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LRFD Bridge Construction Specifications
4th Edition



AMERICAN ASSOCIATION
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AASHTO

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American Association of State Highway and Transportation Officials
444 North Capitol Street, NW, Suite 249
Washington, DC 20001
202-624-5800 phone/202-624-5806 fax
www.transportation.org

Cover photos: **Top:** Erection of the basket handle steel arch of the Edna M. Griffin pedestrian bridge over I-235 in downtown Des Moines, Iowa, during an overnight closure, July 3rd, 2003. Photo provided by Iowa DOT. **Bottom:** Utah South Layton Span 1 over I-15, in Layton, Utah, August 8, 2010. Photo provided by the Utah DOT.

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ABBREVIATED TABLE OF CONTENTS

The *AASHTO LRFD Bridge Construction Specifications*, Fourth Edition, contains the following 33 sections:

1. Structure Excavation and Backfill
2. Removal of Existing Structures
3. Temporary Works
4. Driven Foundation Piles
5. Drilled Shafts
6. Ground Anchors
7. Earth-Retaining Systems
8. Concrete Structures
9. Reinforcing Steel
10. Prestressing
11. Steel Structures
12. Steel Grid Flooring
13. Painting
14. Stone Masonry
15. Concrete Block and Brick Masonry
16. Timber Structures
17. Preservative Treatment of Wood
18. Bearing Devices
19. Bridge Deck Joint Seals
20. Railings
21. Waterproofing
22. Slope Protection
23. Miscellaneous Metal
24. Pneumatically Applied Mortar
25. Steel and Concrete Tunnel Liners
26. Metal Culverts
27. Concrete Culverts
28. Wearing Surfaces
29. Embedment Anchors
30. Thermoplastic Culverts
31. Aluminum Structures
32. Shock Transmission Units
33. Micropiles

FOREWORD

The first broadly recognized national standard to design and construct 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 Highways 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. The title was soon revised to *Standard Specifications for Highway Bridges* and new editions were released about every four years. AASHTO released the 17th and final edition 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 accelerated in recent years.

In 1986, the Subcommittee submitted a request to the AASHTO Standing Committee on Research to assess 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 continuing research, the Standard Specifications were found to have 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 was 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).

A further philosophical extension considers 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 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.

AASHTO members include 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 non-voting member.

Orders for Specifications may be placed by visiting our website, bookstore.transportation.org, or by calling 1-800-231-3475 (toll free within the U.S. and Canada). A free copy of the current publication catalog can be downloaded from our website or requested from the Publications Sales Office.

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 these LRFD Specifications.

AASHTO encourages suggestions to improve these specifications. They should be sent to the Chairman, Subcommittee on Bridges and Structures, AASHTO, 444 North Capitol Street, N.W., Suite 249, Washington, DC 20001. Inquiries as to intent or application of the specifications should be sent to the same address.

AASHTO Highways Subcommittee on Bridges and Structures
August 2017

PREFACE

Units

The *AASHTO LRFD Bridge Construction Specifications*, Fourth Edition, uses U.S. Customary units only. Per a decision by the subcommittee in 2009, SI units will no longer be included in this edition or future interims.

References

If a standard is available as a stand-alone publication—for example, the ACI standards—the title is *italicized* in the text and listed in the references. If a standard is available as part of a larger publication—for example, the AASHTO materials specifications—the standard’s title is not italicized and the larger publication—in this case, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*—is listed in the references.

Unit Abbreviations

Most of the abbreviations commonly used in LRFD Construction are listed below.
Also, please note the following:

- Abbreviations for singular and plural are the same.
- Most units of time have one-letter abbreviations. Unit abbreviations are always set in roman type, while variables and factors are set in *italic* type. Thus, “2 h” is the abbreviation for “two hours.”

Table i—Frequently-Used Unit Abbreviations

Unit	Abbreviation
cubic foot	ft ³
cubic inch	in. ³
cubic yard	yd ³
degrees Fahrenheit	°F
foot	ft
foot-kip	ft-kip
foot per hour	ft/h
foot per minute	ft/min
foot per second	ft/s
foot pound	ft · lb
foot pound-force	ft · lbf
foot second	ft · s
gallon	gal
hour	h
Hertz	Hz
inch	in.
joule	J
kilonewton	kN
kilopascal	kPa
kip per foot	kip/ft
kip per square inch	ksi
kip per square foot	kip/ft ²
megapascal	MPa
microinch	μin
micron	μm
mile	mi
minute	min (min. for “minimum”)

Table i (continued)—Frequently-Used Unit Abbreviations

Unit	Abbreviation
newton	N
newton meter	N · m
newton per meter	N/m
ounce	oz
pascal	Pa
pascal second	Pa · s
pound	lb
pound-force	lbf
pound-force foot	lbf · ft
pound-force inch	lbf · in.
pound-force per foot	lbf/ft
pound-force per inch	lbf/in.
pound-force per pound	lbf/lb
pound-force per square foot	psf
pound-force per square inch	psi
pound per cubic foot	lb/ft ³
pound per cubic inch	lb/in. ³
pound per cubic yard	lb/yd ³
pound per foot	lb/ft
pound per inch	lb/in.
pound per hour	lb/h
pound per square foot	lb/ft ²
pound per yard	lb/yd
radian	rad
radian per second	rad/s
quart	qt
second	s
square inch	in. ²
square foot	ft ²
square mile	mi ²
square yard	yd ²
year	yr

Note: There are no abbreviations for *day*, *degree* (angle), *kip*, *mil*, or *ton*.

AASHTO Publications Staff
August 2017

TABLE OF CONTENTS

1.1—GENERAL	1-1
1.2—WORKING DRAWINGS	1-1
1.3—MATERIALS	1-2
1.4—CONSTRUCTION	1-2
1.4.1—Depth of Footings	1-2
1.4.2—Foundation Preparation and Control of Water	1-2
1.4.2.1—General	1-2
1.4.2.2—Excavations within Channels	1-3
1.4.2.3—Foundations on Rock	1-3
1.4.2.4—Foundations Not on Rock	1-3
1.4.2.5—Approval of Foundation	1-3
1.4.3—Backfill	1-4
1.5—MEASUREMENT AND PAYMENT	1-4
1.5.1—Measurement	1-4
1.5.2—Payment	1-5
1.6—REFERENCE	1-6

SECTION 2: REMOVAL OF EXISTING STRUCTURES

TABLE OF CONTENTS

2.1—DESCRIPTION	2-1
2.2—WORKING DRAWINGS	2-1
2.3—CONSTRUCTION	2-1
2.3.1—General.....	2-1
2.3.2—Salvage.....	2-2
2.3.3—Partial Removal of Structures	2-2
2.3.4—Disposal	2-3
2.4—MEASUREMENT AND PAYMENT	2-3

TABLE OF CONTENTS

3.1—GENERAL	3-1
3.1.1—Description	3-1
3.1.2—Working Drawings	3-1
3.1.3—Design	3-1
3.1.4—Construction	3-2
3.1.5—Removal	3-2
3.2—FALSEWORK	3-2
3.2.1—General	3-2
3.2.2—Foundations	3-2
3.2.3—Timber Construction	3-3
3.2.4—Steel Construction	3-3
3.2.5—Proprietary Shoring Systems	3-4
3.2.6—Manufactured Components	3-4
3.2.7—Noncommercial Components	3-4
3.2.8—Traffic Openings (Clearances)	3-4
3.2.9—Adjustments	3-5
3.2.9.1—Wedges	3-5
3.2.9.2—Jacks	3-5
3.2.10—Camber Strips	3-5
3.2.11—Loading	3-5
3.2.12—Removal of Falsework	3-6
3.2.13—Dismantling	3-6
3.3—FORMWORK	3-6
3.3.1—General	3-6
3.3.2—Tolerances	3-7
3.3.3—Joints	3-8
3.3.4—Form Accessories	3-8
3.3.5—Prefabricated Formwork	3-8
3.3.6—Stay-in-Place Forms	3-8
3.3.7—Tube Forms	3-9
3.3.8—Bracing and Guying	3-9
3.3.9—Removal of Forms	3-10
3.3.9.1—General	3-10
3.3.9.2—Time of Removal	3-10
3.3.10—Reuse of Forms	3-11
3.4—COFFERDAMS AND SHORING	3-11
3.4.1—General	3-11
3.4.2—Protection of Concrete	3-12
3.4.3—Removal	3-12
3.5—TEMPORARY WATER CONTROL SYSTEMS	3-12
3.5.1—General	3-12
3.5.2—Working Drawings	3-12
3.5.3—Operations	3-12
3.6—TEMPORARY BRIDGES	3-12
3.6.1—General	3-12
3.6.2—Detour Bridges	3-13
3.6.3—Haul Bridges	3-13
3.6.4—Maintenance	3-13
3.7—MEASUREMENT AND PAYMENT	3-14
3.8—REFERENCES	3-14

