
12.8.6.4—Hydraulic Protection.....	12-35
12.8.6.4.1—General .....	12-35
12.8.6.4.2—Backfill Protection.....	12-36
12.8.6.4.3—Cut-Off (Toe) Walls .....	12-36
12.8.6.4.4—Hydraulic Uplift.....	12-36
12.8.6.4.5—Scour.....	12-36
12.8.7—Concrete Relieving Slabs.....	12-36
12.8.8—Construction and Installation .....	12-37
12.8.9—Deep Corrugated Structural Plate Structures .....	12-37
12.8.9.1—General.....	12-37
12.8.9.2—Width of Structural Backfill .....	12-37
12.8.9.2.1—Deep Corrugated Structures with Ratio of Crown Radius to Haunch Radius $\leq 5$ .....	12-37
12.8.9.2.2—Deep Corrugated Structures with Ratio of Crown Radius to Haunch Radius $> 5$ .....	12-37
12.8.9.3—Safety against Structural Failure.....	12-38
12.8.9.3.1—Structural Plate Requirements .....	12-38
12.8.9.3.2—Structural Analysis .....	12-38
12.8.9.4—Minimum Depth of Fill.....	12-38
12.8.9.5—Combined Thrust and Moment.....	12-39
12.8.9.6—Global Buckling.....	12-40
12.8.9.7—Connections .....	12-40
12.9—STRUCTURAL PLATE BOX STRUCTURES .....	12-40
12.9.1—General.....	12-40
12.9.2—Loading.....	12-41
12.9.3—Service Limit State.....	12-41
12.9.4—Safety against Structural Failure.....	12-41
12.9.4.1—General.....	12-41
12.9.4.2—Moments Due to Factored Loads.....	12-42
12.9.4.3—Plastic Moment Resistance .....	12-44
12.9.4.4—Crown Soil Cover Factor, $C_H$ .....	12-45
12.9.4.5—Footing Reactions .....	12-45
12.9.4.6—Concrete Relieving Slabs.....	12-46
12.9.5—Construction and Installation .....	12-47
12.10—REINFORCED CONCRETE PIPE .....	12-47
12.10.1—General.....	12-47
12.10.2 Loading.....	12-48
12.10.2.1 Standard Installations.....	12-48
12.10.2.2 Pipe Fluid Weight .....	12-52
12.10.2.3—Live Loads .....	12-52
12.10.3—Service Limit State.....	12-52
12.10.4—Safety against Structural Failure .....	12-52



12.10.4.1—General.....	12-52
12.10.4.2—Direct Design Method.....	12-53
12.10.4.2.1—Loads and Pressure Distribution.....	12-53
12.10.4.2.2—Analysis for Force Effects with the Pipe Ring.....	12-54
12.10.4.2.3—Process and Material Factors.....	12-55
12.10.4.2.4—Flexural Resistance at the Strength Limit State.....	12-55
12.10.4.2.4a—Circumferential Reinforcement.....	12-55
12.10.4.2.4b—Minimum Reinforcement.....	12-55
12.10.4.2.4c—Maximum Flexural Reinforcement without Stirrups.....	12-56
12.10.4.2.4d—Reinforcement for Crack Width Control.....	12-57
12.10.4.2.4e—Minimum Concrete Cover.....	12-58
12.10.4.2.5—Shear Resistance without Stirrups.....	12-58
12.10.4.2.6—Shear Resistance with Radial Stirrups.....	12-60
12.10.4.2.7—Stirrup Reinforcement Anchorage.....	12-61
12.10.4.2.7a—Radial Tension Stirrup Anchorage.....	12-61
12.10.4.2.7b—Shear Stirrup Anchorage.....	12-61
12.10.4.2.7c—Stirrup Embedment.....	12-61
12.10.4.3—Indirect Design Method.....	12-61
12.10.4.3.1—Bearing Resistance.....	12-61
12.10.4.3.2—Bedding Factor.....	12-62
12.10.4.3.2a—Earth Load Bedding Factor for Circular Pipe.....	12-62
12.10.4.3.2b—Earth Load Bedding Factor for Arch and Elliptical Pipe.....	12-63
12.10.4.3.2c—Live Load Bedding Factors.....	12-64
12.10.4.4—Development of Quadrant Mat Reinforcement.....	12-64
12.10.4.4.1—Minimum Cage Reinforcement.....	12-64
12.10.4.4.2—Development Length of Welded Wire Fabric.....	12-64
12.10.4.4.3—Development of Quadrant Mat Reinforcement Consisting of Welded Plain Wire Fabric.....	12-64
12.10.4.4.4—Development of Quadrant Mat Reinforcement Consisting of Deformed Bars, Deformed Wire, or Deformed Wire Fabric.....	12-65
12.10.5—Construction and Installation.....	12-65
<b>12.11—REINFORCED CONCRETE CAST-IN-PLACE AND PRECAST BOX CULVERTS AND REINFORCED CAST-IN-PLACE ARCHES.....</b>	<b>12-65</b>
12.11.1—General.....	12-65
12.11.2—Loads and Live Load Distribution.....	12-66
12.11.2.1—General.....	12-66
12.11.2.2—Modification of Earth Loads for Soil-Structure Interaction.....	12-66
12.11.2.2.1—Embankment and Trench Conditions.....	12-66
12.11.2.2.2—Other Installations.....	12-69
12.11.2.3—Distribution of Concentrated Loads to Bottom Slab of Box Culvert.....	12-69
12.11.2.4—Distribution of Concentrated Loads in Skewed Box Culverts.....	12-69
12.11.3—Service Limit State.....	12-69
12.11.4—Safety against Structural Failure.....	12-70
12.11.4.1—General.....	12-70
12.11.4.2—Design Moment for Box Culverts.....	12-70
12.11.4.3—Minimum Reinforcement.....	12-70

12.11.4.3.1—Cast-in-Place Structures.....	12-70
12.11.4.3.2—Precast Box Structures.....	12-70
12.11.4.4—Minimum Cover for Precast Box Structures.....	12-71
12.11.5—Construction and Installation.....	12-71
12.12—THERMOPLASTIC PIPES.....	12-71
12.12.1—General.....	12-71
12.12.2—Service Limit States.....	12-71
12.12.2.1—General.....	12-71
12.12.2.2—Deflection Requirement.....	12-71
12.12.3—Safety against Structural Failure.....	12-73
12.12.3.1—General.....	12-73
12.12.3.2—Section Properties.....	12-73
12.12.3.3—Chemical and Mechanical Requirements.....	12-73
12.12.3.4—Thrust.....	12-74
12.12.3.5—Factored and Service Loads.....	12-74
12.12.3.6—Handling and Installation Requirements.....	12-78
12.12.3.7—Soil Prism.....	12-79
12.12.3.8—Hydrostatic Pressure.....	12-80
12.12.3.9—Live Load.....	12-80
12.12.3.10—Wall Resistance.....	12-81
12.12.3.10.1—Resistance to Axial Thrust.....	12-81
12.12.3.10.1a—General.....	12-81
12.12.3.10.1b—Local Buckling Effective Area.....	12-81
12.12.3.10.1c—Compression Strain.....	12-82
12.12.3.10.1d—Thrust Strain Limits.....	12-83
12.12.3.10.1e—General Buckling Strain Limits.....	12-83
12.12.3.10.2—Bending and Thrust Strain Limits.....	12-84
12.12.3.10.2a—General.....	12-84
12.12.3.10.2b—Combined Strain.....	12-84
12.12.4—Construction and Installation.....	12-86
12.13—STEEL TUNNEL LINER PLATE.....	12-87
12.13.1—General.....	12-87
12.13.2—Loading.....	12-87
12.13.2.1—Earth Loads.....	12-87
12.13.2.2—Live Loads.....	12-88
12.13.2.3—Grouting Pressure.....	12-88
12.13.3—Safety against Structural Failure.....	12-88
12.13.3.1—Section Properties.....	12-88
12.13.3.2—Wall Area.....	12-88
12.13.3.3—Buckling.....	12-89
12.13.3.4—Seam Strength.....	12-89
12.13.3.5—Construction Stiffness.....	12-89
12.14—PRECAST REINFORCED CONCRETE THREE-SIDED STRUCTURES.....	12-91
12.14.1—General.....	12-91

12.14.2—Materials.....	12-91
12.14.2.1—Concrete .....	12-91
12.14.2.2—Reinforcement.....	12-91
12.14.3—Concrete Cover for Reinforcement .....	12-91
12.14.4—Geometric Properties.....	12-91
12.14.5—Design .....	12-91
12.14.5.1—General.....	12-91
12.14.5.2—Distribution of Concentrated Load Effects in Top Slab and Sides.....	12-92
12.14.5.3—Distribution of Concentrated Loads in Skewed Culverts .....	12-92
12.14.5.4—Shear Transfer in Transverse Joints between Culvert Sections.....	12-92
12.14.5.5—Span Length .....	12-92
12.14.5.6—Resistance Factors.....	12-93
12.14.5.7—Crack Control.....	12-93
12.14.5.8—Minimum Reinforcement.....	12-93
12.14.5.9—Deflection Control at the Service Limit State .....	12-93
12.14.5.10—Footing Design.....	12-93
12.14.5.11—Structural Backfill.....	12-93
12.14.5.12—Scour Protection and Waterway Considerations .....	12-93
12.15—REFERENCES.....	12-94
APPENDIX A12—PLATE, PIPE, AND PIPE ARCH PROPERTIES.....	12-97

SECTION 13: RAILINGS

TABLE OF CONTENTS

13.1—SCOPE ..... 13-1

13.2—DEFINITIONS ..... 13-1

13.3—NOTATION ..... 13-2

13.4—GENERAL ..... 13-3

13.5—MATERIALS ..... 13-5

13.6—LIMIT STATES AND RESISTANCE FACTORS ..... 13-5

    13.6.1—Strength Limit State ..... 13-5

    13.6.2—Extreme Event Limit State ..... 13-5

13.7—TRAFFIC RAILING ..... 13-5

    13.7.1—Railing System ..... 13-5

        13.7.1.1—General ..... 13-5

        13.7.1.2—Approach Railings ..... 13-6

        13.7.1.3—End Treatment ..... 13-6

    13.7.2—Test Level Selection Criteria ..... 13-7

    13.7.3—Railing Design ..... 13-8

        13.7.3.1—General ..... 13-8

            13.7.3.1.1—Application of Previously Tested Systems ..... 13-8

            13.7.3.1.2—New Systems ..... 13-9

        13.7.3.2—Height of Traffic Parapet or Railing ..... 13-9

13.8—PEDESTRIAN RAILING ..... 13-9

    13.8.1—Geometry ..... 13-9

    13.8.2—Design Live Loads ..... 13-10

13.9—BICYCLE RAILINGS ..... 13-11

    13.9.1—General ..... 13-11

    13.9.2—Geometry ..... 13-11

    13.9.3—Design Live Loads ..... 13-11

13.10—COMBINATION RAILINGS ..... 13-12

    13.10.1—General ..... 13-12

    13.10.2—Geometry ..... 13-12

    13.10.3—Design Live Loads ..... 13-12

13.11—CURBS AND SIDEWALKS ..... 13-12

    13.11.1—General ..... 13-12

    13.11.2—Sidewalks ..... 13-13

    13.11.3—End Treatment of Separation Railing ..... 13-13

13.12—REFERENCES ..... 13-13

APPENDIX A13—RAILINGS ..... 13-15

A13.1—GEOMETRY AND ANCHORAGES .....	13-15
A13.1.1—Separation of Rail Elements .....	13-15
A13.1.2—Anchorage.....	13-17
A13.2—TRAFFIC RAILING DESIGN FORCES .....	13-17
A13.3—DESIGN PROCEDURE FOR RAILING TEST SPECIMENS.....	13-19
A13.3.1—Concrete Railings .....	13-19
A13.3.2—Post-and-Beam Railings .....	13-21
A13.3.3—Concrete Parapet and Metal Rail .....	13-22
A13.3.4—Wood Barriers .....	13-24
A13.4—DECK OVERHANG DESIGN .....	13-25
A13.4.1—Design Cases .....	13-25
A13.4.2—Decks Supporting Concrete Parapet Railings.....	13-25
A13.4.3—Decks Supporting Post-and-Beam Railings.....	13-26
A13.4.3.1—Overhang Design.....	13-26
A13.4.3.2—Resistance to Punching Shear.....	13-27

SECTION 14: JOINTS AND BEARINGS

TABLE OF CONTENTS

14.1—SCOPE ..... 14-1

14.2—DEFINITIONS ..... 14-1

14.3—NOTATION ..... 14-3

14.4—MOVEMENTS AND LOADS ..... 14-6

    14.4.1—General ..... 14-6

    14.4.2—Design Requirements ..... 14-10

        14.4.2.1—Elastomeric Pads and Steel Reinforced Elastomeric Bearings ..... 14-11

        14.4.2.2—High Load Multitrotational (HLMR) Bearings ..... 14-12

            14.4.2.2.1—Pot Bearings and Curved Sliding Surface Bearings ..... 14-12

            14.4.2.2.2—Disc Bearings ..... 14-12

14.5—BRIDGE JOINTS ..... 14-12

    14.5.1—Requirements ..... 14-12

        14.5.1.1—General ..... 14-12

        14.5.1.2—Structural Design ..... 14-13

        14.5.1.3—Geometry ..... 14-14

        14.5.1.4—Materials ..... 14-14

        14.5.1.5—Maintenance ..... 14-14

    14.5.2—Selection ..... 14-14

        14.5.2.1—Number of Joints ..... 14-14

        14.5.2.2—Location of Joints ..... 14-15

    14.5.3—Design Requirements ..... 14-15

        14.5.3.1—Movements during Construction ..... 14-15

        14.5.3.2—Design Movements ..... 14-16

        14.5.3.3—Protection ..... 14-16

        14.5.3.4—Bridging Plates ..... 14-17

        14.5.3.5—Armor ..... 14-17

        14.5.3.6—Anchors ..... 14-17

        14.5.3.7—Bolts ..... 14-18

    14.5.4—Fabrication ..... 14-18

    14.5.5—Installation ..... 14-18

        14.5.5.1—Adjustment ..... 14-18

        14.5.5.2—Temporary Supports ..... 14-19

        14.5.5.3—Field Splices ..... 14-19

    14.5.6—Considerations for Specific Joint Types ..... 14-19

        14.5.6.1—Open Joints ..... 14-19

        14.5.6.2—Closed Joints ..... 14-20

        14.5.6.3—Waterproofed Joints ..... 14-20

        14.5.6.4—Joint Seals ..... 14-20

        14.5.6.5—Poured Seals ..... 14-21

        14.5.6.6—Compression and Cellular Seals ..... 14-21

14.5.6.7—Sheet and Strip Seals .....	14-21
14.5.6.8—Plank Seals .....	14-22
14.5.6.9—Modular Bridge Joint Systems (MBJS).....	14-22
14.5.6.9.1—General .....	14-22
14.5.6.9.2—Performance Requirements .....	14-24
14.5.6.9.3—Testing and Calculation Requirements.....	14-25
14.5.6.9.4—Loads and Load Factors .....	14-25
14.5.6.9.5—Distribution of Wheel Loads.....	14-27
14.5.6.9.6—Strength Limit State Design Requirements.....	14-28
14.5.6.9.7—Fatigue Limit State Design Requirements.....	14-29
14.5.6.9.7a—General .....	14-29
14.5.6.9.7b—Design Stress Range .....	14-31
14.6—REQUIREMENTS FOR BEARINGS.....	14-35
14.6.1—General .....	14-35
14.6.2—Characteristics .....	14-36
14.6.3—Force Effects Resulting from Restraint of Movement at the Bearing.....	14-37
14.6.3.1—Horizontal Force and Movement.....	14-37
14.6.3.2—Moment .....	14-38
14.6.4—Fabrication, Installation, Testing, and Shipping.....	14-40
14.6.5—Seismic and Other Extreme Event Provisions for Bearings .....	14-40
14.6.5.1—General .....	14-40
14.6.5.2—Applicability.....	14-40
14.6.5.3—Design Criteria .....	14-41
14.7—SPECIAL DESIGN PROVISIONS FOR BEARINGS .....	14-42
14.7.1—Metal Rocker and Roller Bearings .....	14-42
14.7.1.1—General .....	14-42
14.7.1.2—Materials .....	14-43
14.7.1.3—Geometric Requirements.....	14-43
14.7.1.4—Contact Stresses .....	14-43
14.7.2—PTFE Sliding Surfaces .....	14-44
14.7.2.1—PTFE Surface .....	14-44
14.7.2.2—Mating Surface.....	14-45
14.7.2.3—Minimum Thickness.....	14-45
14.7.2.3.1—PTFE .....	14-45
14.7.2.3.2—Stainless Steel Mating Surfaces .....	14-46
14.7.2.4—Contact Pressure.....	14-46
14.7.2.5—Coefficient of Friction.....	14-47
14.7.2.6—Attachment .....	14-48
14.7.2.6.1—PTFE .....	14-48
14.7.2.6.2—Mating Surface.....	14-48
14.7.3—Bearings with Curved Sliding Surfaces.....	14-49
14.7.3.1—General .....	14-49
14.7.3.2—Bearing Resistance .....	14-49
14.7.3.3—Resistance to Lateral Load .....	14-50

14.7.4—Pot Bearings .....	14-51
14.7.4.1—General.....	14-51
14.7.4.2—Materials .....	14-51
14.7.4.3—Geometric Requirements.....	14-51
14.7.4.4—Elastomeric Disc.....	14-53
14.7.4.5—Sealing Rings .....	14-53
14.7.4.5.1—General .....	14-53
14.7.4.5.2—Rings with Rectangular Cross-Sections.....	14-54
14.7.4.5.3—Rings with Circular Cross-Sections .....	14-54
14.7.4.6—Pot.....	14-54
14.7.4.7—Piston .....	14-55
14.7.5—Steel-Reinforced Elastomeric Bearings—Method B.....	14-56
14.7.5.1—General.....	14-56
14.7.5.2—Material Properties.....	14-58
14.7.5.3—Design Requirements.....	14-59
14.7.5.3.1—Scope .....	14-59
14.7.5.3.2—Shear Deformations .....	14-59
14.7.5.3.3—Combined Compression, Rotation, and Shear .....	14-60
14.7.5.3.4—Stability of Elastomeric Bearings .....	14-63
14.7.5.3.5—Reinforcement.....	14-64
14.7.5.3.6—Compressive Deflection.....	14-65
14.7.5.3.7—Seismic and Other Extreme Event Provisions.....	14-66
14.7.5.4—Anchorage for Bearings without Bonded External Plates.....	14-67
14.7.6—Elastomeric Pads and Steel-Reinforced Elastomeric Bearings—Method A .....	14-67
14.7.6.1—General.....	14-67
14.7.6.2—Material Properties.....	14-69
14.7.6.3—Design Requirements.....	14-70
14.7.6.3.1—Scope .....	14-70
14.7.6.3.2—Compressive Stress.....	14-70
14.7.6.3.3—Compressive Deflection.....	14-71
14.7.6.3.4—Shear .....	14-73
14.7.6.3.5—Rotation .....	14-73
14.7.6.3.5a—General.....	14-73
14.7.6.3.5b—Rotation of CDP .....	14-74
14.7.6.3.6—Stability.....	14-75
14.7.6.3.7—Reinforcement.....	14-75
14.7.6.3.8—Seismic and Other Extreme Event Provisions.....	14-75
14.7.7—Bronze or Copper Alloy Sliding Surfaces.....	14-76
14.7.7.1—Materials .....	14-76
14.7.7.2—Coefficient of Friction.....	14-77
14.7.7.3—Limit on Load .....	14-77
14.7.7.4—Clearances and Mating Surfaces.....	14-77
14.7.8—Disc Bearings.....	14-77
14.7.8.1—General.....	14-77
14.7.8.2—Materials .....	14-78



14.7.8.3—Elastomeric Disc .....	14-78
14.7.8.4—Shear Resisting Mechanism .....	14-79
14.7.8.5—Steel Plates .....	14-79
14.7.9—Guides and Restraints .....	14-79
14.7.9.1—General .....	14-79
14.7.9.2—Design Loads.....	14-80
14.7.9.3—Materials .....	14-80
14.7.9.4—Geometric Requirements.....	14-80
14.7.9.5—Design Basis.....	14-80
14.7.9.5.1—Load Location .....	14-80
14.7.9.5.2—Contact Stress.....	14-81
14.7.9.6—Attachment of Low-Friction Material .....	14-81
14.7.10—Other Bearing Systems.....	14-81
14.8—LOAD PLATES AND ANCHORAGE FOR BEARINGS .....	14-82
14.8.1—Plates for Load Distribution .....	14-82
14.8.2—Tapered Plates .....	14-83
14.8.3—Anchorage and Anchor Bolts .....	14-83
14.8.3.1—General .....	14-83
14.8.3.2—Seismic and Other Extreme Event Design and Detailing Requirements .....	14-84
14.9—CORROSION PROTECTION .....	14-84
14.10—REFERENCES .....	14-84

SECTION 15: DESIGN OF SOUND BARRIERS

TABLE OF CONTENTS

15.1—SCOPE ..... 15-1

15.2—DEFINITIONS ..... 15-1

15.3—NOTATION ..... 15-1

15.4—GENERAL FEATURES ..... 15-2

    15.4.1—Functional Requirements ..... 15-2

        15.4.1.1—General ..... 15-2

        15.4.1.2—Lateral Clearance ..... 15-2

    15.4.2—Drainage ..... 15-2

    15.4.3—Emergency Responders and Maintenance Access ..... 15-2

    15.4.4—Differential Settlement of Foundations ..... 15-3

15.5—LIMIT STATES AND RESISTANCE FACTORS ..... 15-3

    15.5.1—General ..... 15-3

    15.5.2—Service Limit State ..... 15-3

    15.5.3—Strength Limit State ..... 15-3

    15.5.4—Extreme Event Limit State ..... 15-4

15.6—EXPANSION DEVICES ..... 15-4

    15.6.1—General ..... 15-4

    15.6.2—Structure-Mounted Sound Barriers ..... 15-4

    15.6.3—Ground-Mounted Sound Barriers ..... 15-5

15.7—SOUND BARRIERS INSTALLED ON EXISTING BRIDGES ..... 15-5

15.8—LOADS ..... 15-5

    15.8.1—General ..... 15-5

    15.8.2—Wind Load ..... 15-5

    15.8.3—Earth Load ..... 15-9

    15.8.4—Vehicular Collision Forces ..... 15-9

15.9—FOUNDATION DESIGN ..... 15-12

    15.9.1—General ..... 15-12

    15.9.2—Determination of Soil and Rock Properties ..... 15-12

    15.9.3—Limit States ..... 15-12

    15.9.4—Resistance Requirements ..... 15-12

    15.9.5—Resistance Factors ..... 15-13

    15.9.6—Loading ..... 15-13

    15.9.7—Movement and Stability at the Service Limit State ..... 15-13

        15.9.7.1—Movement ..... 15-13

        15.9.7.2—Overall Stability ..... 15-13

    15.9.8—Safety against Geotechnical Failure at the Strength Limit State ..... 15-13

    15.9.9—Seismic Design ..... 15-13

    15.9.10—Corrosion Protection ..... 15-13

    15.9.11—Drainage ..... 15-14

15.10—REFERENCES ..... 15-14

## INDEX

- Abutments and retaining walls
  - backfill..... 11-5
  - bearing resistance ..... 11-8, 11-15
  - conventional walls and abutments..... 11-16, 11-18
  - drainage..... 11-33
  - expansion and contraction joints ..... 11-18
  - extreme event limit state..... 11-7
  - free-standing abutments ..... 11-110
  - integral abutments ..... 11-18
  - load combinations and load factors ..... 11-10
  - loading..... 11-17
  - movement and stability ..... 11-19
  - overturning ..... 11-64, 11-103
  - passive resistance ..... 11-23
  - reinforcement ..... 11-18
  - resistance factors ..... 11-6, 11-10
  - safety against structural failure..... 11-23
  - seismic design ..... 11-23
  - service limit state..... 11-6, 11-19
  - sliding ..... 11-23, 11-65, 11-102
  - strength limit state ..... 11-7, 11-20
  - subsurface erosion ..... 11-22
  - wingwalls ..... 11-18
- Aeroelastic instability
  - aeroelastic phenomena ..... 3-43
  - control of dynamic responses ..... 3-44
  - wind tunnel tests..... 3-44
- Alkali-silica reactive aggregates..... 5-175
- Aluminum
  - minimum thickness ..... 7-21
- Aluminum orthotropic decks
  - See: Orthotropic aluminum decks
- Anchor bolts
  - bearings ..... 14-83
  - deck joints ..... 14-17
- Anchorage
  - bearings ..... 14-67, 14-82
  - deck joints ..... 14-17
  - elastomeric bearings..... 14-63
  - footings..... 10-53
  - post-tensioned anchorage zones ..... 5-122
  - post-tensioning ..... 5-21
  - railings..... 13-17
  - tension ties..... 5-33
- Anchored walls..... 11-43
  - anchor pullout capacity ..... 11-46
  - anchor stressing and testing..... 11-53
  - anchors ..... 11-49
  - bearing resistance ..... 11-45
  - construction and installation..... 11-53
  - corrosion protection..... 11-52
  - drainage..... 11-54
  - dynamic load allowance ..... 3-30, 3-23
  - earth pressure..... 3-99, 3-113
  - facing..... 11-51
  - loading..... 11-44
  - movement..... 11-44
  - overall stability..... 11-45
  - passive resistance ..... 11-49
  - safety against soil failure..... 11-45
  - safety against structural failure..... 11-49
  - seismic design ..... 11-51
  - ultimate unit bond stress for anchors..... 11-46
  - vertical wall elements..... 11-51
- Angles
  - flexural resistance..... 6-205, 6-209
- Annual frequency of collapse
  - geometric probability ..... 3-138, 3-141
  - probability of aberrancy ..... 3-143
  - probability of collapse ..... 3-147
  - vessel frequency distribution..... 3-142
- Approximate methods of analysis
  - analysis of segmental concrete bridges ..... 4-65
  - beam-slab bridges..... 4-29
  - decks..... 4-22
  - effective flange width..... 4-54
  - effective length factor..... 4-49
  - equivalent strip widths for box culverts ..... 4-67
  - equivalent strip widths for slab-type
    - bridges..... 4-48
    - lateral wind load distribution in
      - multibeam bridges..... 4-62
  - moment magnification..... 4-14, 4-15
  - orthotropic decks ..... 9-20, 9-27
  - seismic lateral load distribution..... 4-63
  - stress analyses and design ..... 5-137
  - truss and arch bridges..... 4-49
- Arch bridges
  - refined analysis..... 4-70
- Arch structures
  - See: Metal pipe, pipe arch, and arch structures
- Arches..... 5-231
  - aluminum structures ..... 7-56
  - arch ribs..... 5-231
  - load distribution..... 4-49, 4-73
  - moment magnification..... 4-15
  - steel, diaphragms..... 6-60
- Backfill
  - See: Abutments and retaining walls
- Barriers
  - See: Railings
- Basic requirements of structural dynamics
  - damping..... 4-77
  - distribution of masses ..... 4-77
  - natural frequencies ..... 4-77
  - stiffness ..... 4-77
- Batter piles..... 10-82
- Beam columns
  - moment magnification..... 4-14
- Beam ledges ..... 5-182
  - design for bearing..... 5-186
  - design for flexure and horizontal force ..... 5-184