TABLE OF CONTENTS

4.1—INTRODUCTION	4-1
4.2—MATERIALS.....	4-2
4.2.1—Steel Piles.....	4-2
4.2.1.1—Rolled Structural Steel Piles	4-2
4.2.1.1.1—Specifications for Steel Properties.....	4-2
4.2.1.1.2—Minimum Dimensions	4-2
4.2.1.2—Steel Pipe Piles	4-3
4.2.1.2.1—Specification for Steel	4-3
4.2.1.2.2—Concrete for Concrete-Filled Pipe Piles	4-3
4.2.2—Timber Piles.....	4-4
4.2.2.1—General	4-4
4.2.2.2—Submittals	4-4
4.2.2.3—Field Fabrication.....	4-4
4.2.2.4—Pressure Treatment	4-4
4.2.2.5—Required Retentions.....	4-4
4.2.3—Prestressed Concrete Piles	4-5
4.2.3.1—Forms	4-5
4.2.3.2—Casting.....	4-5
4.2.3.3—Finish	4-6
4.2.3.4—Curing and Protection.....	4-6
4.2.3.5—Prestressing.....	4-6
4.2.3.6—Shop Drawings	4-6
4.2.3.7—Storage and Handling	4-6
4.3—PROTECTIVE COATINGS	4-7
4.4—DRIVING PILES.....	4-7
4.4.1—Pile Driving Equipment	4-7
4.4.1.1—Hammers.....	4-8
4.4.1.1.1—General	4-8
4.4.1.1.2—Drop Hammers	4-9
4.4.1.1.3—Air Hammers	4-9
4.4.1.1.4—Diesel Hammers	4-9
4.4.1.1.5—Hydraulic Hammers.....	4-9
4.4.1.1.6—Vibratory Hammers	4-10
4.4.1.1.7—Additional Equipment or Methods	4-10
4.4.1.2—Driving Appurtenances.....	4-10
4.4.1.2.1—Hammer Cushion.....	4-10
4.4.1.2.2—Helmet	4-11
4.4.1.2.3—Pile Cushion.....	4-11
4.4.1.2.4—Leads	4-11
4.4.1.2.5—Followers	4-12
4.4.1.2.6—Jetting	4-12
4.4.2—Preparation for Driving.....	4-13
4.4.2.1—Site Work.....	4-13
4.4.2.1.1—Excavation.....	4-13
4.4.2.1.2—Predrilling to Facilitate Driving.....	4-13
4.4.2.1.3—Additional Requirements for Predrilled Holes in Embankments.....	4-13
4.4.2.2—Preparation of Piling.....	4-13
4.4.2.2.1—Pile Heads.....	4-13
4.4.2.2.2—Collars	4-14
4.4.2.2.3—Pile Shoes and End Plates.....	4-14
4.4.3—Driving.....	4-14
4.4.3.1—Heaved Piles	4-15
4.4.3.2—Obstructions.....	4-15
4.4.3.3—Installation Sequence.....	4-15
4.4.3.4—Practical Refusal	4-15

4.4.3.5—Limiting Driving Stresses	4-16
4.4.3.6—Driving of Probe Piles.....	4-16
4.4.3.7—Accuracy of Driving.....	4-16
4.4.4—Determination of Nominal Resistance	4-17
4.4.4.1—General.....	4-17
4.4.4.2—Static Load Tests.....	4-17
4.4.4.3—Dynamic Testing.....	4-18
4.4.4.4—Wave Equation Analysis.....	4-19
4.4.4.5—Dynamic Formula	4-19
4.4.5—Splicing of Piles	4-20
4.4.5.1—Steel Piles.....	4-20
4.4.5.2—Concrete Piles	4-20
4.4.5.3—Timber Piles	4-20
4.4.6 Defective Piles.....	4-20
4.4.7—Pile Cut-Off.....	4-21
4.4.7.1—General.....	4-21
4.4.7.2—Special Requirements for Timber Piles.....	4-21
4.5—MEASUREMENT AND PAYMENT.....	4-22
4.5.1—Method of Measurement	4-22
4.5.1.1—Timber, Steel, and Concrete Piles	4-22
4.5.1.1.1—Piles Furnished.....	4-22
4.5.1.1.2—Piles Driven.....	4-22
4.5.1.2—Pile Splices and Pile Shoes	4-22
4.5.1.3—Static Load Tests.....	4-23
4.5.2—Basis of Payment.....	4-23
4.5.2.1—Unit Cost Contracts.....	4-23
4.5.2.2—Lump Sum Contracts	4-24
4.6—REFERENCES.....	4-24

SECTION 5: DRILLED SHAFTS

TABLE OF CONTENTS

5.1—DESCRIPTION	5-1
5.2—SUBMITTALS, APPROVALS AND MEETINGS	5-1
5.2.1—Experience and Personnel	5-1
5.2.2—Drilled Shaft Installation Plan	5-2
5.2.3—Slurry Technical Assistance	5-4
5.2.4—Approvals	5-5
5.2.5—Drilled Shaft Preconstruction Conference	5-5
5.3—MATERIALS	5-5
5.3.1—Concrete	5-5
5.3.2—Reinforcing Steel	5-6
5.3.3—Casings	5-6
5.3.4—Mineral Slurry	5-7
5.3.5—Polymer Slurry	5-7
5.3.6—Water Slurry	5-8
5.3.7—Access Tubes for Cross-Hole Sonic Log Testing	5-8
5.3.8—Grout	5-9
5.4—CONSTRUCTION	5-9
5.4.1—Drilled Shaft Excavation	5-9
5.4.2—Drilled Shaft Excavation Protection	5-9
5.4.3—Drilled Shaft Excavation Protection Methods	5-10
5.4.3.1—Temporary Casing Construction Method	5-10
5.4.3.2—Permanent Casing Construction Method	5-10
5.4.3.3—Alternative Casing Methods	5-11
5.4.3.4—Slurry	5-11
5.4.3.4.1—Slurry Technical Assistance	5-11
5.4.3.4.2—Minimum Level of Slurry in the Excavation	5-12
5.4.3.4.3—Cleaning Slurry	5-12
5.4.4—Obstructions	5-12
5.4.5—Protection of Existing Structures	5-12
5.4.6—Slurry Sampling and Testing	5-12
5.4.7—Drilled Shaft Excavation Inspection	5-13
5.4.8—Assembly and Placement of Reinforcing Steel	5-14
5.4.9—Concrete Placement, Curing, and Protection	5-15
5.4.10—Tremies	5-16
5.4.11—Drilled Shaft Construction Tolerances	5-16
5.4.12—Integrity Testing	5-16
5.5—MEASUREMENT AND PAYMENT	5-19
5.5.1—Measurement	5-19
5.5.1.1—Drilled Shafts in Soil	5-19
5.5.1.2—Drilled Shafts in Rock	5-19
5.5.1.3—Obstruction Removal	5-19
5.5.1.4—Trial Drilled Shafts	5-20
5.5.1.5—Exploration Holes	5-20
5.5.1.6—Permanent Casing—Furnishing and Placing	5-20
5.5.1.7—Load Tests	5-21
5.5.1.8—Cross-Hole Sonic Logging Casing	5-21
5.5.1.9—Drilled Shaft Construction	5-21
5.5.1.10—Reinforcing Steel	5-21
5.5.2—Payment	5-21
5.5.2.1—Drilled Shafts in Soil	5-21
5.5.2.2—Drilled Shafts in Rock	5-21
5.5.2.3—Obstruction Removal	5-21
5.5.2.4—Trial Drilled Shafts	5-22
5.5.2.5—Exploration Holes	5-22
5.5.2.6—Permanent Casing—Furnishing and Placing	5-22

5.5.2.7—Load Tests.....	5-22
5.5.2.8—Cross-Hole Sonic Logging Casing.....	5-22
5.5.2.9—Drilled Shaft Construction	5-22
5.5.2.10—Reinforcing Steel	5-22
5.6—REFERENCES.....	5-22

SECTION 6: GROUND ANCHORS

TABLE OF CONTENTS

6.1—DESCRIPTION.....	6-1
6.2—WORKING DRAWINGS	6-1
6.3—MATERIALS.....	6-2
6.3.1—Prestressing Steel	6-2
6.3.2—Grout	6-2
6.3.3—Steel Elements.....	6-3
6.3.4—Corrosion Protection Elements	6-3
6.3.5—Miscellaneous Elements.....	6-4
6.4—FABRICATION.....	6-4
6.4.1—Bond Length and Tendon Bond Length.....	6-4
6.4.1.1—Grout-Protected Ground Anchor Tendon.....	6-4
6.4.1.2—Encapsulation-Protected Ground Anchor Tendon	6-5
6.4.2—Unbonded Length.....	6-5
6.4.3—Anchorage and Trumpet.....	6-6
6.4.4—Tendon Storage and Handling.....	6-6
6.5—INSTALLATION.....	6-6
6.5.1—Drilling.....	6-7
6.5.2—Tendon Insertion	6-7
6.5.3—Grouting.....	6-7
6.5.4—Trumpet and Anchorage.....	6-8
6.5.5—Testing and Stressing	6-8
6.5.5.1—Testing Equipment.....	6-8
6.5.5.2—Performance Test	6-9
6.5.5.3—Proof Test.....	6-10
6.5.5.4—Creep Test.....	6-11
6.5.5.5—Ground Anchor Load Test Acceptance Criteria.....	6-12
6.5.5.6—Lock-Off	6-13
6.6—MEASUREMENT AND PAYMENT	6-14
6.7—REFERENCES.....	6-14

SECTION 7: EARTH-RETAINING SYSTEMS

TABLE OF CONTENTS

7.1—DESCRIPTION	7-1
7.2—WORKING DRAWINGS	7-1
7.3—MATERIALS	7-2
7.3.1—Concrete	7-2
7.3.1.1—Cast-in-Place	7-2
7.3.1.2—Pneumatically Applied Mortar	7-2
7.3.1.3—Precast Elements	7-2
7.3.1.4—Segmental Concrete Facing Blocks	7-2
7.3.2—Reinforcing Steel	7-2
7.3.3—Structural Steel	7-3
7.3.4—Timber	7-3
7.3.5—Drainage Elements	7-3
7.3.5.1—Pipe and Perforated Pipe	7-3
7.3.5.2—Filter Fabric	7-3
7.3.5.3—Permeable Material	7-3
7.3.5.4—Geocomposite Drainage Systems	7-3
7.3.6—Structure Backfill Material	7-3
7.3.6.1—General	7-3
7.3.6.2—Crib and Cellular Walls	7-4
7.3.6.3—Mechanically Stabilized Earth Walls	7-4
7.4—EARTHWORK	7-5
7.4.1—Structure Excavation	7-5
7.4.2—Foundation Treatment	7-5
7.4.3—Structure Backfill	7-5
7.5—DRAINAGE	7-5
7.5.1—Concrete Gutters	7-5
7.5.2—Weep Holes	7-5
7.5.3—Drainage Blankets	7-6
7.5.4—Geocomposite Drainage Systems	7-6
7.5.5—Horizontal Drains	7-7
7.6—CONSTRUCTION	7-7
7.6.1—Concrete and Masonry Gravity Walls, Reinforced Concrete Retaining Walls	7-7
7.6.2—Sheet Pile and Soldier Pile Walls	7-7
7.6.2.1—Sheet Pile Walls	7-7
7.6.2.2—Soldier Pile Walls	7-8
7.6.2.3—Anchored Sheet Pile and Soldier Pile Walls	7-9
7.6.2.3.1—General	7-9
7.6.2.3.2—Wales	7-10
7.6.2.3.3—Concrete Anchor System	7-10

7.6.2.3.4—Tie-Rods	7-10
7.6.2.3.5—Ground Anchors	7-10
7.6.2.3.6—Earthwork	7-10
7.6.3—Crib Walls and Cellular Wall	7-11
7.6.3.1—Foundation	7-11
7.6.3.2—Crib Members	7-11
7.6.3.3—Concrete Monolithic Cell Members	7-12
7.6.3.4—Member Placement	7-12
7.6.3.5—Backfilling	7-12
7.6.4—Mechanically Stabilized Earth Walls	7-13
7.6.4.1—Facing	7-13
7.6.4.2—Soil Reinforcement	7-13
7.6.4.3—Construction	7-14
<u>7.6.5—Soil Nail Walls</u>	<u>7-14</u>
<u>7.6.5.1—Excavation</u>	<u>7-14</u>
<u>7.6.5.2—Soil Nails</u>	<u>7-15</u>
<u>7.6.5.3—Drainage Components</u>	<u>7-15</u>
<u>7.6.5.4—Shotcrete and Concrete Facing</u>	<u>7-15</u>
7.7—MEASUREMENT AND PAYMENT	7-15
7.8—REFERENCES	7-16

TABLE OF CONTENTS

8.1—GENERAL.....	8-1
8.1.1—Description.....	8-1
8.1.2—Related Work.....	8-1
8.1.3—Construction Methods.....	8-1
8.2—CLASSES OF CONCRETE.....	8-1
8.2.1—General.....	8-1
8.2.2—Normal-Weight (-Density) Concrete.....	8-2
8.2.3—Lightweight (Low-Density) Concrete.....	8-3
8.3—MATERIALS.....	8-3
8.3.1—Cements.....	8-3
8.3.2—Water.....	8-4
8.3.3—Fine Aggregate.....	8-4
8.3.4—Coarse Aggregate.....	8-4
8.3.5—Combined Aggregates.....	8-4
8.3.6—Lightweight (Low-Density) Aggregate.....	8-5
8.3.7—Air-Entraining and Chemical Admixtures.....	8-5
8.3.8—Mineral Admixtures.....	8-5
8.3.9—Steel.....	8-6
8.4—PROPORTIONING OF CONCRETE.....	8-6
8.4.1—Mix Design.....	8-6
8.4.1.1—Responsibility and Criteria.....	8-6
8.4.1.2—Trial Batch Tests.....	8-7
8.4.1.3—Approval.....	8-7
8.4.2—Water Content.....	8-7
8.4.3—Cement Content.....	8-8
8.4.4—Mineral Admixtures.....	8-8
8.4.5—Air-Entraining and Chemical Admixtures.....	8-9
8.5—MANUFACTURE OF CONCRETE.....	8-9
8.5.1—Storage of Aggregates.....	8-9
8.5.2—Storage of Cement.....	8-9
8.5.3—Measurement of Materials.....	8-9
8.5.4—Batching and Mixing Concrete.....	8-10
8.5.4.1—Batching.....	8-10
8.5.4.2—Mixing.....	8-10
8.5.5—Delivery.....	8-11
8.5.6—Sampling and Testing.....	8-11
8.5.7—Evaluation of Concrete Strength.....	8-12
8.5.7.1—Tests.....	8-12
8.5.7.2—For Controlling Construction Operations.....	8-12
8.5.7.3—For Acceptance of Concrete.....	8-12
8.5.7.4—For Control of Mix Design.....	8-13
8.5.7.5—Precast Concrete Cured by the Waterproof Cover Method, Steam, or Radiant Heat.....	8-13
8.6—PROTECTION OF CONCRETE FROM ENVIRONMENTAL CONDITIONS.....	8-14
8.6.1—General.....	8-14
8.6.2—Rain Protection.....	8-14
8.6.3—Hot-Weather Protection.....	8-14
8.6.4—Cold-Weather Protection.....	8-15
8.6.4.1—Protection during Cure.....	8-15
8.6.4.2—Mixing and Placing.....	8-15
8.6.4.3—Heating of Mix.....	8-16
8.6.5—Special Requirements for Bridge Decks.....	8-16
8.6.6—Concrete Exposed to Salt Water.....	8-16
8.6.7—Concrete Exposed to Sulfate Soils or Sulfate Water.....	8-17
8.7—HANDLING AND PLACING CONCRETE.....	8-17
8.7.1—General.....	8-17