design of hanger reinforcement .....	5-185	special design provisions .....	14-42
design for punching shear .....	5-184	tapered plates .....	14-83
design for shear .....	5-183	Bicycle railings .....	13-11
Beam-slab bridges		design live loads .....	13-11
application .....	4-29	geometry .....	13-11
distribution factor method for moment		Bolted connections .....	6-214
and shear .....	4-35	See also: Bolted splices, Bolts	
distribution factor method for shear .....	4-42	bearing resistance at fastener holes .....	7-53
refined methods of analysis .....	4-68	bearing-type .....	6-215
special loads with other traffic .....	4-47	block shear or end rupture .....	7-54
Bearing area		bolts and nuts .....	7-50
concrete .....	5-57	combined tension and shear .....	6-226
Bearing pressure		edge distance .....	6-220, 7-52
spread footings .....	10-52	end distance .....	6-219, 7-52
Bearing resistance		factored resistance .....	6-215
abutments and retaining walls .....	11-10, 11-20	holes .....	6-217
anchored walls .....	11-45	maximum pitch for sealing fasteners .....	7-51
buried structures .....	12-18	maximum pitch for stitch bolts .....	6-219
fastener holes .....	7-53	maximum pitch for stitch fasteners .....	7-52
flat surfaces and pins .....	7-53	maximum spacing for sealing bolts .....	6-218
MSE walls .....	11-64	minimum edge distance .....	6-220
prefabricated modular walls .....	11-102	minimum pitch and clear distance .....	7-51
reinforced concrete pipe .....	12-61	minimum spacing and clear distance .....	6-218
at rivet and bolt holes .....	7-53	nuts .....	6-26
spread footings .....	10-64	shear resistance .....	6-220
Bearing stiffeners .....	6-165	shear resistance of fasteners .....	7-52
axial resistance .....	6-166	size of fasteners .....	7-51
bearing resistance .....	6-165	slip-critical .....	6-214
projecting width .....	6-165	slip-critical connections .....	7-53
steel .....	6-285	slip resistance .....	6-221
Bearings .....	14-1	spacing of fasteners .....	7-51
See also: Disc bearings, Elastomeric		stitch fasteners at the end of compression	
bearings, Pot bearings		members .....	7-52
anchor bolts .....	14-82	tension .....	7-53
applicability .....	14-40	washers .....	6-26, 6-216
bearing resistance .....	14-49	Bolted splices	
bronze or copper alloy sliding surfaces .....	14-76	compression members .....	6-233
characteristics .....	14-36	fillers .....	6-241
corrosion protection .....	14-84	flange splices .....	6-238
curved sliding surfaces .....	14-12, 14-49	flexural members .....	6-233
design criteria .....	14-41	tension members .....	6-232
design requirements .....	14-10	web splices .....	6-243
fabrication, installation, testing, and		welded splices .....	6-242
shipping .....	14-40	Bolts	
force effects resulting from restraint of		bearing resistance .....	6-224
movement at the bearing .....	14-37	materials .....	6-25
guides and restraints .....	14-79	minimum required bolt tension .....	6-221
horizontal force and movement .....	14-37	prying action .....	6-225
launching .....	5-211, 5-228, 5-232	size .....	6-218
metal rocker and roller bearings .....	14-42	spacing .....	6-218
moment .....	14-38	tensile resistance .....	6-225
movements and loads .....	14-6	Boundary conditions	
other bearing systems .....	14-81	mathematical modeling .....	4-10
plates for load distribution .....	14-82	Box culverts	
PTFE sliding surfaces .....	14-44	equivalent strip widths .....	4-67
resistance to lateral load .....	14-50	live loads .....	3-27, 4-27
seismic design .....	14-84	Box girders	
seismic provisions .....	14-40	effective flange width .....	4-54
		wind load distribution .....	4-62

- Bracing  
 See also: Diaphragms and cross-frames,  
 Lateral bracing  
 box sections ..... 4-63  
 glued laminated timber girders ..... 8-37  
 portal bracing ..... 6-246, 7-56  
 sawn wood beams ..... 8-36  
 sway bracing ..... 6-246, 7-56  
 trusses ..... 6-246, 8-37
- Brackets and corbels ..... 5-179  
 alternative to strut-and-tie model ..... 5-181
- Braking force ..... 3-32
- Bridge aesthetics ..... 2-16
- Bridge joints  
 See: Deck joints
- Bridge scour  
 See: Scour
- Bridge site arrangement ..... 2-4  
 traffic safety ..... 2-4
- Bridge testing ..... 4-90
- Bridges composed of simple span precast  
 girders made continuous ..... 5-201  
 age of girder when continuity is  
 established ..... 5-203  
 continuity diaphragms ..... 5-209  
 degree of continuity at various limit states ..... 5-204  
 material properties ..... 5-203  
 negative moment connections ..... 5-206  
 positive moment connections ..... 5-206  
 restraint moments ..... 5-202  
 service limit state ..... 5-205  
 strength limit state ..... 5-206
- Bronze or copper alloy sliding surfaces ..... 14-76  
 clearances and mating surfaces ..... 14-77  
 coefficient of friction ..... 14-77  
 limit on load ..... 14-77  
 materials ..... 14-76
- Builtup members ..... 6-78  
 perforated plates ..... 6-78
- Bundled reinforcement  
 development length ..... 5-162  
 number of bars in a bundle ..... 5-112  
 spacing ..... 5-112  
 ties ..... 5-120
- Buried structures  
 bearing resistance and stability ..... 12-18  
 corner backfill for metal pipe arches ..... 12-19  
 corrosive and abrasive conditions ..... 12-23  
 cross-section properties ..... 12-91  
 differential settlement between structure  
 and backfill ..... 12-14  
 embankment installations ..... 12-19  
 end treatment ..... 12-22  
 flexibility limits and construction  
 stiffness ..... 12-13  
 flexible culverts constructed on skew ..... 12-22  
 footing settlement ..... 12-14  
 hydraulic design ..... 12-19  
 load modifiers and load factors ..... 12-9  
 loading ..... 12-13  
 longitudinal differential settlement ..... 12-14  
 mechanical properties ..... 12-73  
 minimum longitudinal seam strength  
 ..... 12-90, 12-100, 12-101, 12-103  
 minimum soil cover ..... 12-20  
 minimum spacing between multiple lines  
 of pipe ..... 12-21  
 resistance factors ..... 12-10  
 safety against soil failure ..... 12-18  
 scour ..... 12-19  
 service limit state ..... 12-9, 12-14  
 settlement ..... 12-14  
 soil envelope ..... 12-19  
 strength limit state ..... 12-9  
 tolerable movement ..... 12-14  
 trench installations ..... 12-19  
 unbalanced loading ..... 12-15  
 uplift ..... 12-18
- Cable-stayed bridges  
 refined analysis ..... 4-72
- Cables  
 bridge strand ..... 6-29  
 bright wire ..... 6-28  
 epoxy-coated wire ..... 6-29  
 galvanized wire ..... 6-28
- Caissons.  
 See: Drilled shafts
- Camber  
 aluminum structures ..... 7-18  
 glued laminated timber girders ..... 8-37  
 heat-curved rolled beams and welded  
 plate girders ..... 6-70, 6-71  
 steel structures ..... 6-57  
 stress laminated timber deck bridge ..... 8-37  
 trusses ..... 6-245, 8-37
- Cantilever slabs  
 design ..... 9-8  
 segmental construction ..... 5-211  
 wheel load position ..... 3-25
- Cantilevered retaining walls ..... 11-34  
 corrosion protection ..... 11-42  
 drainage ..... 11-43  
 earth pressure ..... 3-99  
 facing ..... 11-36  
 loading ..... 11-34  
 movement ..... 11-34  
 overall stability ..... 11-35  
 safety against soil failure ..... 11-35  
 safety against structural failure ..... 11-36  
 seismic design ..... 11-38  
 vertical wall elements ..... 11-36
- Cast-in-place box culverts and arches ..... 12-65  
 cast-in-place structures ..... 12-70  
 construction and installation ..... 12-71  
 design moment for box culverts ..... 12-70  
 distribution of concentrated loads in  
 skewed box culverts ..... 12-69

distribution of concentrated loads to		Combined force effects	
bottom slab of culvert.....	12-69	aluminum.....	7-48
earth load modification.....	12-66	Compact sections	
embankment and trench conditions.....	12-66	nominal flexural resistance.....	6-136, 6-187
loads and live load distribution.....	12-66	Composite box girders	
minimum cover for precast box		See also: Box girders	
structures.....	12-71	diaphragms.....	6-59
minimum reinforcement.....	12-71	fatigue.....	6-157
other installations.....	12-69	lateral bracing.....	6-65
precast box structures.....	12-70	wind effects.....	4-79
safety against structural failure.....	12-70	Composite sections	
service limit state.....	12-69	aluminum.....	7-19
soil-structure interaction.....	12-66	concrete-encased shapes.....	6-99, 6-212
Cast-in-place girders and box and T-beams		concrete-filled tubes.....	6-99, 6-212, 6-213
bottom flange.....	5-210	nominal shear resistance.....	6-212
bottom slab reinforcement in box girders.....	5-211	sequence of loading.....	6-102
deck slab reinforcement cast-in-place in		steel.....	6-102
T-beams and box girders.....	5-210	stresses.....	6-102
effective flange width.....	4-54, 4-55	Compression flange flexural resistance..	6-142, 6-284
flange and web thickness.....	5-210	lateral torsional buckling resistance..	6-144, 6-279
reinforcement.....	5-210	local buckling resistance.....	6-143, 6-278
top flange.....	5-210	Compression flange proportions.....	6-196
web.....	5-210	Compression members	
Cast-in-place piles		aluminum.....	7-24
See: Concrete piles		axial resistance.....	5-51
Cast-in-place solid slab superstructures.....	5-231	biaxial flexure.....	5-52
Cast-in-place voided slab superstructures.....	5-232	compressive resistance.....	6-77
compressive zones in negative moment		concrete.....	5-53
area.....	5-234	hollow rectangular.....	5-38, 5-53, 5-54
cross-section dimensions.....	5-232	limiting slenderness ratio.....	6-81
drainage of voids.....	5-234	splices.....	7-54
general design requirements.....	5-233	steel composite members.....	6-98
minimum number of bearings.....	5-233	steel noncomposite members.....	6-82
solid end sections.....	5-233	subjected to torsion.....	7-45
Cast metal		wood.....	8-33
cast iron.....	6-28	Compressive resistance	
cast steel and ductile iron.....	6-28	aluminum.....	7-26, 7-27, 7-29, 7-31, 7-35
malleable castings.....	6-28	axial compression.....	6-81
Cellular and box bridges		combined axial compression and flexure.....	6-81
refined analysis.....	4-72	concrete.....	5-53
Centrifugal forces.....	3-32	steel.....	6-81
Charpy V-notch test		steel composite members.....	6-98
requirements.....	6-48	steel noncomposite members.....	6-82
temperature zones.....	6-49	steel piles.....	6-252
Clearances		Compressive struts	
drilled shafts.....	10-124	effective cross-sectional area of strut.....	5-32
highway horizontal.....	2-6	limiting compressive stress in strut.....	5-33
highway vertical.....	2-6	reinforced strut.....	5-33
navigational.....	2-6	strength of unreinforced strut.....	5-31
piles.....	10-81	Concrete	
railroad overpass.....	2-6	basic steps for concrete bridges.....	5-247
Coefficient of thermal expansion		classes.....	5-13
concrete.....	5-15	coefficient of thermal expansion.....	5-15
Collision force		cohesion factor.....	5-83
See: Vehicular collision force, Vessel		compressive strength.....	5-13
collisions		creep.....	5-15
Combination railings.....	13-12	effects of imposed deformation.....	5-29
design live loads.....	13-12	friction factor.....	5-82
geometry.....	13-12	modulus of elasticity.....	5-21

- modulus of rupture ..... 5-18
- Poisson's ratio ..... 5-18
- properties ..... 5-20
- shrinkage ..... 3-133
- strut-and-tie model ..... 5-29
- tensile strength ..... 5-18
- unit weight ..... 3-16
- Concrete box girders
  - bridges composed of simple span precast
    - girders made continuous ..... 5-201
  - cross-section dimensions and details ..... 5-220
  - effective flange width ..... 4-54
  - girder segment design ..... 5-200
  - joints between segments ..... 5-205
  - length of top flange cantilever ..... 5-199
  - live load distribution factors ..... 4-30
  - minimum flange thickness ..... 5-220
  - minimum web thickness ..... 5-220
  - overlays ..... 5-222
  - post-tensioning ..... 5-201
  - prestress losses ..... 5-105
  - spliced precast girders ..... 5-198, 5-200
  - torsional resistance ..... 5-77
- Concrete deck slabs
  - See: Concrete slabs
- Concrete formwork
  - bedding of panels ..... 9-14
  - creep and shrinkage control ..... 9-14
  - depth ..... 9-13
  - reinforcement ..... 9-14
- Concrete piles ..... 5-192
  - cast-in-place piles ..... 5-194
  - pile dimensions ..... 5-192
  - precast prestressed ..... 5-192
  - precast reinforced ..... 5-192
  - reinforcing steel ..... 5-192
  - seismic requirements ..... 5-194
  - splices ..... 5-112
  - structural resistance ..... 10-117
- Concrete slabs
  - application of empirical design ..... 9-9
  - composite action ..... 9-7
  - design conditions ..... 9-10
  - design of cantilever slabs ..... 9-8
  - distribution reinforcement ..... 9-12
  - edge support ..... 9-8
  - effective length ..... 9-9
  - empirical design ..... 9-8
  - minimum depth and cover ..... 9-7
  - precast deck slabs on girders ..... 9-14
  - reinforcement requirements ..... 9-11
  - segmental construction ..... 9-15
  - shear ..... 5-57
  - skewed bridges ..... 4-40
  - skewed decks ..... 9-7
  - stay-in-place formwork ..... 9-12
  - traditional design ..... 9-12
- Concrete stress limits
  - partially prestressed components ..... 5-98
  - service limit state after losses ..... 5-95
  - temporary stresses before losses ..... 5-93
- Connections
  - See also: Bolted connections, Splices, Welded connections
  - block shear or end rupture ..... 7-54
  - block shear rupture resistance ..... 6-230
  - elements ..... 6-231
  - rigid frame ..... 6-243
  - rigid frame connections ..... 6-243
- Constructibility ..... 6-120, 6-179
  - dead load deflections ..... 6-126
  - deck placement ..... 6-124
  - design objectives ..... 2-7, 2-20
  - flexure ..... 6-121, 6-179
  - shear ..... 6-124, 6-182
- Continuous beam bridges
  - approximate method of analysis ..... 4-22
  - refined method of analysis ..... 4-68
- Continuously braced flanges in tension ..... 6-190
- Continuously braced flanges in tension or compression ..... 6-123, 6-141
- Corrosion
  - buried structures ..... 12-23
  - piles ..... 10-119
- Corrosion protection
  - alternative coating ..... 8-23
  - anchored walls ..... 11-52
  - bearings ..... 14-84
  - cantilevered retaining walls ..... 11-42
  - metallic coating ..... 8-23
- Corrugated metal decks
  - composite action ..... 9-30
  - distribution of wheel loads ..... 9-30
- Cover plates ..... 6-170
  - end requirements ..... 6-170
  - yield moment ..... 6-317
- Creep effect ..... 3-135, 5-15
- Cross-frames
  - See: Diaphragms and cross-frames
- Cross-section proportion limits
  - flange proportions ..... 6-119, 6-178
  - special restrictions on use of live load
    - distribution factor for multiple box sections ..... 6-178
  - web proportions ..... 6-118, 6-177
- Culverts
  - See also: Long-span structural plate structures
  - design for flexure ..... 5-236
  - design for shear in slabs of box culverts ..... 5-236
  - live loads ..... 3-25
  - location, length, and waterway area ..... 2-23
  - segmental construction ..... 5-211
- Curbs ..... 13-12
  - end treatment of separation railing ..... 13-13
- Curved structures
  - concrete cover, prestressing tendons ..... 5-118
  - multicell concrete box girders ..... 4-32