8.7.2—Sequence of Placement	8-18
8.7.2.1—Vertical Members.....	8-18
8.7.2.2—Superstructures.....	8-18
8.7.2.3—Arches	8-18
8.7.2.4—Box Culverts	8-19
8.7.2.5—Precast Elements	8-19
8.7.3—Placing Methods.....	8-19
8.7.3.1—General.....	8-19
8.7.3.2—Equipment	8-19
8.7.4—Consolidation	8-20
8.7.5—Underwater Placement	8-21
8.7.5.1—General.....	8-21
8.7.5.2—Equipment	8-21
8.7.5.3—Clean-Up	8-22
8.8—CONSTRUCTION JOINTS	8-22
8.8.1—General	8-22
8.8.2—Bonding.....	8-22
8.8.3—Bonding and Doweling to Existing Structures	8-22
8.8.4—Forms at Construction Joints.....	8-23
8.9—EXPANSION AND CONTRACTION JOINTS	8-23
8.9.1—General	8-23
8.9.2—Materials	8-23
8.9.2.1—Premolded Expansion Joint Fillers.....	8-23
8.9.2.2—Polystyrene Board Fillers.....	8-24
8.9.2.3—Contraction Joint Material	8-24
8.9.2.4—Pourable Joint Sealants	8-24
8.9.2.5—Metal Armor.....	8-24
8.9.2.6—Waterstops	8-25
8.9.2.6.1—Rubber Waterstops.....	8-25
8.9.2.6.2—Polyvinyl Chloride Waterstops	8-25
8.9.2.6.3—Copper Waterstops.....	8-26
8.9.2.6.4—Testing of Waterstop Material	8-26
8.9.3—Installation.....	8-26
8.9.3.1—Open Joints	8-26
8.9.3.2—Filled Joints.....	8-26
8.9.3.3—Sealed Joints.....	8-27
8.9.3.4—Waterstops	8-27
8.9.3.5—Expansion Joint Armor Assemblies	8-27
8.10—FINISHING PLASTIC CONCRETE	8-27
8.10.1—General.....	8-27
8.10.2—Roadway Surface Finish	8-28
8.10.2.1—Striking Off and Floating.....	8-28
8.10.2.2—Straightedging.....	8-29
8.10.2.3—Texturing.....	8-29
8.10.2.3.1—Dragged.....	8-29
8.10.2.3.2—Broomed	8-30
8.10.2.3.3—Tined.....	8-30
8.10.2.4—Surface Testing and Correction.....	8-30
8.10.3—Pedestrian Walkway Surface Finish.....	8-30
8.10.4—Troweled and Brushed Finish	8-31
8.10.5—Surface under Bearings	8-31
8.11—CURING CONCRETE.....	8-31
8.11.1—General.....	8-31
8.11.2—Materials.....	8-32
8.11.2.1—Water.....	8-32
8.11.2.2—Liquid Membranes	8-32
8.11.2.3—Waterproof Sheet Materials	8-32
8.11.3—Methods.....	8-32
8.11.3.1—Forms-in-Place Method.....	8-32

8.11.3.2—Water Method	8-32
8.11.3.3—Liquid Membrane Curing Compound Method	8-32
8.11.3.4—Waterproof Cover Method.....	8-33
8.11.3.5—Steam or Radiant-Heat Curing Method	8-33
8.11.4—Bridge Decks	8-34
8.12—FINISHING FORMED CONCRETE SURFACES.....	8-35
8.12.1—General.....	8-35
8.12.2—Class 1—Ordinary Surface Finish	8-35
8.12.3—Class 2—Rubbed Finish	8-36
8.12.4—Class 3—Tooled Finish.....	8-36
8.12.5—Class 4—Sandblasted Finish.....	8-37
8.12.6—Class 5—Wire-Brushed or Scrubbed Finish	8-37
8.13—PRECAST CONCRETE MEMBERS	8-37
8.13.1—General.....	8-37
8.13.2—Working Drawings.....	8-37
8.13.3—Materials and Manufacture	8-37
8.13.4—Curing	8-38
8.13.5—Storage and Handling.....	8-39
8.13.6—Erection.....	8-39
8.13.7—Epoxy-Bonding Agents for Precast Segmental Box Girders	8-39
8.13.7.1—Materials	8-39
8.13.7.1.1—Test 1—Sag Flow of Mixed Epoxy- Bonding Agent	8-40
8.13.7.1.2—Test 2—Gel Time of Mixed Epoxy-Bonding Agent	8-40
8.13.7.1.3—Test 3—Open Time of Bonding Agent.....	8-40
8.13.7.1.4—Test 4—Three-Point Tensile Bending Test	8-41
8.13.7.1.5—Test 5—Compression Strength of Cured Epoxy-Bonding Agent.....	8-41
8.13.7.1.6—Test 6—Temperature Deflection of Epoxy-Bonding Agent.....	8-42
8.13.7.1.7—Test 7—Compression and Shear Strength of Cured Epoxy-Bonding Agent	8-42
8.13.7.2—Mixing and Installation of Epoxy	8-42
8.14—MORTAR AND GROUT	8-43
8.14.1—General.....	8-43
8.14.2—Materials and Mixing.....	8-44
8.14.3—Placing and Curing.....	8-44
8.15—APPLICATION OF LOADS	8-45
8.15.1—General.....	8-45
8.15.2—Earth Loads.....	8-45
8.15.3—Construction Loads	8-45
8.15.4—Traffic Loads	8-45
8.16—SPECIAL REQUIREMENTS FOR SEGMENTAL BRIDGES.....	8-46
8.16.1—Geometry Control.....	8-46
8.16.1.1—Deflection and Camber Data.....	8-46
8.16.1.2—Geometry Control	8-46
8.16.2—Tolerances.....	8-47
8.16.3—Shop Drawings and Design Calculations for Construction Procedures	8-49
8.16.3.1—General.....	8-49
8.16.3.2—Design Calculations for Construction Procedures	8-49
8.16.3.3—Shop Drawings	8-50
8.16.4—Forms	8-50
8.16.4.1—General.....	8-50
8.16.4.2—Forms for Precast Segmental Construction.....	8-51
8.16.5—Permanent Bearings	8-52
8.16.6—Special Provisions for Cast-in-Place Segmental Construction.....	8-52
8.16.6.1—General.....	8-52
8.16.6.2—Forming System.....	8-53
8.16.6.3—Superstructure Construction	8-53
8.16.7—Special Provisions for Precast Concrete Segmental Construction	8-55
8.16.7.1—General.....	8-55
8.16.7.2—Fabrication	8-56
8.16.7.3—Separation of Match-Cast Segments.....	8-57

8.16.7.4—Handling and Erection of Segments.....	8-57
8.16.8—Special Provisions for Incremental Launching.....	8-57
8.16.8.1—General.....	8-57
8.16.8.2—Casting of Segments.....	8-57
8.16.8.3—Geometric Tolerances	8-58
8.16.8.4—Launching Force	8-58
8.16.8.5—Pier Monitoring.....	8-58
8.16.9—Defects and Breakage.....	8-58
8.17—MEASUREMENT AND PAYMENT	8-59
8.17.1—Measurement.....	8-59
8.17.2—Payment.....	8-60
8.18—REFERENCES.....	8-60
APPENDIX A8—PROPOSED STANDARD SPECIFICATION FOR COMBINED AGGREGATES FOR HYDRAULIC CEMENT CONCRETE	8-62