multiple beam superstructures .....	4-20	Deck overhang load .....	3-28
single girder superstructures .....	4-18	Decks	
torsionally stiff superstructures .....	4-18	See also: Deck joints, Deck overhang	
Curved tendons		design	
effects of curved tendons .....	5-114	applicability .....	4-22
in-plane force effects .....	5-115	concrete appurtenances .....	9-5
out-of-plane force effects .....	5-118	cross-sectional frame action .....	4-27
Dead loads		deck drainage .....	9-4
load factors .....	3-16	distribution of wheel loads .....	4-26
MSE walls .....	11-96	edge supports .....	9-5
steel structures .....	6-57, 6-126	edges of slabs .....	4-25
unit weight of materials .....	3-7	equivalent strips .....	4-23
Deck analysis		force effects .....	4-24
deck slab design table .....	4-97	inelastic analysis .....	4-29
loading .....	9-6	interface action .....	9-4
methods .....	4-22	live load effects on grids .....	4-27
methods of analysis .....	9-6	live loads .....	3-25
Deck joints		longitudinal edges .....	4-25
adjustment .....	14-18	stay-in-place formwork .....	9-5
anchors .....	14-17	transverse edges .....	4-25
armor .....	14-17	Deep beams	
bolts .....	14-18	detailing requirements .....	5-178
bridging plates .....	14-17	Deflection	
closed joints .....	14-20	aluminum .....	7-9
compression and cellular seals .....	14-21	criteria .....	2-11
design requirements .....	14-10, 14-15	Deformations	
fabrication .....	14-18	axial .....	5-48
field splices .....	14-19	concrete .....	5-59
geometry .....	14-14	criteria for deflection .....	2-11
installation .....	14-18	criteria for span-to-depth ratios .....	2-13
joint seals .....	14-20	force effects due to superimposed	
location .....	14-15	deformations .....	3-133
maintenance .....	14-14	permanent .....	6-127
materials .....	14-14	steel .....	6-127
modular bridge joint systems .....	14-22	Deformed bars and deformed wire in tension	
movements and loads .....	14-6	tension development length .....	5-160
movements during construction .....	14-15	Deformed bars in compression	
movements in service .....	14-16	compressive development length .....	5-162
number of joints .....	14-14	modification factors .....	5-162
open joints .....	14-19	Depth of the web in compression	
plank seals .....	14-22	in the elastic range .....	6-317
poured seals .....	14-21	at plastic moment .....	6-318
protection .....	14-16	Design lane load .....	3-24
requirements .....	14-12	Design lanes	
segmental construction .....	9-15	number of .....	3-17
selection .....	14-14	Design objectives	
sheet and strip seals .....	14-21	bridge aesthetics .....	2-16
specific joint type considerations .....	14-19	constructibility .....	2-14
structural design .....	14-13	economy .....	2-15
temporary supports .....	14-19	safety .....	2-7
waterproofed joints .....	14-20	serviceability .....	2-8
Deck overhang design .....	13-25	Design philosophy	
decks supporting concrete parapet		ductility .....	1-5
railings .....	13-25	limit states .....	1-3
decks supporting post-and-beam railings .....	13-26	operational importance .....	1-7
design cases .....	13-25	redundancy .....	1-6
overhang design .....	13-26		
resistance to punching shear .....	13-27		
stay-in-place formwork .....	9-5		



- Design tandem ..... 3-24
- Design truck ..... 3-23
- Design vessel ..... 3-138
- Development of reinforcement
- basic requirements ..... 5-157
  - bonded strand ..... 5-168
  - bundled bars ..... 5-112
  - deformed bars and deformed wire in
    - tension ..... 5-160
  - deformed bars in compression ..... 5-162
  - development by mechanical anchorages ..... 5-167
  - flexural reinforcement ..... 5-167
  - footings ..... 5-187
  - modification factors ..... 5-161, 5-162, 5-163
  - partially debonded strands ..... 5-169
  - prestressing strand ..... 5-166
  - shear reinforcement ..... 5-185
  - standard hooks in tension ..... 5-163
  - welded wire fabric ..... 5-164
- Diaphragms and cross-frames ..... 6-59
- aluminum structures ..... 7-21
  - concrete structures ..... 5-174, 5-211, 5-220
  - orthotropic deck superstructures ..... 6-247
  - steel arches ..... 6-64
  - steel box section members ..... 6-62
  - steel I-section members ..... 6-60
  - steel trusses ..... 6-64, 6-246
- Disc bearings ..... 14-77
- See also: Bearings
- elastomeric disc ..... 14-78
  - materials ..... 14-78
  - movements and loads ..... 14-12
  - shear resistance mechanism ..... 14-79
  - steel plates ..... 14-79
- Distortion-induced fatigue ..... 7-17
- lateral connection plates ..... 6-52, 7-18
  - orthotropic decks ..... 6-53
  - transverse connection plates ..... 6-52, 7-18
- Distribution of load
- concrete slabs ..... 4-27
  - curved steel bridges ..... 4-46
  - exterior beams ..... 4-39, 4-44, 4-46
  - interior beams ..... 4-35, 4-38, 4-42, 4-46
  - skewed bridges ..... 4-40, 4-46
  - wheel loads through earth fills ..... 3-25
- Dowels
- concrete columns ..... 5-187
- Downdrag ..... 3-131, 10-83, 10-89, 10-95, 10-128,  
..... 10-126, 10-130, 10-147, 10-148
- Drainage
- See also: Roadway drainage
- abutments and retaining walls ..... 11-33
  - anchored walls ..... 11-54
  - cantilevered retaining walls ..... 11-43
  - cast-in-place voided slab superstructures ..... 5-232
  - MSE walls ..... 11-94
  - prefabricated modular walls ..... 11-105
  - sound barrier ..... 15-2, 15-14
  - steel box-section flexural members ..... 6-177
- Drilled shafts ..... 10-123
- battered shafts ..... 10-124
  - buckling ..... 10-143
  - clearance ..... 10-124
  - combined side and tip resistance ..... 10-138
  - concrete ..... 10-144
  - diameter ..... 10-124
  - downdrag ..... 10-126, 10-130
  - embedment ..... 10-124
  - enlarged bases ..... 10-124, 10-144
  - extreme event limit state ..... 10-144
  - groundwater table and buoyancy ..... 10-130
  - group resistance ..... 10-140
  - horizontal movement ..... 10-130
  - horizontal resistance ..... 10-143
  - lateral squeeze ..... 10-130
  - lateral stability ..... 10-143
  - load test ..... 10-139
  - reinforcement ..... 10-143, 10-144
  - resistance in cohesionless soils ..... 10-134, 10-140
  - resistance in cohesive soils ..... 10-131, 10-141
  - resistance in rock ..... 10-136
  - scour ..... 10-130
  - service limit state ..... 10-126
  - settlement ..... 10-126, 10-130
  - shaft loads ..... 10-126
  - shaft resistance ..... 10-125
  - shaft resistance in intermediate geo
    - materials ..... 10-139
  - shafts in strong soil overlying weaker
    - compressible soil ..... 10-136
  - side resistance ..... 10-132, 10-134, 10-137
  - spacing ..... 10-124
  - strength limit state ..... 10-130
  - structural resistance ..... 10-143
  - tip resistance ..... 10-133, 10-135, 10-138
  - tolerable movements ..... 10-126
  - transverse reinforcement ..... 10-144
  - uplift ..... 10-126
  - uplift resistance ..... 10-142
- Driven piles
- See: Piles
- Ductility ..... 1-5
- Ductility requirements
- steel I-section flexural members ..... 6-140
- Ducts
- at deviation saddles ..... 5-23
  - size of ..... 5-22
  - spacing ..... 5-112, 5-113
- Durability ..... 5-174
- alkali-silica reactive aggregates ..... 5-175
  - concrete cover ..... 5-175
  - materials ..... 2-8
  - protection for prestressing tendons ..... 5-176
  - protective coatings ..... 5-176
  - self-protecting measures ..... 2-8
- Dynamic analysis
- Analysis of blast effects ..... 4-90
  - analysis for collision loads ..... 4-90

analysis for earthquake loads.....	4-77	compressive stress .....	14-70
basic requirements .....	4-79	design method A .....	14-67
elastic dynamic responses.....	4-76	design method B .....	14-56
inelastic dynamic responses.....	4-80	extreme event provisions .....	14-66, 14-75
Dynamic load allowance		material properties .....	14-58, 14-69
buried components.....	3-31	movements and loads.....	14-11
wood components .....	3-32	reinforcement.....	14-64, 14-75
Earth loads .....	3-17	rotation.....	14-73
sound barrier .....	15-9	seismic provisions .....	14-66, 14-75
Earth pressure .....	3-99	shear.....	14-73
active .....	3-103	shear deformation .....	14-59
anchored walls .....	3-113	stability .....	14-63, 14-75
at-rest.....	3-103	Elastomeric pads	
cantilevered walls .....	3-109	See: Elastomeric bearings	
compaction .....	3-100	Emergency responder access to sound	
downdrag .....	3-131	barriers.....	15-2
effect of earthquake .....	3-101	End requirements	
equivalent-fluid method of estimating.....	3-107	cover plates .....	6-170
friction angle for dissimilar materials.....	3-105	Environment .....	2-7
lateral earth pressure.....	3-101, 3-109	Equivalent members	
mechanically stabilized earth walls .....	3-116	mathematical modeling.....	4-10
passive .....	3-105	Erosion control.....	11-22, 11-95, 11-103
prefabricated modular walls .....	3-118	Existing bridges, sound barrier installation	
presence of water .....	3-100	for .....	15-5
reduction due to earth pressure .....	3-131	Expansion	
surcharge loads .....	3-123	See: Coefficient of thermal expansion	
Earthquake effects		Expansion devices for sound barriers .....	15-4
See: Seismic loads		Extreme event limit states.....	1-5
Economy		abutments and retaining walls .....	11-7, 11-16
alternative plans.....	2-15	concrete structures .....	5-44
Edge distance .....	6-220	decks .....	9-6
Edge support		drilled shafts .....	10-144
slabs.....	9-8	foundations .....	10-31, 10-50
Effective area		load combinations.....	3-11, 3-13
aluminum.....	7-23	piles .....	10-118
steel.....	6-57	railings .....	13-5
welds.....	6-229	spread footings.....	10-80
Effective flange width.....	4-54	steel structures .....	6-31
cast-in-place multicell superstructures.....	4-59	vessel collision damage .....	3-138
orthotropic steel decks .....	4-59	wood structures.....	8-31
analysis of segmental concrete bridges.....	4-65	Eyebars	
segmental concrete box beams and single		factored resistance .....	6-78
cell cast-in-place box beams.....	4-55	minimum size pin for.....	6-69
Effective length		packing .....	6-80
columns .....	4-49	proportions.....	6-80
span.....	6-57, 7-19	Fasteners	
Effective plastic moment		See also: Bolts	
all other interior-pier sections.....	6-290	alternative .....	6-27
interior-pier sections with enhanced		shear resistance of.....	7-52
moment-rotation characteristics .....	6-289	spacing of.....	7-51
Elastic dynamic responses		Fatigue	
vehicle-induced vibration .....	4-79	distortion-induced.....	6-46
wind-induced vibration.....	4-79	load-induced .....	6-31
Elastic stress analysis.....	5-136	Fatigue and fracture limit states.....	1-4
Elastomeric bearings		aluminum structures .....	7-9
See also: Bearings		concrete structures .....	5-23, 5-35
combined compression, rotation, and		decks .....	9-6, 9-18, 9-19
shear .....	14-60	modular bridge joint systems.....	14-29
compressive deflection .....	14-65, 14-71	orthotropic aluminum decks .....	9-26

- prestressing tendons .....5-25
- reinforcing bars .....5-24
- steel box-section flexural members .....6-183
- steel I-section flexural members.....6-130
- steel structures .....6-29
- welded or mechanical splices of reinforcement .....5-25
- Fatigue design
  - cycles..... 6-49, 6-51
  - orthotropic steel decks .....6-83
- Fatigue load
  - approximate methods .....3-25
  - frequency .....3-29
  - load distribution for fatigue.....3-29
  - magnitude and configuration .....3-28
  - refined methods .....3-29
- Fatigue resistance
  - shear connectors .....6-157
- Filled and partially filled grid decks
  - design requirements.....9-17
  - fatigue and fracture limit state .....9-18
- Fillers
  - bolted splices .....6-241
- Fillet-welded connections .....6-228
  - size .....6-229
- Flange proportions.....6-178
- Flange-strength reduction factors
  - hybrid factor .....6-113
  - web load-shedding factor .....6-114
- Flexibility limits and construction stiffness
  - corrugated metal pipe and structural plate structures .....12-12
  - spiral rib metal pipe and pipe arches .....12-12
  - steel tunnel liner plate.....12-13
  - thermoplastic pipe .....12-13
- Flexural members
  - aluminum.....7-30
  - concrete .....5-39, 5-121
  - splices .....7-54
  - wood.....8-28, 8-31
- Flexural resistance
  - based on tension flange yielding .....6-282
  - based on the compression flange .....6-277
  - box flanges in compression .....6-190
  - compact sections .....6-136, 6-187
  - compression-flange flexural resistance .....6-142
  - concrete .....5-44
  - continuously braced flanges in tension.....6-190
  - continuously braced flanges in tension or compression .....6-141
  - discretely braced flanges in compression .....6-141
  - discretely braced flanges in tension.....6-141
  - ductility requirement .....6-140
  - interior-pier I-sections in straight continuous-span bridges .....6-286
  - lateral torsional buckling
    - resistance .....6-144, 6-279
  - local buckling resistance .....6-143, 6-278
  - noncompact sections .....6-139, 6-187
  - straight composite I-sections in negative flexure .....6-271
  - straight noncomposite I-sections with compact or noncompact webs .....6-271
  - tension-flange flexural resistance .....6-150
- Flexure
  - composite sections in negative flexure and noncomposite sections .....6-134
  - composite sections in positive flexure.....6-132
  - concrete deck .....6-123
  - continuously braced flanges in tension or compression .....6-123
  - discretely braced flanges in compression .....6-121
  - discretely braced flanges in tension.....6-123
- Footings .....5-187
  - development of reinforcement.....5-190
  - distribution of moment reinforcement.....5-188
  - loads and reactions .....5-187
  - moment in.....5-187
  - reactions .....5-187, 12-30
  - resistance factors .....5-187
  - shear in slabs and footings.....5-59, 5-188
  - transfer of force at base of column .....5-190
- Foundation design .....10-163
- Foundation investigation .....2-7, 10-163
  - topographic studies.....2-7
- Fracture
  - aluminum.....7-18
  - steel .....6-53
  - toughness requirements .....6-53
- Free-standing abutments
  - design for displacement.....11-120
  - Mononobe-Okabe analysis .....11-110
  - nonyielding abutments .....11-30
- Friction forces.....3-138
- General zone.....5-124
  - application of the strut-and-tie model.....5-132
  - blister and rib reinforcement .....5-130
  - design methods.....5-125
  - design principles.....5-126
  - deviation saddles .....5-132
  - diaphragms .....5-131
  - intermediate anchorages .....5-129
  - multiple slab anchorages .....5-131
  - responsibilities.....5-125
  - special anchorage devices .....5-144
  - tie-backs .....5-130
- Geometry
  - bicycle railings .....13-11
  - combination railings .....13-12
  - deck joints .....14-14
  - large deflection theory .....4-12
  - pedestrian railings .....13-9
  - small deflection theory .....4-12
  - traffic railings .....13-15
- Geophysical tests
  - soil and rock .....10-12
- Glued laminated decks .....9-32
  - deck tie-downs.....9-32

interconnected decks.....	9-32	on vehicles.....	3-42
noninterconnected decks.....	9-33	Hydraulic analysis	
Glued laminated timber		bridge foundations.....	2-20
See also: Wood		bridge waterway.....	2-20
bracing.....	8-36	roadway approaches to bridge.....	2-23
camber.....	8-37	stream stability.....	2-17
dimensions.....	8-13	Hydrology and hydraulics	
reference design values.....	8-14	culvert location, length, and waterway	
volume factor.....	8-27	area.....	2-23
Gravel		hydraulic analysis.....	2-19
unit weight.....	3-16	hydrologic analysis.....	2-18
Gravity loads		roadway drainage.....	2-24
design vehicular live load.....	3-19	site data.....	2-18
vehicular live load.....	3-17	Ice loads	
Groove-welded connections		adhesion.....	3-50
complete penetration.....	6-227	combination of forces.....	3-49
partial penetration.....	6-228	crushing and flexing.....	3-47
Grout		dynamic ice forces on piers.....	3-46
steel tunnel liner plate.....	12-88	effective ice strength.....	3-46
Guides and restraints.....	14-79	hanging dams and ice jams.....	3-50
attachment of low-friction material.....	14-81	ice accretion and snow loads on	
contact stress.....	14-81	superstructures.....	3-51
design basis.....	14-80	slender and flexible piers.....	3-50
design loads.....	14-80	small streams.....	3-48
geometric requirements.....	14-80	static ice loads on piers.....	3-50
load location.....	14-80	Idealization	
materials.....	14-80	See: Mathematical modeling	
Gusset plates.....	6-246	Impact	
Heat-curved rolled beams and welded plate		See: Dynamic load allowance	
girders camber.....	6-70	In-situ tests	
minimum radius of curvature.....	6-70	See: Soil properties	
High load multirotational (HLMR) bearings		Inelastic dynamic responses.....	4-80
curved sliding surface bearings.....	14-12	plastic hinges and yield lines.....	4-80
disc bearings.....	14-12	Influence of plan geometry	
pot bearings.....	14-12	curved structures.....	4-17
Holes		plan aspect ratio.....	4-17
long-slotted.....	6-217, 7-51	Instantaneous losses	
maximum hole size.....	6-217	anchorage set.....	5-98
oversize.....	6-217, 7-51	elastic shortening.....	5-101
short-slotted.....	6-217, 7-51	friction.....	5-99
size.....	6-217	Interaction systems	
type.....	6-217	See: Culverts	
Hollow rectangular compression members		Interconnected decks	
hoops.....	5-157	panels parallel to traffic.....	9-32
limitations on the use of the rectangular		panels perpendicular to traffic.....	9-32
stress block method.....	5-54	Interface shear transfer—shear friction	
reinforcement.....	5-156	cohesion and friction factors.....	5-82
splices.....	5-156	computation of factored interface shear	
ties.....	5-156	force.....	5-80
wall slenderness ratio.....	5-53	minimum area of interface shear	
Hooks and bends		reinforcement.....	5-83
basic hook development length.....	5-163	Interior beams	
hooked-bar tie requirements.....	5-164	distribution of load.....	4-35, 4-38, 4-42
minimum bend diameters.....	5-110	Laboratory tests	
modification factors.....	5-162	rock properties.....	10-11
seismic hooks.....	5-110	soil properties.....	10-11
standard hooks.....	5-110	Lap splices	
Horizontal wind pressure		in compression.....	5-172
on structures.....	3-41	general requirements.....	5-170

- in tension ..... 5-171
- Large deflection theory ..... 4-12
  - approximate methods ..... 4-13
  - refined methods ..... 4-16
- Lateral bracing
  - See also: Bracing, Diaphragms and cross-frames
  - aluminum structures ..... 7-22, 7-55
  - I-section members ..... 6-65
  - through-spans ..... 7-22
  - trusses ..... 6-68
  - tub section members ..... 6-66
- Lateral buckling
  - equations for ..... 6-319
- Lateral clearance, sound barrier ..... 15-2
- Lateral torsional buckling resistance ..... 6-144, 6-279
- Lightweight concrete
  - coefficient of thermal expansion ..... 5-15
  - compressive strength ..... 5-13
  - creep ..... 5-15
  - modifications for ..... 5-59
  - modulus of elasticity ..... 5-17
  - modulus of rupture ..... 5-18
  - Poisson's ratio ..... 5-18
  - shrinkage ..... 5-17
  - tensile strength ..... 5-19
  - unit weight ..... 3-16
- Limit states
  - See: Extreme event limit states, Fatigue and fracture limit states, Service limit states, Strength limit states
- Live loads
  - application ..... 3-25
  - braking force ..... 3-32
  - centrifugal forces ..... 3-32
  - deck overhang load ..... 3-28
  - decks, deck systems, top slabs of box culverts ..... 3-27, 4-68
  - design lane load ..... 3-24
  - design tandem ..... 3-24
  - design truck ..... 3-23
  - distribution of wheel loads through earth
    - fills ..... 3-25
  - gravity loads ..... 3-17
  - live load deflection ..... 3-26
  - multiple box sections ..... 6-178
  - multiple presence ..... 3-18
  - reinforced concrete pipe ..... 12-52
  - steel tunnel liner plate ..... 12-88
  - tire contact area ..... 3-24
  - vehicular collision force ..... 3-35
- Load factors ..... 3-8
  - buried structures ..... 12-9
  - combinations ..... 3-8, 3-15
  - construction loads ..... 3-15, 5-213, 5-226, 5-229
  - definition ..... 1-2
  - jacking ..... 3-16
  - modular bridge joint systems ..... 14-25
  - post-tensioning ..... 3-16
- Load indicator devices ..... 6-27
- Load-induced fatigue
  - application ..... 6-32, 7-12
  - design criteria ..... 6-33, 7-12
  - detail categories ..... 6-34, 7-12
  - detailing to reduce constraint ..... 6-48
  - fatigue resistance ..... 6-48, 7-16
- Local buckling
  - steel ..... 6-143, 6-278
- Local zone ..... 5-124
  - bearing resistance ..... 5-143
  - dimensions of ..... 5-142
  - responsibilities ..... 5-125
  - special anchorage devices ..... 5-129
- Location features
  - bridge site arrangement ..... 2-4
  - clearances ..... 2-6
  - environment ..... 2-7
  - route location ..... 2-3
- Long-slotted holes ..... 6-217, 7-51
- Long-span structural plate structures ..... 12-26
  - acceptable special features ..... 12-29
  - backfill protection ..... 12-38
  - balanced support ..... 12-35
  - concrete relieving slabs ..... 12-36
  - construction and installation ..... 12-37
  - construction requirements ..... 12-31
  - continuous longitudinal stiffeners ..... 12-29
  - cross-section ..... 12-27
  - cut-off (toe) walls ..... 12-36
  - end treatment design ..... 12-33
  - footing design ..... 12-31
  - footing reactions in arch structures ..... 12-30
  - foundation design ..... 12-29
  - hydraulic protection ..... 12-35
  - hydraulic uplift ..... 12-36
  - mechanical and chemical requirements ..... 12-28
  - reinforcing ribs ..... 12-29
  - safety against structural failure ..... 12-25, 12-27, 12-29, 12-33
  - scour ..... 12-36
  - seam strength ..... 12-29
  - section properties ..... 12-27
  - service limit state ..... 12-27
  - service requirements ..... 12-32
  - settlement limits ..... 12-29
  - shape control ..... 12-28
  - soil envelope design ..... 12-31
  - standard shell end types ..... 12-33
  - thrust ..... 12-29
  - wall area ..... 12-29
- Longitudinal stiffeners ..... 6-166
  - limiting slenderness ratio ..... 6-82
  - long-span structural plate structures ..... 12-29
  - moment of inertia and radius of gyration ..... 6-169
  - projecting width ..... 6-169
- Loss of prestress
  - approximate estimate of time-dependent losses ..... 5-103

creep .....	5-108, 5-114	metal grid decks .....	9-16
instantaneous losses .....	5-98	open grid floors .....	9-16
losses for deflection calculations .....	5-109	orthotropic aluminum decks .....	9-28
refined estimate .....	5-104	orthotropic steel decks .....	9-20
relaxation .....	5-106	superposition of local and global effects .....	9-25
shrinkage .....	5-105, 5-108	Metal fasteners and hardware .....	8-21
total .....	5-98	corrosion protection .....	8-23
Maintenance access to sound barriers .....	15-2	drift pins and bolts .....	8-22
Materials		fasteners .....	8-21
adjustment factors for reference design		minimum requirements .....	8-21
values .....	8-24	nails and spikes .....	8-22
alternative fasteners .....	6-27	prestressing bars .....	8-21
aluminum castings .....	7-7	shear plate connectors .....	8-22
aluminum forgings .....	7-7	spike grids .....	8-22
aluminum pipe and structural plate		split ring connectors .....	8-22
structures .....	12-7	toothed metal plate connectors .....	8-22
aluminum sheet, plate, and shapes .....	7-3	Metal pipe, pipe arch, and arch structures .....	12-24
bolts, nuts, and washers .....	6-25	construction and installation .....	12-26
bronze or copper alloy sliding surfaces .....	14-76	corner backfill for corner pipe arches .....	12-19
cables .....	6-28	flexibility limits and construction	
cast metal .....	6-28	stiffness .....	12-12
concrete .....	5-12, 12-7	handling and installation requirements .....	12-25
deck joints .....	14-14	resistance to buckling .....	12-25
disc bearings .....	14-77	safety against structural failure .....	12-24
fasteners—rivets and bolts .....	7-6	seam resistance .....	12-25
glued laminated timber .....	8-12	section properties .....	12-24
guides and restraints .....	14-79	smooth lined pipe .....	12-26
load indicator devices .....	6-25	stiffening elements for structural plate	
metal fasteners and hardware .....	8-21	structures .....	12-26
pins, rollers, and expansion rockers .....	7-6	thrust .....	12-24
pins, rollers, and rockers .....	6-25	Methods of analysis	
pot bearings .....	14-51	See: Dynamic analysis, Mathematical	
precast concrete pipe .....	12-7	modeling, Physical model analysis, Static	
precast concrete structures .....	12-7	analysis	
precast reinforced concrete three-sided		Modular bridge joint systems (MBJS) .....	14-22
structures .....	12-91	design stress range .....	14-31
preservative treatment .....	8-23	distribution of wheel loads .....	14-27
prestressing steel .....	5-22	fatigue limit state design requirements .....	14-29
railings .....	13-5	loads and load factors .....	14-25
sawn lumber .....	8-5	performance requirements .....	14-24
stainless steel .....	6-28	strength limit state design requirements .....	14-28
steel pipe and structural plate structures .....	12-8	testing and calculation requirements .....	14-25
steel reinforcement .....	12-7	Modulus of elasticity	
structural steels .....	6-22	concrete .....	5-18
stud shear connectors .....	6-27	reinforcing steel .....	5-19
thermoplastic pipe .....	12-7	wood piles .....	8-21
weld metal .....	6-27, 7-7	Modulus of rupture .....	5-18
wood products .....	8-5	Moment redistribution	
Mathematical modeling .....	4-10	concrete .....	5-47
equivalent members .....	4-16	from interior-pier I-sections in straight	
geometry .....	4-12	continuous-span bridges .....	6-283, 6-287
modeling boundary conditions .....	4-16	Mononobe-Okabe analysis .....	11-110
structural material behavior .....	4-11	MSE walls .....	11-54
Mechanically stabilized earth walls		abutments .....	11-99
See: MSE walls		bearing resistance .....	11-64
Metal decks		boundary between active and resistant	
corrugated .....	9-29	zones .....	11-70
filled and partially filled grid decks .....	9-17	concentrated dead loads .....	11-95
limit states .....	9-25	corrosion issues for facing .....	11-60