TABLE OF CONTENTS

9.1—DESCRIPTION.....	9-1
9.2—MATERIAL	9-1
9.2.1—Uncoated Reinforcing	9-1
9.2.2—Epoxy-Coated Reinforcing	9-1
9.2.3—Stainless Steel Reinforcing Bars	9-2
9.2.4—Low Carbon, Chromium, Steel Reinforcing Bars.....	9-2
9.2.5—Mill Test Reports	9-2
9.3—BAR LISTS AND BENDING DIAGRAMs	9-3
9.4—FABRICATION.....	9-3
9.4.1—Bending.....	9-3
9.4.2—Hooks and Bend Dimensions	9-3
9.4.3—Identification.....	9-3
9.5—HANDLING, STORING, AND SURFACE CONDITION OF REINFORCEMENT	9-3
9.6—PLACING AND FASTENING	9-4
9.6.1—General.....	9-4
9.6.2—Support Systems.....	9-4
9.6.3—Precast Concrete Blocks	9-4
9.6.4—Wire Bar Supports.....	9-5
9.6.5—Adjustments	9-5
9.6.6—Repair of Damaged Epoxy Coating	9-5
9.7—SPLICING OF BARS.....	9-6
9.7.1—General.....	9-6
9.7.2—Lap Splices.....	9-6
9.7.3—Welded Splices	9-6
9.7.4—Mechanical Splices	9-6
9.8—SPLICING OF WELDED WIRE FABRIC	9-7
9.9—SUBSTITUTIONS	9-7
9.10—MEASUREMENT	9-7
9.11—PAYMENT	9-8
9.12—REFERENCES.....	9-8

SECTION 10: PRESTRESSING

TABLE OF CONTENTS

10.1—GENERAL	10-1
10.1.1—Description	10-1
10.1.2—Details of Design	10-1
10.2—SUPPLEMENTARY DRAWINGS	10-2
10.2.1—Working Drawings and Shop Drawings	10-2
10.2.2—Integrated Drawings	10-3
10.3—MATERIALS	10-4
10.3.1—Prestressing Steel and Anchorages	10-4
10.3.1.1—Strand	10-4
10.3.1.2—Wire	10-4
10.3.1.3—Bars	10-4
10.3.2—Post-Tensioning Anchorages and Couplers	10-5
10.3.2.1—Bonded Systems	10-5
10.3.2.2—Unbonded Systems	10-5
10.3.2.3—Special Anchorage Device Acceptance Test	10-6
10.3.2.3.1—Test Block Requirements	10-6
10.3.2.3.2—Test Block Dimensions	10-6
10.3.2.3.3—Local Zone Reinforcement	10-7
10.3.2.3.4—Skin Reinforcement	10-7
10.3.2.3.5—Concrete Strength	10-8
10.3.2.3.6—Test Procedures	10-8
10.3.2.3.7—Cyclic Loading Test	10-8
10.3.2.3.7a—General	10-8
10.3.2.3.7b—Crack Widths and Patterns	10-8
10.3.2.3.8—Sustained Loading Test	10-9
10.3.2.3.8a—General	10-9
10.3.2.3.8b—Crack Widths and Patterns	10-9
10.3.2.3.9—Monotonic Loading Test	10-9
10.3.2.3.9a—General	10-9
10.3.2.3.9b—Crack Widths and Patterns	10-9
10.3.2.3.10—Anchorage Zone Requirements	10-10
10.3.2.3.11—Test Series Requirements	10-10
10.3.2.3.12—Records of the Anchorage Device	10-10
10.4—PLACEMENT OF DUCTS, STEEL, AND ANCHORAGE HARDWARE	10-11
10.4.1—Placement of Ducts	10-11
10.4.1.1—General	10-11
10.4.1.2—Duct Inlets and Outlets	10-13
10.4.1.3—Proving of Post-Tensioning Ducts	10-13
10.4.1.4—Duct Pressure Field Test	10-14
10.4.2—Placement of Prestressing Steel	10-14
10.4.2.1—Placement for Pretensioning	10-14

10.4.2.2—Placement for Post-Tensioning	10-14
10.4.2.2.1— <i>Protection of Steel After Installation</i>	10-15
10.4.3—Placement of Anchorage Hardware	10-15
10.5—IDENTIFICATION AND TESTING	10-16
10.5.1—Pretensioning Tendons	10-17
10.5.2—Post-Tensioning Tendons	10-17
10.5.3—Anchorage Assemblies and Couplers	10-17
10.6—PROTECTION OF PRESTRESSING STEEL	10-18
10.7—CORROSION INHIBITOR	10-18
10.8—DUCTS	10-18
10.8.1—General.	10-18
10.8.2—Metal Ducts	10-19
10.8.3—Plastic Ducts	10-19
10.8.4—Duct Area	10-20
10.8.5—Duct Fittings	10-20
10.9—GROUT	10-21
10.9.1—Approval.	10-22
10.9.2—Mixing	10-22
10.9.3—Grout Physical Properties.	10-22
10.10—TENSIONING	10-24
10.10.1—General Tensioning Requirements	10-24
10.10.1.1—Concrete Strength	10-25
10.10.1.2—Prestressing Equipment	10-25
10.10.1.3—Sequence of Stressing	10-26
10.10.1.4—Measurement of Stress	10-26
10.10.2—Pretensioning Requirements	10-27
10.10.3—Post-Tensioning Requirements	10-28
10.10.4—Record of Stressing Operation.	10-29
10.10.5—Protection of Tendon	10-29
10.11—GROUTING.	10-30
10.11.1—General	10-30
10.11.2—Preparation of Ducts.	10-31
10.11.3—Equipment	10-31
10.11.4—Mixing of Grout	10-32
10.11.5—Injection of Grout	10-32
10.11.6—Temperature Considerations	10-33
10.11.7—Vertical Grouting	10-33
10.11.8—Post-Grouting Inspection	10-33
10.11.9—Finishing	10-33
10.11.10—Protection of End Anchorages.	10-34
10.11.11—Construction Traffic and Operations Causing Vibrations	10-35
10.12—MEASUREMENT AND PAYMENT	10-35
10.12.1—Measurement	10-35
10.12.2—Payment	10-35
10.13—REFERENCES	10-36

SECTION 11: STEEL STRUCTURES

TABLE OF CONTENTS

11.1—GENERAL	11-1
11.1.1—Description	11-1
11.1.2—Notice of Beginning of Work	11-1
11.1.3—Inspection	11-1
11.1.4—Inspector's Authority	11-2
11.2—WORKING DRAWINGS	11-2
11.2.1—Shop Drawings	11-2
11.2.2—Erection Drawings	11-3
11.2.3—Camber Diagram	11-3
11.3—MATERIALS	11-3
11.3.1—Structural Steel General	11-3
11.3.1.1—General	11-3
11.3.1.2—Plates and Structural Shapes	11-4
11.3.1.3—Structural Tubing	11-4
11.3.2—High-Strength Fasteners	11-4
11.3.2.1—Material	11-4
11.3.2.2—Direct Tension Indicators	11-5
11.3.3—Welded Stud Shear Connectors	11-5
11.3.4—Steel Forgings and Steel Shafting	11-5
11.3.4.1—Steel Forgings	11-5
11.3.4.2—Cold-Finished Carbon Steel Shafting	11-5
11.3.5—Steel Castings	11-5
11.3.6—Iron Castings	11-6
11.3.6.1—Materials	11-6
11.3.6.2—Work Quality and Finish	11-6
11.3.6.3—Cleaning	11-6
11.3.7—Galvanizing	11-6
11.4—FABRICATION	11-7
11.4.1—Identification of Steels During Fabrication	11-7
11.4.2—Storage of Materials	11-7
11.4.3—Plates	11-7
11.4.3.1—Direction of Rolling	11-7
11.4.3.2—Sheared Edges	11-7
11.4.3.3—Bent Plates	11-7
11.4—BENDING, CURVING, AND STRAIGHTENING	11-8
11.4.3.3.1—General	11-8
11.4.3.3.2—Cold-Bending	11-8
11.4.3.3.3—Hot-Bending	11-8
11.4.4—Fit of Stiffeners	11-9
11.4.5—Abutting Joints	11-9