- design life considerations ..... 11-76
- design tensile resistance ..... 11-80
- drainage ..... 11-94
- dynamic load allowance ..... 3-31
- earth pressure ..... 3-117
- external stability ..... 11-62, 11-86
- facing ..... 11-58
- facing reinforcement connections ..... 11-82
- flexible wall facings ..... 11-59
- geosynthetic reinforcements ..... 11-78, 11-80, 11-82
- hydrostatic pressures ..... 11-98
- internal stability ..... 11-65, 11-87
- lateral displacement ..... 11-61
- loading ..... 11-60, 11-63, 11-65
- maximum reinforcement loads ..... 11-66
- minimum front face embedment ..... 11-58
- minimum length of soil reinforcement ..... 11-57
- obstructions in the reinforced soil zone ..... 11-98
- overall stability ..... 11-61
- overturning ..... 11-64
- reinforcement/facing connection design
  - strength ..... 11-82
- reinforcement loads at connection to wall
  - face ..... 11-70
- reinforcement pullout ..... 11-70
- reinforcement strength ..... 11-74
- safety against soil failure ..... 11-62
- safety against structural failure ..... 11-65
- seismic design ..... 11-86
- settlement ..... 11-60
- sliding ..... 11-64
- special loading conditions ..... 11-95
- steel reinforcements ..... 11-76, 11-80, 11-82
- stiff or rigid concrete, steel, and timber
  - facings ..... 11-59
- structure dimensions ..... 11-56
- subsurface erosion ..... 11-94
- traffic loads and barriers ..... 11-96
- Multimode spectral analysis method ..... 4-85
- Multiple presence of live load ..... 3-18
- Multispan bridges
  - multimode spectral method of analysis ..... 4-85
  - selection of method ..... 4-81
  - single-mode method of analysis ..... 4-82
  - single-mode spectral method of analysis ..... 4-82
  - time-history method of analysis ..... 4-85
  - uniform load method of analysis ..... 4-83
- Net area
  - aluminum ..... 7-24
  - steel ..... 6-77
- Noncompact sections
  - nominal flexural resistance ..... 6-140, 6-188
- Noncomposite sections
  - box-shaped members ..... 6-202
  - builtup members ..... 6-78
  - channels, angles, tees, and bars ..... 6-205, 6-207, 6-209
  - circular tubes ..... 6-204
  - I- and H-shaped members ..... 6-201
  - nominal compressive resistance ..... 6-82
  - rectangular bars and solid rounds ..... 6-210
  - tees and double angles ..... 6-205
- Nondestructive testing
  - aluminum ..... 7-19
- Nonyielding abutments ..... 11-100
- Nordlund/Thurman method ..... 10-103
- Nuts
  - grade and finish of ..... 7-50
  - materials ..... 6-26
- Operational importance ..... 1-7
- Orthotropic aluminum decks
  - approximate analysis ..... 9-29
  - limit states ..... 9-29
- Orthotropic deck superstructures ..... 6-247
  - decks in global compression ..... 6-247
  - effective width of deck ..... 6-249
  - superposition of global and local effects ..... 6-249
- Orthotropic decks
  - See: Orthotropic aluminum decks;
  - Orthotropic steel decks
- Orthotropic steel decks
  - approximate analysis ..... 9-21
  - closed ribs ..... 9-24, 9-26
  - deck and rib details ..... 9-27
  - design ..... 9-23
  - detailing requirements ..... 9-26
  - effective flange width ..... 4-54
  - load-induced fatigue ..... 6-32
  - minimum plate thickness ..... 9-26
  - refined analysis ..... 9-21
  - unauthorized welding ..... 9-27
  - wearing surface ..... 9-20
  - wheel load distribution ..... 9-20
- Oversize holes ..... 6-217, 7-51
- Parapets
  - See: Railings
- PE pipes
  - See: Plastic
- Pedestrian loads ..... 3-30
- Pedestrian railings
  - design live loads ..... 13-10
  - geometry ..... 13-9
- Perforated plates ..... 6-78, 6-94
- Permanent loads ..... 3-16
  - dead loads ..... 3-16
  - earth loads ..... 3-17
- Physical model analysis
  - bridge testing ..... 4-90
  - scale model testing ..... 4-90
- Piers
  - barge collision force ..... 3-154
  - collision protection ..... 11-34
  - collision walls ..... 11-34
  - facing ..... 11-34
  - ice loads ..... 3-44, 3-50
  - load combinations and load factors ..... 11-10
  - load effects ..... 11-33

longitudinal reinforcement of hollow rectangular precast segmental piers .....	5-230	wave equation analysis .....	10-98
protection .....	11-34	Pin-connected plates .....	6-79
scour .....	11-34	packing .....	6-80
seismic design .....	5-147	pin plates .....	6-79
service limit state .....	11-6	proportions .....	6-80
ship collision force .....	3-151	Pins	
Pile bents .....	3-97	location .....	6-68
Piles		materials .....	6-25
See also: Concrete piles, Steel piles,		minimum size pin for eyebars .....	6-69
Wood piles		pins and pin nuts .....	6-70
$\alpha$ -method .....	10-101	resistance .....	6-69
axial resistance change after pile driving .....	10-93	Pipe arch structures	
batter piles .....	10-82	See: Metal pipe, pipe arch, and arch structures	
$\beta$ -method .....	10-102	Pipes	
buckling and lateral stability .....	10-118	flexibility factor .....	12-12
buoyancy .....	10-94	Plank decks	
corrosion and deterioration .....	10-119	See: Wood decks and deck systems	
design requirements .....	10-82	Plastic	
determination of $R_{ndr}$ .....	10-121	polyethylene (PE) pipes .....	12-8, 12-102
downdrag .....	10-83, 10-95	polyvinyl chloride (PVC) pipes .....	12-8, 12-103
drivability analysis .....	10-121	Plastic hinges .....	4-80
driven to hard rock .....	10-90	Plastic moment .....	6-313, 6-318
driven to soft rock .....	10-90	Polytetrafluorethylene sliding surfaces	
dynamic formula .....	10-99	See: PTFE sliding surfaces	
dynamic testing .....	10-97	Portal and sway bracing .....	6-246, 7-56
extreme event limit state .....	10-118	deck truss spans .....	6-246
$\lambda$ -method .....	10-102	through-truss spans .....	6-246
groundwater effects .....	10-94	Post-and-beam railings .....	13-21, 13-26
horizontal pile foundation movement .....	10-87	Post-tensioned anchorage zones .....	5-122
length estimates for contract documents .....	10-91	application of the strut-and-tie model to	
load determination .....	10-83	the design of general zone .....	5-132
minimum pile penetration .....	10-120	approximate stress analyses and design .....	5-137
minimum pile spacing, clearance, and		bursting forces .....	5-140
embedment into cap .....	10-81	compressive stresses .....	5-138
nearby structures .....	10-84	design of general zone .....	5-125
Nordlund/Thurman method in		design of local zones .....	5-142
cohesionless soils .....	10-103	edge tension forces .....	5-141
piles through embankment fill .....	10-82	elastic stress analysis .....	5-136
point bearing piles on rock .....	10-90	general zone and local zone .....	5-123
relaxation .....	10-93	limitations of application .....	5-137
resistance factors .....	10-38	Pot bearings .....	14-51
resistance of pile groups in compression .....	10-112	elastomeric disc .....	14-53
scour .....	10-94	geometric requirements .....	14-51
service limit state .....	10-84	materials .....	14-51
settlement .....	10-84	movements and loads .....	14-15, 14-16
setup .....	10-93	piston .....	14-55
special requirements .....	10-167	pot .....	14-54
static analysis .....	10-100	sealing rings .....	14-53
static load test .....	10-97	Precast beams	
strength limit state .....	10-29, 10-89	bridges composed of simple span precast	
structural resistance .....	10-117	girders made continuous .....	5-201
test piles .....	10-123	concrete strength .....	5-198
tip resistance in cohesive soils .....	10-103	detail design .....	5-197
tolerable movements .....	10-84	extreme dimensions .....	5-197
uplift .....	10-114	lifting devices .....	5-197
uplift due to expansive soil .....	10-83	preservice conditions .....	5-197
using SPT or CPT in cohesionless soils .....	10-108	Precast deck bridges .....	5-234
		cast-in-place closure joint .....	5-236



- design ..... 5-235
- longitudinal construction joints ..... 5-235
- longitudinally post-tensioned precast
  - decks ..... 9-15
  - post-tensioning ..... 5-235
  - shear-flexure transfer joints ..... 5-236
  - shear transfer joints ..... 5-235
  - structural overlay ..... 5-236
  - transversely joined precast decks ..... 9-14
- Precast prestressed piles
  - concrete quality ..... 5-192
  - pile dimensions ..... 5-192
  - reinforcement ..... 5-193
- Precast reinforced concrete three-sided
  - structures ..... 12-91
  - concrete ..... 12-91
  - concrete cover for reinforcement ..... 12-91
  - crack control ..... 12-93
  - deflection control at the service limit
    - state ..... 12-93
  - design ..... 12-91
  - distribution of concentrated load effects
    - in top slab and sides ..... 12-92
  - distribution of concentrated loads in
    - skewed culverts ..... 12-92
  - footing design ..... 12-93
  - geometric properties ..... 12-91
  - materials ..... 12-91
  - minimum reinforcement ..... 12-93
  - reinforcement ..... 12-91
  - resistance factors ..... 12-93
  - scour protection and waterway
    - considerations ..... 12-93
  - shear transfer in transverse joints
    - between culvert sections ..... 12-92
  - span length ..... 12-92
  - structural backfill ..... 12-93
- Precast reinforced piles
  - pile dimensions ..... 5-192
  - reinforcing steel ..... 5-192
- Prefabricated modular walls ..... 11-102
  - See also: Earth pressure
  - abutments ..... 11-105
  - bearing resistance ..... 11-102
  - drainage ..... 11-105
  - dynamic load allowance ..... 3-31
  - loading ..... 11-102
  - module members ..... 11-103
  - movement at the service limit state ..... 11-102
  - overturning ..... 11-103
  - passive resistance and sliding ..... 11-103
  - safety against soil failure ..... 11-102
  - safety against structural failure ..... 11-103
  - seismic design ..... 11-104
  - sliding ..... 11-102, 11-103
  - subsurface erosion ..... 11-103
- Preservative treatment for wood
  - fire retardant treatment ..... 8-24
  - inspection and marking ..... 8-24
  - requirement for ..... 8-23
  - treatment chemicals ..... 8-23
- Prestressed concrete
  - See also: Prestressing steel
  - buckling ..... 5-91
  - crack control ..... 5-91
  - loss of prestress ..... 5-98
  - section properties ..... 5-91
  - specified concrete strengths ..... 5-91
  - stress limitations for prestressing tendons ..... 5-92
  - stresses due to imposed deformation ..... 5-92
  - tendons with angle points or curves ..... 5-91
- Prestressing steel
  - concrete cover ..... 5-175
  - materials ..... 5-20
  - modulus of elasticity ..... 5-21
  - post-tensioning anchorages and couplers ..... 5-21
  - stress at nominal flexural resistance ..... 5-40
- Prestressing strand
  - bonded ..... 5-168
  - partially debonded ..... 5-169
- Prestressing tendons
  - protection for ..... 5-176
- Pretensioned anchorage zones
  - confinement reinforcement ..... 5-146
  - factored bursting resistance ..... 5-149
- Probability of aberrancy
  - approximate method ..... 3-143
  - statistical method ..... 3-143
- Protective coatings ..... 5-176
  - See: Corrosion protection
- Provisional post-tensioning ducts and
  - anchorages ..... 5-219
  - bridges with internal ducts ..... 5-219
  - provision for future dead load or
    - deflection adjustment ..... 5-219
- Provisions for structure types
  - arches ..... 5-231, 7-56
  - beam and girder framing ..... 7-55
  - beams and girders ..... 5-196
  - culverts ..... 5-236
  - floor system ..... 7-55
  - lateral bracing ..... 7-55
  - orthotropic deck superstructures ..... 6-247
  - segmental construction ..... 5-211
  - slab superstructures ..... 5-232
  - solid web arches ..... 6-249
  - through-girder spans ..... 6-250
  - trusses ..... 6-244, 7-55
- PTFE sliding surfaces ..... 14-44
  - attachment ..... 14-48
  - coefficient of friction ..... 14-47
  - contact pressure ..... 14-46
  - mating surface ..... 14-45, 14-48
  - minimum thickness ..... 14-45
  - PTFE surface ..... 14-44
  - stainless steel mating surfaces ..... 14-46

PVC pipes	
See: Plastic	
Railing design	
protection of users .....	2-5
railing test specimens.....	13-19
Railings.....	13-3
See also: Bicycle railings, Combination railings, Pedestrian railings, Traffic railings	
concrete parapet and metal rail .....	13-22
extreme event limit state.....	13-5
materials .....	13-5
post-and-beam railings .....	13-21, 13-26
strength limit state .....	13-5
wood barriers.....	13-24
Railroads	
rail transit load.....	3-30
Rectangular stress block method .....	5-54
Redundancy .....	1-6
Refined methods of analysis .....	4-16, 4-68
arch bridges .....	4-73
beam-slab bridges.....	4-70
cable-stayed bridges .....	4-73
cellular and box bridges.....	4-72
decks.....	4-67
fatigue load .....	3-28
nominal moment-rotation curves.....	6-292
orthotropic steel decks .....	9-21
suspension bridges.....	4-74
truss bridges.....	4-72
Reinforced concrete pipe .....	12-47
bearing resistance .....	12-61
bedding factor .....	12-62
circumferential reinforcement .....	12-55
concrete cover.....	12-58
construction and installation.....	12-65
crack width control .....	12-57
development of quadrant mat reinforcement.....	12-65
direct design method.....	12-53
flexural resistance .....	12-55
indirect design method.....	12-61
live loads.....	12-52
loading .....	12-48
loads and pressure distribution .....	12-53
maximum flexural reinforcement without stirrups.....	12-56
minimum reinforcement .....	12-55
pipe fluid weight.....	12-52
pipe ring analysis.....	12-54
process and material factors.....	12-55
safety against structural failure.....	12-52
service limit state.....	12-52
shear resistance .....	12-58, 12-60
standard installations .....	12-48
stirrup anchorage .....	12-61
stirrup embedment .....	12-61
stirrup reinforcement anchorage .....	12-61
Reinforcement	
See also: Spacing of reinforcement	
abutments and retaining walls .....	11-18
approximate stress analyses and design.....	5-137
cast-in-place girders and box and T-beams .....	5-210
compression members .....	5-48
concrete cover.....	5-110, 5-175
crack control .....	5-34, 5-91
drilled shafts .....	10-142, 10-143
elastic stress analysis .....	5-136
elastomeric bearings .....	14-64, 14-75
external tendon supports.....	5-119
hollow rectangular compression members .....	5-156
hooks and bends .....	5-110
longitudinal.....	5-75, 5-77
materials .....	5-18
maximum reinforcement.....	5-43
minimum reinforcement .....	5-43
post-tensioned anchorage zones .....	5-122
pretensioned anchorage zones .....	5-144
shrinkage and temperature.....	5-121
spacing of.....	5-111
special applications.....	5-20
spirals and ties .....	5-53
tendon confinement .....	5-114
torsional .....	5-88
transverse..	5-62, 5-77, 5-119, 5-121, 5-150, 5-151
Reinforcing steel	
See: Reinforcement	
Relaxation losses	
after transfer.....	5-107
at transfer.....	5-106
Relieving slabs	
long-span structural plate structures .....	12-86
structural plate box structures.....	12-46
Resistance factors	
abutments, piers, and walls.....	11-6, 11-13, 11-16
aluminum structures .....	7-10
buried structures .....	12-10
compression members .....	5-51
concrete structures .....	5-147
conventional construction.....	5-26
drilled shafts .....	10-47
driven piles .....	10-39
footings .....	5-187
foundations .....	10-38
precast reinforced concrete three-sided structures .....	12-93
segmental construction .....	5-28
seismic zones 3 and 4 .....	5-149
spread footings.....	10-39
steel.....	6-30
Retaining walls	
See: Abutments and retaining walls	
Rigid frame connections .....	6-243
Roadway drainage	
design storm.....	2-24
discharge from deck drains.....	2-25