11.4.6—Facing of Bearing Surfaces	11-9
11.4.7—Straightening Material	11-9
11.4.8—Bolt Holes	11-10
11.4.8.1—Holes for High-Strength Bolts and Unfinished Bolts	11-10
11.4.8.1.1—General	11-10
11.4.8.1.2—Punched Holes	11-11
11.4.8.1.3—Reamed or Drilled Holes	11-11
11.4.8.1.4—Accuracy of Holes	11-11
11.4.8.2—Accuracy of Hole Group	11-11
11.4.8.2.1—Accuracy before Reaming	11-11
11.4.8.2.2—Accuracy after Reaming	11-12
11.4.8.3—Numerically-Controlled Drilled Field Connections	11-12
11.4.8.4—Holes for Turned Bolts or Other Approved Bearing-Type Bolts	11-12
11.4.8.5—Preparation of Field Connections	11-12
11.4.9—Pins and Rollers	11-13
11.4.9.1—General	11-13
11.4.9.2—Boring Pin Holes	11-13
11.4.9.3—Threads for Bolts and Pins	11-13
11.4.10—Eyebars	11-14
11.4.11—ANNEALING AND STRESS RELIEVING	11-14
11.4.12—Curved Girders	11-15
11.4.12.1—General	11-15
11.4.12.2—Heat-Curving Rolled Beams and Welded Girders	11-15
11.4.12.2.1—Materials	11-15
11.4.12.2.2—Geometric Limitations	11-15
11.4.12.2.2a—Cross-Sectional Criteria	11-15
11.4.12.2.2b—Minimum Radius for Doubly-Symmetric Beams and Girders	11-16
11.4.12.2.2c—Minimum Radius of Curvature for Singly-Symmetric Girders	11-17
11.4.12.2.2d—Minimum Radius of Curvature for Hybrid Girders	11-17
11.4.12.2.3—Type of Heating	11-18
11.4.12.2.4—Temperature	11-19
11.4.12.2.5—Position for Heating	11-19
11.4.12.2.6—Sequence of Operations	11-19
11.4.12.2.7—Camber	11-20
11.4.12.2.8—Measurement of Curvature and Camber	11-20
11.4.13—Orthotropic-Deck Superstructures	11-20
11.4.13.1—General	11-20
11.4.13.2—Flatness of Panels	11-20
11.4.13.3—Straightness of Longitudinal Stiffeners Subject to Calculated Compressive Stress, Including Orthotropic-Deck Ribs	11-21
11.4.13.4—Straightness of Transverse Web Stiffeners and Other Stiffeners Not Subject to Calculated Compressive Stress	11-21
11.4.14—Full-Size Tests	11-21
11.4.15—MARKING AND SHIPPING	11-22
11.5—ASSEMBLY	11-22

11.5.2—Preassembly of Field Connections	11-22
11.5.2.1—General	11-22
11.5.2.27—BOLTED CONNECTIONS	11-22
11.5.2.1—Bolting	11-22
11.5.2.37.1.1—Check Assembly—Numerically-Controlled Drilling	11-23
11.5.2.47.1.2—Field-Welded Connections	11-23
11.5.37.2—Match-Marking	11-23
11.5.47.3—Connections Using Unfinished or Turned Bolts	11-23
11.5.47.3.1—General	11-23
11.5.47.3.2—Turned Bolts	11-24
11.5.57.4—Connections Using High-Strength Bolts	11-24
11.5.57.4.1—General	11-24
11.5.57.4.2—Bolted Parts	11-24
11.5.57.4.3—Surface Conditions	11-24
11.5.57.4.4—Installation	11-25
11.5.57.4.4.1—General	11-25
11.5.57.4.4.2—Rotational-Capacity Tests	11-27
11.5.57.4.4.3—Requirement for Washers	11-28
11.5.57.4.4.4—Turn-of-Nut Installation Method	11-29
11.5.57.4.4.5—Calibrated Wrench Installation Method	11-30
11.5.57.4.4.6—Direct Tension Indicator Installation Method	11-30
11.5.57.4.4.6a—Verification	11-30
11.5.57.4.4.6b—Installation	11-32
11.5.57.4.4.7—Inspection	11-32
11.5.57.4.4.7a—General	11-32
11.5.57.4.4.7b—Responsibilities of the Engineer	11-32
11.5.57.4.4.7c—Inspection Procedures	11-33
11.68—ERECTION	11-34
11.68.1—General	11-34
11.68.2—Handling and Storing Materials	11-34
11.68.3—Bearings and Anchorages	11-34
11.68.4—Erection Procedure	11-34
11.68.4.1—Conformance to Drawings	11-34
11.68.4.2—Erection Stresses	11-34
11.68.4.3—Maintaining Alignment and Camber	11-35
11.68.5—Field Assembly	11-35
11.68.6—Pin Connections	11-35
11.68.7—Misfits	11-35
11.7—MEASUREMENT AND PAYMENT	11-36
11.7.1—Method of Measurement	11-36
11.7.2—Basis of Payment	11-37
11.89—ADDITIONAL PROVISIONS FOR CURVED STEEL GIRDERS	11-38
11.8.1—General	11-38
11.8.1.1—Scope	11-38

11.8.29.1—Contractor's Construction Plan for Curved Girder Bridges	11-38
11.8.3—Fabrication	11-39
11.8.3.1—General	11-39
11.8.3.2—Handling	11-39
11.8.3.3—Girders	11-39
11.8.3.3.1—Rolled I-Beams	11-39
11.8.3.3.2—Welded I-Girders	11-39
11.8.3.3.3—Welded Box and Tub Girders	11-40
11.8.3.4—Cross-Frames and Diaphragms	11-40
11.8.3.5—Bolt Holes	11-40
11.8.3.6—Tolerances	11-40
11.8.3.6.1—General	11-40
11.8.3.6.2—Camber	11-40
11.8.3.6.3—Girder Lengths	11-40
11.8.3.7—Fit-Up	11-41
11.8.3.7.1—General	11-41
11.8.3.7.2—Girder Section Field Splices	11-41
11.8.49.2—Transportation Plan	11-41
11.8.59.3—Steel Erection	11-42
11.8.59.3.1—General	11-42
11.8.59.3.2—Falsework	11-42
11.8.59.3.3—Bearings	11-42
11.8.59.3.4—I-Girders	11-42
11.8.59.3.5—Closed Box and Tub Girders	11-43
11.8.69.4—Deck	11-43
11.8.69.4.1—Forms	11-43
11.8.69.4.1.1—General	11-43
11.8.69.4.1.2—Overhangs	11-43
11.8.69.4.1.3—Tub Girders	11-43
11.8.69.4.2—Placement of Concrete	11-43
11.8.79.5—Reports	11-44
11.10—FABRICATION AND REPORTING REQUIREMENTS FOR TEMPORARY STRUCTURAL STEEL MEMBERS SUPPORTING NONREDUNDANT STEEL TENSION MEMBERS (NSTMS), SYSTEM REDUNDANT MEMBERS (SRMS), OR INTERNALLY REDUNDANT MEMBERS (IRMS)	11-44
11.10.1—Fabrication	11-44
11.10.2—Reporting Requirements	11-45
11.911—ULTRASONIC IMPACT TREATMENT (UIT)	11-45
11.9.1—General	11-45
11.9.2—Procedure	11-48
11.9.3—Other Weld Metal and Base Metal Treatments	11-48
11.12—MEASUREMENT AND PAYMENT	11-48
11.12.1—Method of Measurement	11-48
11.12.2—Basis of Payment	11-49
11.103—REFERENCES	11-49