- drainage of structures ..... 2-25
- type, size, and number of drains ..... 2-24
- Rock bearing resistance ..... 10-77
- analytic method ..... 10-78
- load test ..... 10-78
- semiempirical procedures ..... 10-78
- Rock properties
- erodability ..... 10-27
- geophysical tests ..... 10-12
- in-situ tests ..... 10-11
- informational needs ..... 10-7
- laboratory tests ..... 10-11
- mass deformation ..... 10-25
- mass strength ..... 10-21
- selection of design properties ..... 10-13
- Rocker bearings ..... 14-42
- contact stresses ..... 14-43
- geometric requirements ..... 14-43
- materials ..... 6-25, 14-43
- Roller bearings ..... 14-42
- contact stresses ..... 14-43
- geometric requirements ..... 14-43
- materials ..... 6-25, 14-43
- Route location ..... 2-3
- waterway and floodplain crossings ..... 2-3
- Safety
- See also: Traffic safety
- abutments and retaining walls ..... 11-23
- anchored walls ..... 11-45, 11-49
- cantilevered retaining walls ..... 11-35, 11-36
- design objective ..... 2-7
- MSE walls ..... 11-62, 11-65
- prefabricated modular walls ..... 11-102, 11-103
- Sawn lumber
- See also: Wood
- bracing ..... 8-36
- dimensions ..... 8-6
- moisture content ..... 8-6
- reference design values ..... 8-6
- size factor ..... 8-26
- Scale model testing ..... 4-90
- Scour ..... 2-21
- buried structures ..... 12-19
- change in foundations ..... 3-39
- drilled shafts ..... 10-130
- piers ..... 11-34
- piles ..... 10-94
- Sealing rings
- rings with circular cross-sections ..... 14-53
- rings with rectangular cross-sections ..... 14-53
- Sectional design model
- combined shear and torsion ..... 5-77
- longitudinal reinforcement ..... 5-75, 5-77
- nominal shear resistance ..... 5-67
- procedures for determining shear
- resistance ..... 5-68
- sections near supports ..... 5-65
- Segmental bridge analysis
- analysis of the final structural system ..... 5-212
- effective flange width ..... 4-65
- erection analysis ..... 4-66
- final structural system ..... 4-66
- longitudinal analysis ..... 4-66
- strut-and-tie models ..... 4-65
- transverse analysis ..... 4-66
- Segmental bridge design
- deck joints ..... 9-15
- principal stresses in webs ..... 5-84
- Segmental bridge substructures
- design ..... 5-235
- Segmental construction ..... 5-211
- alternative construction methods ..... 5-228
- analysis of segmental bridges ..... 5-212
- box girder cross-section dimensions and
- details ..... 5-220
- cantilever construction ..... 5-225
- construction analysis ..... 5-225
- construction loads ..... 5-213, 5-215, 5-226, 5-229
- creep and shrinkage ..... 5-217
- design ..... 5-213
- design details ..... 5-227
- design of construction equipment ..... 5-228
- details for cast-in-place construction ..... 5-225
- details for precast construction ..... 5-223
- force effects due to construction
- tolerances ..... 5-226
- incrementally launched construction ..... 5-226
- plan presentation ..... 5-219
- prestress losses ..... 5-218
- provisional post-tensioning ducts and
- anchorage ..... 5-219
- seismic design ..... 5-222
- span-by-span construction ..... 5-225
- substructures ..... 5-217
- thermal effects during construction ..... 5-217
- types of segmental bridges ..... 5-223
- Seismic design
- abutments and retaining walls ..... 11-23
- anchored walls ..... 11-51
- bearings ..... 14-40, 14-75
- cantilevered retaining walls ..... 11-23
- column connections ..... 5-155
- concrete piles ..... 5-191, 5-192
- construction joints in piers and columns ..... 5-155
- elastomeric bearings ..... 14-66
- hold-down devices ..... 3-98
- lateral load distribution ..... 4-63
- MSE walls ..... 11-86
- prefabricated modular walls ..... 11-104
- segmental construction ..... 5-211
- seismic zone 1 ..... 5-148
- seismic zone 2 ..... 5-148
- seismic zones 3 and 4 ..... 5-149
- wall-type piers ..... 5-154
- Seismic loads
- acceleration coefficient ..... 3-54
- combination of seismic force effects ..... 3-92
- design of bridge components ..... 3-167

dynamic analysis.....	4-77	structural plate box structures.....	12-41
elastic seismic response coefficient.....	3-90	wood structures.....	8-33
forces resulting from plastic hinging.....	3-91	Serviceability	
longitudinal restrainers.....	3-98	deformations.....	2-10
minimum support length requirements.....	4-85	durability.....	2-8
multispan bridges.....	4-78	inspectability.....	2-9
operational classification.....	3-90	maintainability.....	2-9
<i>P</i> - $\Delta$ requirements.....	4-86	rideability.....	2-9
requirements for temporary bridges and		utilities.....	2-9
stage construction.....	3-98	widening.....	2-14
response modification factors.....	3-91	Settlement	
seismic hazard.....	3-54, 3-89	buried structures.....	12-14
seismic zone 1.....	3-93	cohesionless soils.....	10-58
seismic zone 2.....	3-94	cohesive soils.....	10-58, 10-86
seismic zones 3 and 4.....	3-94	downdrag.....	10-95
single-span bridges.....	4-78	due to downdrag.....	10-130
site effects.....	3-84	equivalent footing analogy.....	10-84
Seismic zone 1.....	3-93, 5-148	force effects.....	3-138
Seismic zone 2.....	3-94, 5-148	group settlement.....	10-130
Seismic zones 3 and 4		intermediate geo materials.....	10-129
column and pile bent design forces.....	3-97	on rock.....	10-63
column connections.....	5-155	single-drilled shaft.....	10-127
column requirements.....	5-149	Shear and torsion	
concrete piles.....	5-191	aluminum.....	7-40, 7-45
construction joints in piers and columns.....	5-155	beam ledges.....	5-177
foundation design forces.....	3-97	concrete.....	5-56, 5-63
inelastic hinging forces.....	3-94	design and detailing requirements.....	5-62
modified design forces.....	3-94	development of reinforcement.....	5-160
pier design forces.....	3-97	interface shear transfer—shear friction.....	5-78
piers with two or more columns.....	3-96	interior-pier I-sections in straight	
resistance factors.....	5-26	continuous-span bridges.....	6-285
single columns and piers.....	3-95	longitudinal reinforcement.....	5-77
wall-type piers.....	5-154	modifications for lightweight concrete.....	5-59
Service limit states.....	1-3	nominal shear resistance.....	5-67
abutments and retaining walls.....	11-6, 11-19	sectional design model.....	5-64
aluminum structures.....	7-7	segmental box girder bridges.....	5-85
bridges composed of simple span		shear in slabs and footings.....	5-188
precast girders made continuous.....	5-201	skewed bridges.....	4-40
buried structures.....	12-9, 12-14	steel.....	6-151
cast-in-place box culverts and		torsional resistance.....	5-77
arches.....	12-71	transfer and development lengths.....	5-60
concrete structures.....	5-23, 5-35, 5-95	transverse reinforcement.....	5-60, 5-77
decks.....	9-5	in tubes.....	7-49
drilled shafts.....	10-126	warping torsion.....	7-47
flexure.....	6-286	Shear connectors.....	6-136, 6-154
foundations.....	10-27, 10-28, 10-29	cover and penetration.....	6-157
interior-pier I-sections in straight		fatigue resistance.....	6-157
continuous-span bridges.....	6-286	permanent load contraflexure.....	6-158
lateral squeeze.....	10-89	pitch.....	6-155
long-span structural plate structures.....	12-27	steel box-section flexural members.....	6-194
orthotropic aluminum decks.....	9-26	strength limit state.....	6-158
piers.....	11-6	studs.....	6-27
piles.....	10-84	transverse spacing.....	6-156
redistribution moments.....	6-287	Shear resistance	
reinforced concrete pipe.....	12-52	aluminum.....	7-40
sound barriers.....	15-3	bolted connections.....	6-220
steel box-section flexural members.....	6-182	disc bearings.....	14-73
steel I-section members.....	6-127	reinforced concrete pipe.....	12-58, 12-60
steel structures.....	6-29	steel box-section flexural members.....	6-194

- steel I-section flexural members.....6-151
- wood.....8-31
- Ship collision force
  - See: Vessel collisions
- Short-slotted holes..... 6-217, 7-51
- Shrinkage..... 3-137, 5-17
- Sidewalks ..... 13-12
  - end treatment of separation railing..... 13-13
- Skewed bridges
  - live load distribution..... 4-32, 4-47
- Slab superstructures
  - cast-in-place solid slab superstructures .....5-231
  - cast-in-place voided slab
    - superstructures .....5-232
  - precast deck bridges .....5-234
- Slabs
  - See: Concrete slabs
- Slenderness effects and limits
  - compression members .....5-51
  - ice loads, piers .....3-50
- Slenderness ratios
  - aluminum.....7-20
  - steel ..... 6-77, 6-82
- Slip-critical connections ..... 6-214, 7-53
- Slip resistance
  - bolted connections.....6-221
- Small deflection theory.....4-12
- Soil bearing resistance.....10-66
  - basic formulation.....10-67
  - considerations for footings in slopes.....10-71
  - considerations for punching shear.....10-70
  - considerations for two-layer soil
    - systems—critical depth .....10-73
  - plate load tests .....10-77
  - semiempirical procedures.....10-76
  - theoretical estimation .....10-67
  - two-layered soil system in drained
    - loading.....10-76
  - two-layered soil system in undrained
    - loading.....10-74
- Soil properties
  - determination of ..... 11-5, 12-6, 15-12
  - envelope backfill soils .....12-6
  - foundation soils .....12-6
  - geophysical tests.....10-12
  - in-situ tests .....10-11
  - informational needs .....10-7
  - laboratory tests .....10-11
  - selection of design properties .....10-13
  - soil deformation.....10-18
  - soil strength .....10-15
  - subsurface exploration.....10-8
  - unit weight.....3-17
- Soil strength
  - drained strength of cohesive soils.....10-16
  - drained strength of granular soils .....10-16
  - undrained strength of cohesive soils.....10-15
- Soil-structure interaction systems
  - See: Culverts
- Solid web arches
  - flange stability .....6-250
  - moment amplification for deflection .....6-249
  - web slenderness.....6-249
- Sound barriers
  - corrosion protection.....15-13
  - design limit states .....15-12
  - drainage ..... 15-2, 15-14
  - earth load .....15-9
  - extreme event limit state.....15-4
  - foundation design .....15-12
  - loading.....15-13
  - resistance factors .....15-13
  - safety against geotechnical failure.....15-13
  - seismic design .....15-13
  - service limit state.....15-3, 15-13
  - soil and rock properties .....15-12
  - strength limit state .....15-3, 15-13
  - wind load .....15-5
  - vehicle collision forces .....15-9
- Spacing of reinforcement
  - bundled bars .....5-112
  - cast-in-place concrete .....5-111
  - couplers in post-tensioning tendons .....5-114
  - curved post-tensioning ducts .....5-113
  - hollow rectangular compression
    - members .....5-156
  - maximum spacing of reinforcing bars .....5-112
  - minimum spacing of prestressing tendons
    - and ducts .....5-112
  - minimum spacing of reinforcing bars.....5-111
  - multilayers .....5-111
  - post-tensioning ducts straight in plan .....5-113
  - precast concrete .....5-111
  - pretensioning strand .....5-112
  - splices .....5-112
- Spike laminated decks .....9-38
  - deck tie-downs.....9-39
  - panel decks .....9-39
- Splices
  - See also: Bolted splices, Splices of bar reinforcement, Splices of welded wire fabric
  - compression members .....7-54
  - flexural members.....7-54
  - tension members.....7-54
  - welded .....6-248
  - welding .....7-55
- Splices of bar reinforcement
  - See also: Lap splices
  - bars in compression .....5-172
  - detailing.....5-170
  - end-bearing splices .....5-173
  - general requirements .....5-170
  - mechanical connections.....5-171
  - mechanical connections or welded
    - splices in compression.....5-172

mechanical connections or welded		modulus of elasticity.....	6-22
splices in tension .....	5-172	thickness of metal .....	6-22
reinforcement in tension .....	5-171	Steel box-section flexural members.....	6-171
tension tie members.....	5-172	access and drainage .....	6-177
welded splices.....	5-171	bearings .....	6-176
Splices of welded wire fabric		compact sections.....	6-187
deformed wire in tension .....	5-173	constructibility .....	6-179
smooth wire in tension.....	5-173	cross-section proportion limits .....	6-177
Spread footings .....	10-51	fatigue and fracture limit state .....	6-183
anchorage of inclined footings.....	10-53	flange-to-web connections.....	6-176
bearing depth .....	10-51	flexural resistance—sections in negative	
bearing resistance at the service limit		flexure.....	6-189
state.....	10-64	flexural resistance—sections in positive	
bearing stress distributions .....	10-52	flexure.....	6-187
eccentric load limitations.....	10-81	noncompact sections.....	6-187
effective footing dimensions.....	10-52	service limit state .....	6-182
extreme event limit state.....	10-80	shear connectors .....	6-194
failure by sliding.....	10-79	shear resistance .....	6-194
groundwater.....	10-53	stiffeners .....	6-195
loads.....	10-54	strength limit state .....	6-185
nearby structures.....	10-53	stress determination .....	6-173
overall stability .....	10-64	Steel dimension and detail requirements	
resistance factors.....	10-38	dead load camber .....	6-57
service limit state .....	10-53	diaphragms and cross-frames .....	6-57
settlement on cohesionless soils .....	10-55	effective length of span.....	6-57
settlement on cohesive soils.....	10-58	heat-curved rolled beams and welded	
settlement on rock.....	10-63	plate girders .....	6-70
strength limit state .....	10-38, 10-66	lateral bracing .....	6-65
structural design.....	10-81	minimum thickness of steel .....	6-59
tolerable movements.....	10-53	pins .....	6-68
uplift .....	10-53	Steel I-girders	
St. Venant torsion		See: Steel I-section flexural members	
aluminum.....	7-46	Steel I-section flexural members	
Stability		compact sections.....	6-136
buried structures .....	12-17	composite sections.....	6-102
elastomeric bearings .....	14-63, 14-75	constructibility .....	6-120
MSE walls .....	11-60, 11-62, 11-65, 11-86, 11-87	cover plates.....	6-170
sound barriers .....	15-13	cross-section proportion limits .....	6-118
static analysis.....	4-75	diaphragms or cross-frames .....	6-59
Stainless steel.....	6-28	ductility requirement.....	6-140
Static analysis		fatigue and fracture limit state .....	6-130
analysis for temperature gradient.....	4-75	flange-strength reduction factors .....	6-113
approximate methods.....	4-19	flange stresses and member bending	
axial pile resistance in compression.....	10-93	moments .....	6-106
influence of plan geometry .....	4-17	flexural resistance.....	6-136, 6-141
redistribution of negative moments in		flexural resistance—composite sections	
continuous beam bridges .....	4-74	in negative flexure and	
refined methods .....	4-68	noncomposite sections.....	6-139
stability .....	4-75	flexural resistance—composite sections	
Stay-in-place formwork		in positive flexure.....	6-136
concrete.....	9-13	flowcharts for design .....	6-300
deck overhangs .....	9-5	fundamental calculations .....	6-313
steel.....	9-13	hybrid sections.....	6-104
Steel		lateral bracing .....	6-60
basic steps for steel bridge		minimum negative flexure concrete deck	
superstructures.....	6-295	reinforcement.....	6-108
coefficient of thermal expansion .....	6-22	moment redistribution from interior-pier	
minimum mechanical properties by		I sections in straight continuous-	
shape, strength, and thickness.....	6-25	span bridges.....	6-283