SECTION 12: STEEL GRID FLOORING

TABLE OF CONTENTS

12.1—GENERAL	12-1
12.1.1—Description	12-1
12.1.2—Working Drawings	12-1
12.2—MATERIALS	12-1
12.2.1—Steel	12-1
12.2.2—Protective Treatment	12-1
12.2.3—Concrete	12-2
12.2.4—Skid Resistance	12-2
12.3—ARRANGEMENT OF SECTIONS	12-2
12.4—PROVISION FOR CAMBER	12-2
12.5—FIELD ASSEMBLY	12-3
12.6—CONNECTION TO SUPPORTS	12-3
12.7—WELDING	12-3
12.8—REPAIRING DAMAGED GALVANIZED COATINGS	12-4
12.9—PLACEMENT OF CONCRETE FILLER	12-4
12.9.1—Forms	12-4
12.9.2—Placement	12-4
12.10—MEASUREMENT AND PAYMENT	12-5
12.11—REFERENCES	12-5

TABLE OF CONTENTS

13.1—GENERAL	13-1
13.1.1—Description	13-1
13.1.2—Protection of Public and Property	13-1
13.1.3—Protection of the Work	13-1
13.1.4—Thickness and Color	13-2
13.2—PAINTING METAL STRUCTURES	13-2
13.2.1—Coating Systems and Paints	13-2
13.2.2—Weather Conditions	13-2
13.2.3—Surface Preparation	13-3
13.2.3.1—Blast Cleaning	13-3
13.2.3.2—Steam Cleaning	13-4
13.2.3.3—Solvent Cleaning	13-4
13.2.3.4—Hand Cleaning	13-4
13.2.3.5—Power Washing	13-4
13.2.4—Application of Paints	13-4
13.2.4.1—Application of Zinc-rich Primers	13-6
13.2.5—Measurement and Payment	13-7
13.3—PAINTING GALVANIZED SURFACES	13-7
13.4—PAINTING TIMBER	13-7
13.4.1—General	13-7
13.4.2—Preparation of Surfaces	13-7
13.4.3—Paint	13-8
13.4.4—Application	13-8
13.4.5—Painting Treated Timber	13-8
13.4.6—Payment	13-8
13.5—PAINTING CONCRETE	13-9
13.5.1—Surface Preparation	13-9
13.5.2—Paint	13-9
13.5.3—Application	13-9
13.5.4—Measurement and Payment	13-9
13.6—REFERENCES	13-9

TABLE OF CONTENTS

14.1—DESCRIPTION.....	14-1
14.1.1—Rubble Masonry.....	14-1
14.1.2—Ashlar Masonry.....	14-1
14.2—MATERIALS.....	14-1
14.2.1—General.....	14-1
14.2.1.1—Rubble Stone.....	14-1
14.2.1.2—Ashlar Stone.....	14-1
14.2.2—Shipment and Storage of Stone.....	14-2
14.2.3—Mortar.....	14-2
14.3—MANUFACTURE OF STONE FOR MASONRY.....	14-2
14.3.1—General.....	14-2
14.3.2—Surface Finishes of Stone.....	14-3
14.3.3—Rubble Masonry.....	14-3
14.3.3.1—Size.....	14-3
14.3.3.2—Shape.....	14-3
14.3.3.3—Dressing.....	14-3
14.3.4—Ashlar Masonry.....	14-4
14.3.4.1—Size.....	14-4
14.3.4.2—Dressing.....	14-4
14.3.4.3—Stretchers.....	14-4
14.3.5—Arch Ring Stones.....	14-4
14.4—CONSTRUCTION.....	14-5
14.4.1—Weather Conditions.....	14-5
14.4.2—Mixing Mortar.....	14-5
14.4.3—Selection and Placing of Stone.....	14-5
14.4.3.1—General.....	14-5
14.4.3.2—Rubble Masonry.....	14-6
14.4.3.3—Ashlar Masonry.....	14-6
14.4.4—Beds and Joints.....	14-6
14.4.5—Headers.....	14-7
14.4.6—Cores and Backing.....	14-7
14.4.6.1—General.....	14-7
14.4.6.2—Stone.....	14-7
14.4.6.3—Concrete.....	14-7
14.4.6.4—Leveling Courses.....	14-8
14.4.7—Facing for Concrete.....	14-8
14.4.8—Copings.....	14-8
14.4.8.1—Stone.....	14-8
14.4.8.2—Concrete.....	14-9
14.4.9—Dowels and Cramps.....	14-9
14.4.10—Weep Holes.....	14-9
14.4.11—Pointing.....	14-9
14.4.12—Arches.....	14-10
14.5—MEASUREMENT AND PAYMENT.....	14-10
14.6—REFERENCES.....	14-10

TABLE OF CONTENTS

15.1—DESCRIPTION.....	15-1
15.2—MATERIALS.....	15-1
15.2.1—Concrete Block	15-1
15.2.2—Brick	15-1
15.2.3—Reinforcing Steel	15-1
15.2.4—Mortar	15-1
15.2.5—Grout	15-2
15.2.6—Sampling and Testing.....	15-2
15.2.6.1—Mortar	15-2
15.2.6.2—Grout	15-2
15.3—CONSTRUCTION.....	15-3
15.3.1—Weather Conditions	15-3
15.3.2—Laying Block and Brick	15-3
15.3.3—Placement of Reinforcement	15-4
15.3.4—Grouting of Voids	15-4
15.3.5—Copings, Bridge Seats, and Backwalls.....	15-5
15.4—MEASUREMENT AND PAYMENT	15-6
15.5—REFERENCES.....	15-6

SECTION 16: TIMBER STRUCTURES

TABLE OF CONTENTS

16.1—GENERAL	16-1
16.1.1—Related Work	16-1
16.2—MATERIALS	16-1
16.2.1—Lumber and Timber (Solid Sawn or Glue Laminated)	16-1
16.2.2—Steel Components	16-2
16.2.3—Castings	16-2
16.2.4—Hardware	16-2
16.2.5—Galvanizing	16-3
16.2.5.1—General	16-3
16.2.6—Timber Connectors	16-3
16.2.6.1—Dimensions	16-3
16.2.6.2—Split Ring Connectors	16-4
16.2.6.3—Shear-Plate Connectors	16-5
16.2.6.4—Spike-Grid Connectors	16-5
16.3—FABRICATION AND CONSTRUCTION	16-5
16.3.1—Quality	16-5
16.3.2—Storage of Material	16-6
16.3.3—Treated Timber	16-6
16.3.3.1—Handling	16-6
16.3.3.2—Framing and Boring	16-6
16.3.3.3—Cuts and Abrasions	16-6
16.3.3.4—Bored Holes	16-7
16.3.3.5—Temporary Attachment	16-7
16.3.4—Installation of Connectors	16-7
16.3.5—Holes for Bolts, Dowels, Rods, and Lag Screws	16-8
16.3.6—Bolts and Washers	16-8
16.3.7—Countersinking	16-8
16.3.8—Framing	16-8
16.3.9—Framed Bents	16-8
16.3.9.1—Mud Sills	16-8
16.3.9.2—Concrete Pedestals	16-9
16.3.9.3—Sills	16-9
16.3.9.4—Posts	16-9
16.3.9.5—Caps	16-9
16.3.9.6—Bracing	16-9
16.3.10—Stringers	16-10
16.3.11—Plank Floors	16-10
16.3.12—Nail-Laminated or Strip Floors	16-10
16.3.13—Glue Laminated Panel Decks	16-11
16.3.14—Composite Wood-Concrete Decks	16-12
16.3.15—Wheel Guards and Railing	16-12
16.3.16—Trusses	16-12
16.4—PAINTING	16-12
16.5—MEASUREMENT	16-12
16.6—PAYMENT	16-13
16.7—REFERENCES	16-13

SECTION 17: PRESERVATIVE TREATMENT OF WOOD

TABLE OF CONTENTS

17.1—GENERAL	17-1
17.2—MATERIALS.....	17-1
17.2.1—Wood.....	17-1
17.2.2—Preservatives and Treatments.....	17-1
17.2.3—Coal-Tar Roofing Cement.....	17-1
17.3—IDENTIFICATION AND INSPECTION.....	17-2
17.3.1—Branding and Job Site Inspection.....	17-2
17.3.2—Inspection at Treatment Plant.....	17-2
17.3.3—Certificate of Compliance	17-2
17.4—MEASUREMENT AND PAYMENT	17-2
17.5—REFERENCES.....	17-3