- net section fracture ..... 6-110
- noncompact sections ..... 6-139, 6-140
- noncomposite sections ..... 6-103
- service limit state ..... 6-127
- shear connectors ..... 6-154
- shear resistance ..... 6-151
- stiffeners ..... 6-161
- stiffness ..... 6-106
- strength limit state ..... 6-131
- variable web depth members ..... 6-104
- web bend-buckling resistance ..... 6-110
- Steel I-section proportioning
  - flange proportions ..... 6-119
  - web proportions ..... 6-118
- Steel orthotropic decks
  - See: Orthotropic steel decks
- Steel piles ..... 6-250
  - axial compression ..... 6-252
  - buckling ..... 6-252
  - combined axial compression and flexure ..... 6-252
  - compressive resistance ..... 6-252
  - maximum permissible driving stresses ..... 6-252
  - structural resistance ..... 6-250, 10-117
- Steel tension members ..... 6-71
  - builtup members ..... 6-78
  - eyebars ..... 6-78
  - limiting slenderness ratio ..... 6-77
  - net area ..... 6-77
  - pin-connected plates ..... 6-79
  - tensile resistance ..... 6-72
- Steel tunnel liner plate ..... 12-87
  - buckling ..... 12-89
  - construction stiffness ..... 12-89
  - earth loads ..... 12-87
  - flexibility limits and construction
    - stiffness ..... 12-13
  - grouting pressure ..... 12-88
  - live loads ..... 12-88
  - loading ..... 12-87
  - safety against structural failure ..... 12-88
  - seam strength ..... 12-89
  - section properties ..... 12-88
  - wall area ..... 12-88
- Stiffened webs
  - nominal resistance ..... 6-152
- Stiffeners
  - See also: Longitudinal stiffeners,  
Transverse intermediate stiffeners
  - bearing stiffeners ..... 6-165
  - design of ..... 7-42
  - longitudinal compression-flange ..... 6-196
  - web ..... 6-195
- Stirrups
  - See: Transverse reinforcement
- Stream pressure
  - lateral ..... 3-38
  - longitudinal ..... 3-37
- Strength limit states ..... 1-3
  - abutments and retaining walls ..... 11-7, 11-20
  - aluminum structures ..... 7-10
  - bridges composed of simple span precast
    - girders made continuous ..... 5-201
  - buried structures ..... 12-9
  - combined flexure and axial load ..... 6-199
  - concrete structures ..... 5-44
  - decks ..... 9-6
  - drilled shafts ..... 10-130
  - flexure ..... 6-131, 6-185
  - foundations ..... 10-29, 10-38
  - interior-pier I-sections in straight
    - continuous-span bridges ..... 6-288
  - modular bridge joint systems ..... 14-28
  - railings ..... 13-5
  - resistance factors ..... 5-26, 6-30
  - shear ..... 6-136, 6-186, 6-200
  - shear connectors ..... 6-136, 6-158, 6-186
  - spread footings ..... 10-66
  - stability ..... 5-29
  - steel box-section flexural members ..... 6-185
  - steel structures ..... 6-29, 6-199
  - wood structures ..... 8-30
- Stress analyses and design
  - bursting forces ..... 5-140
  - compressive stresses ..... 5-138
  - edge tension forces ..... 5-141
  - limitations of application ..... 5-137
- Stress laminated decks ..... 9-33
  - camber ..... 8-37
  - deck tie-downs ..... 9-34
  - holes in lamination ..... 9-34
  - nailing ..... 9-33
  - staggered butt joints ..... 9-34
  - stressing ..... 9-34
- Stressing
  - corrosion protection ..... 9-38
  - design requirements ..... 9-37
  - prestressing materials ..... 9-36
  - prestressing system ..... 9-34
  - railings ..... 9-38
- Structural analysis ..... 4-1
  - acceptable methods ..... 4-9
  - dynamic ..... 4-77
  - mathematical modeling ..... 4-10
  - by physical models ..... 4-90
  - static analysis ..... 4-17
- Structural material behavior
  - elastic behavior ..... 4-11
  - elastic versus inelastic behavior ..... 4-11
  - inelastic behavior ..... 4-11
- Structural plate box structures ..... 12-40
  - concrete relieving slabs ..... 12-46
  - construction and installation ..... 12-47
  - crown soil cover factor ..... 12-45
  - footing reactions ..... 12-45
  - loading ..... 12-41
  - moments due to factored loads ..... 12-42
  - plastic moment resistance ..... 12-44
  - safety against structural failure ..... 12-41

service limit state .....	12-41	temperature range for procedure B .....	3-134
Structure-mounted sound barriers.....	15-4	uniform temperature .....	3-133
Strut-and-tie model		Thermoplastic pipes.....	12-71
crack control reinforcement.....	5-34	bending strain .....	12-84
general zone.....	5-132	buckling .....	12-81, 12-83
proportioning of compressive struts .....	5-31	chemical and mechanical requirements .....	12-73
proportioning of node regions .....	5-34	combined strain .....	12-84
proportioning of tension ties .....	5-33	flexibility limits and construction	
structural modeling .....	5-30	stiffness.....	12-13
Substructures		handling and installation requirements .....	12-83
construction load combinations .....	5-230	materials .....	12-8
design.....	5-222	resistance to local buckling of pipe	
longitudinal reinforcement of hollow		wall.....	12-81
rectangular precast segmental piers.....	5-230	safety against structural failure .....	12-73
vessel collisions .....	2-5, 3-156	section properties.....	12-73
Superimposed deformations		service limit state .....	12-71
creep .....	3-133	slenderness and effective width .....	12-82
design thermal movements .....	3-136	thrust.....	12-83
differential shrinkage.....	3-137	wall resistance .....	12-81
settlement.....	3-138	Through-girder spans.....	6-247
temperature gradient.....	3-133	Timber	
uniform temperature .....	3-130	See: Wood	
Superstructure design.....	5-222	Timber floors	
Surcharge loads		See: Wood decks and deck systems	
live load surcharge.....	3-129	Time-history method .....	4-85
point line and strip loads.....	3-124	Tire contact area .....	3-24
reduction of surcharge .....	3-130	Torsion	
strip loads—flexible walls .....	3-127	See: Shear and torsion	
uniform surcharge.....	3-123	Traffic railings .....	13-5
Suspension bridges		application of previously tested systems .....	13-8
refined analysis .....	4-72	approach railings.....	13-6
Temperature gradients .....	3-136, 4-75	design forces .....	13-17
Temporary stresses before losses		end treatment .....	13-6
compression stresses.....	5-93	height of traffic parapet or railing.....	13-9
tension stresses .....	5-93	new systems.....	13-9
Tendon confinement		railing design .....	13-8
effects of curved tendons.....	5-114	railing system.....	13-5
wobble effect in slabs .....	5-114	separation of rail elements.....	13-15
Tensile resistance		test level selection criteria .....	13-7
aluminum.....	7-23, 7-30	Traffic safety	
combined tension and flexure.....	6-76	geometric standards .....	2-5
fatigue resistance .....	6-225	protection of structures .....	2-4
MSE walls .....	11-62	protection of users .....	2-5
nominal .....	6-225	road surfaces.....	2-5
prying action.....	6-225	vessel collisions .....	2-5
reduction factor.....	6-73	Transverse intermediate stiffeners	
Tension-flange flexural resistance .....	6-193	moment of inertia.....	6-162
Tension members		projecting width.....	6-162
aluminum.....	7-23	Transverse reinforcement	
concrete.....	5-58	compression members .....	5-122, 5-120
splices .....	7-54	concrete.....	5-60
Tension ties		drilled shafts .....	10-144
anchorage of tie .....	5-34	flexural members .....	5-121
proportioning .....	5-33	Truss bridges	
strength of tie.....	5-33	refined analysis .....	4-71
Test piles.....	10-123	Trusses .....	6-244
Thermal forces		bracing .....	8-37
temperature gradient.....	3-136	camber .....	6-245, 8-37
temperature range for procedure A.....	3-133	diaphragms .....	6-59, 6-245



factored resistance .....	6-247	Water loads	
gusset plates .....	6-256	buoyancy .....	3-37
half-through .....	6-257	drag coefficient.....	3-37
lateral bracing.....	6-64	scour .....	3-39
load distribution.....	4-47	static pressure .....	3-37
portal and sway bracing.....	6-246, 7-56	stream pressure.....	3-37
secondary stresses .....	6-245	wave load .....	3-39
truss members.....	6-245	Wearing surface	
working lines and gravity axes .....	6-245	chip seal.....	9-40
Tub-section members		orthotropic steel decks.....	9-20
lateral bracing.....	6-66	plant mix asphalt .....	9-40
Unfilled grid decks composite with		wood decks.....	9-40
reinforced concrete slabs		Web bend-buckling resistance	
design .....	9-19	webs with longitudinal stiffeners.....	6-86
fatigue limit state.....	9-19	webs without longitudinal stiffeners .....	6-86
Unstiffened webs		Web crippling	
nominal resistance .....	6-152	aluminum.....	7-9
Uplift		steel .....	6-321
aluminum.....	7-19	Web local yielding.....	6-321
buried structures .....	12-18	Web plastification factors	
drilled shafts.....	10-126	compact web sections.....	6-274
load test .....	10-139	noncompact web sections.....	6-275
pile group uplift resistance .....	10-114, 10-143	Web proportions	
piles penetrating expansive soil.....	10-83	webs with longitudinal stiffeners.....	6-119, 6-178
resistance .....	10-142	webs without longitudinal stiffeners .	6-118, 6-178
single-pile uplift resistance.....	10-114	Webs	
spread footings .....	10-53	nominal resistance of stiffened webs.....	6-152
Vehicle-induced vibration .....	4-79	nominal resistance of unstiffened webs.....	6-152
Vehicular collision force		Welded connections.....	6-227
protection of structures .....	3-35	complete penetration groove-welded	
vehicle collision with barriers .....	3-36	connections.....	6-227
Vehicular live load		effective area .....	6-229
multiple presence of live load .....	3-18	factored resistance .....	6-227
number of design lanes.....	3-17	fillet weld end returns.....	6-230
Vertical wind pressure.....	3-43	fillet-welded .....	6-228
Vessel collisions.....	3-138	minimum effective length of fillet welds .....	6-230
annual frequency of collapse.....	3-140	partial penetration groove-welded	
barge bow damage length.....	3-155	connections.....	6-228
barge collision force on pier.....	3-154	seal welds .....	6-230
damage at extreme limit state.....	3-155	size of fillet welds .....	6-229
design collision velocity.....	3-150	Welded wire fabric	
design vessel.....	3-140	deformed .....	5-164
impact force.....	3-147	plain.....	5-165
impact force, substructure design.....	3-156	quadrant mat reinforcement.....	12-64
impact force, superstructure design.....	3-157	Welding	
owner's responsibility .....	3-140	procedures for aluminum.....	7-18
protection against .....	2-5	requirements for aluminum .....	7-18
protection of substructures .....	3-157	splices.....	7-55
ship bow damage length.....	3-153	weld metal .....	6-27
ship collision force on pier .....	3-151	Wheel loads	
ship collision force on superstructure.....	3-153	corrugated metal decks.....	9-30
ship collision with bow.....	3-153	decks.....	4-27
ship collision with deck house.....	3-153	distribution through earth fills.....	3-25
ship collision with mast.....	3-154	modular bridge joint systems .....	14-27
vessel collision energy.....	3-150	orthotropic steel decks.....	9-20
Warping torsion.....	7-47	Widening	
Washers.....	6-216	exterior beams .....	2-14
materials .....	6-26	substructure .....	2-14

Wind-induced vibration .....	4-79
Wind load	
aeroelastic instability .....	3-43
horizontal wind pressure.....	3-39
multibeam bridges .....	4-59
sound barriers .....	15-5
vertical wind pressure.....	3-43
Wind pressure on structures.....	3-41
box sections .....	4-63
construction .....	4-63
I-sections.....	4-62
loads from superstructures.....	3-41
Wind pressure on vehicles .....	3-42
Wood	
bracing .....	8-36
camber .....	8-37
components in combined flexure and	
axial loading .....	8-35
components in compression.....	8-33
components in flexure .....	8-31
components in tension parallel to grain .....	8-35
components under shear .....	8-33
connection design .....	8-37
deck factor .....	8-29
flat-use factor.....	8-28
format conversion factor.....	8-25
glued laminated timber .....	8-12
incising factor .....	8-29
metal fasteners and hardware.....	8-21
preservative treatment.....	8-21
sawn lumber.....	8-5
wet service factor.....	8-26
Wood barriers	
railing design .....	13-23
Wood decks and deck systems.....	9-30
deck tie-downs.....	9-32, 9-34, 9-39, 9-40
deformation.....	9-31
design requirements .....	9-30
glued laminated decks .....	9-32
interconnected decks.....	9-32
load distribution.....	9-30
nailing .....	9-33
noninterconnected decks.....	9-33
plank decks .....	9-40
shear design .....	9-31
skewed decks .....	9-31
spike laminated decks .....	9-38
stress laminated decks .....	9-33
thermal expansion.....	9-31
wearing surfaces .....	9-31, 9-40
Wood piles	
base resistance and modulus of elasticity .....	8-14
structural resistance .....	10-118
Yield lines.....	4-80
Yield moment .....	6-315
composite sections in negative flexure .....	6-316
composite sections in positive flexure.....	6-316
noncomposite sections.....	6-315
sections with cover plates .....	6-317