SECTION 18: BEARING DEVICES

TABLE OF CONTENTS

18.1—GENERAL.....	18-1
18.1.1—Working Drawings.....	18-1
18.1.2—Materials	18-2
18.1.2.1—Rolled Steel.....	18-2
18.1.2.2—Steel Laminates.....	18-2
18.1.2.3—Cast Steel	18-2
18.1.2.4—Forged Steel.....	18-3
18.1.2.5—Stainless Steel.....	18-3
18.1.3—Packaging, Handling, and Storage	18-3
18.1.4—Manufacture or Fabrication.....	18-3
18.1.4.1—General.....	18-3
18.1.4.2—Fabrication Tolerances.....	18-4
18.1.5—Testing and Acceptance	18-6
18.1.5.1—General.....	18-6
18.1.5.1.1—Scope	18-6
18.1.5.1.2—Adapter Plates and Attachments	18-6
18.1.5.2—Tests.....	18-6
18.1.5.2.1—General	18-6
18.1.5.2.2—Material Certification Tests	18-6
18.1.5.2.3—Material Friction Test—Sliding Surfaces Only	18-7
18.1.5.2.4—Dimension Check	18-7
18.1.5.2.5—Clearance Test	18-7
18.1.5.2.6—Bearing Friction Test—Sliding Surfaces Only	18-8
18.1.5.2.7—Long-Term Deterioration Test.....	18-8
18.1.5.2.8—Bearing Horizontal Force Capacity—Fixed or Guided Bearings Only	18-9
18.1.6—Performance Criteria.....	18-9
18.1.7—Construction and Installation	18-9
18.2—ELASTOMERIC BEARINGS.....	18-10
18.2.1—Scope	18-10
18.2.2—General Requirements.....	18-10
18.2.3—Materials	18-10
18.2.4—Fabrication	18-10
18.2.5—Testing	18-11
18.2.6—Installation	18-11
18.3—POT AND DISC BEARINGS	18-11
18.3.1—General.....	18-11
18.3.2—Materials	18-11
18.3.2.1—General.....	18-11
18.3.2.2—Steel	18-11
18.3.2.3—Stainless Steel	18-12
18.3.2.4—Elastomeric Rotational Element for Pot Bearings	18-12
18.3.2.5—Sealant for Pot Bearings	18-12
18.3.2.6—Sealing Rings for Pot Bearings.....	18-12
18.3.2.7—Polytetrafluorethylene (PTFE) Sheet and Strip	18-12
18.3.2.8—Polyether Urethane Structural Element for Disc Bearings.....	18-12
18.3.3—Fabrication Details	18-13
18.3.3.1—General.....	18-13
18.3.3.2—Fabrication Requirements for Pot Bearings	18-14
18.3.3.2.1—The Pot.....	18-14
18.3.3.2.2—Sealing Rings.....	18-14
18.3.3.2.3—Elastomeric Rotational Element	18-15
18.3.3.3—Fabrication Requirements for Disc Bearings	18-15
18.3.3.3.1—Steel Housing.....	18-15
18.3.3.3.2—Polyether Urethane Rotational Element	18-15
18.3.4—Sampling and Testing	18-15

18.3.4.1—Lot Size	18-15
18.3.4.2—Sampling and Acceptance	18-15
18.3.4.3—Quality-Assurance Testing by the Engineer	18-16
18.3.4.4—Performance Testing	18-16
18.3.4.4.1—Material Certification Testing	18-16
18.3.4.4.2—Dimension Check and Clearance Test	18-17
18.3.4.4.3—Long-Term Deterioration Test	18-17
18.3.4.4.4—Proof Load Test	18-17
18.3.4.4.5—Sliding Coefficient of Friction	18-18
18.3.5—Installation	18-18
18.4—ROCKER AND ROLLER BEARINGS	18-18
18.4.1—Materials	18-18
18.4.2—Fabrication	18-18
18.4.2.1—Steel	18-18
18.4.2.2—Lubrication	18-19
18.4.3—Installation	18-19
18.5—SPHERICAL BEARINGS	18-19
18.6—BRONZE OR COPPER-ALLOYED PLATES FOR BEARINGS	18-19
18.6.1—Bronze Bearing and Expansion Plates	18-19
18.6.2—Rolled Copper-Alloy Bearings and Expansion Plates	18-20
18.6.3—Test Requirements	18-20
18.7—MASONRY, SOLE, AND SHIM PLATES FOR BEARINGS	18-20
18.7.1—Materials	18-20
18.7.2—Fabrication	18-20
18.7.3—Installation	18-20
18.8—POLYTETRAFLUORETHYLENE (PTFE) SURFACES FOR BEARINGS	18-20
18.8.1—General	18-20
18.8.2—Materials	18-21
18.8.2.1—Polytetrafluorethylene (PTFE) Sheet and Strip	18-21
18.8.2.2—PTFE Resin	18-21
18.8.2.3—Filler Material	18-21
18.8.2.4—Adhesive Material	18-21
18.8.2.5—Unfilled PTFE Sheet	18-22
18.8.2.6—Filled PTFE Sheet	18-22
18.8.2.7—Fabric Containing PTFE Fibers	18-22
18.8.2.8—Lubricants	18-22
18.8.2.9—Interlocked Bronze and Filled PTFE Structures	18-23
18.8.2.10—Surface Treatment	18-23
18.8.2.11—Stainless Steel Mating Surface	18-23
18.8.3—Fabrication Requirements	18-23
18.8.3.1—General	18-23
18.8.3.2—Attachment of PTFE Material	18-23
18.8.3.2.1—General	18-23
18.8.3.2.2—Flat Sheet PTFE	18-23
18.8.3.2.3—Curved Sheet	18-24
18.8.3.2.4—Fabric Containing PTFE Fibers	18-24
18.8.3.3—Stainless Steel Mating Surface	18-24
18.8.3.4—Lubrication	18-24
18.8.4—Testing and Acceptance	18-24
18.8.4.1—General	18-24
18.8.5—Installation	18-25
18.9—ANCHOR BOLTS	18-25
18.9.1—Materials	18-25
18.9.2—Fabrication	18-25
18.9.3—Installation	18-25
18.10—BEDDING OF MASONRY PLATES	18-26
18.10.1—General	18-26
18.10.2—Materials	18-26
18.11—FABRICATION REQUIREMENTS FOR GUIDES	18-26

18.12—LOAD PLATES	18-27
18.13—MEASUREMENT	18-27
18.14—PAYMENT	18-27
18.15—REFERENCES	18-27

SECTION 19: BRIDGE DECK JOINT SEALS

TABLE OF CONTENTS

19.1—GENERAL	19-1
19.2—WORKING DRAWINGS	19-1
19.2.1—General.....	19-1
19.2.2—Special Contract-Document Requirements for Modular Bridge Joint Systems (MBJS)	19-1
19.3—MATERIALS.....	19-5
19.3.1—Bridge Deck Joint Seal Materials and Joint Seal Assemblies Other than Modular Bridge Joint Systems	19-5
19.3.2—Modular Bridge Joint Systems.....	19-5
19.4—MANUFACTURE AND FABRICATION.....	19-7
19.4.1—Compression Seal Joints	19-7
19.4.2—Joint Seal Assemblies Other than Modular Bridge Joint Systems	19-7
19.4.3—Modular Bridge Joint Systems.....	19-7
19.4.3.1—General.....	19-7
19.4.3.2—Edgebeam Profile and Anchorage.....	19-8
19.4.3.3—Centerbeam and Support Bar	19-8
19.4.3.4—Seals.....	19-9
19.4.3.5—Support Boxes.....	19-10
19.4.3.6—PTFE Sliding Surface	19-10
19.4.3.7—Stainless Steel Sliding Surface for MBJS	19-10
19.4.3.8—Corrosion Protection.....	19-10
19.5—INSTALLATION.....	19-10
19.5.1—General.....	19-10
19.5.2—Compression Seal Joints	19-10
19.5.3—Joint Seal Assemblies Other than Modular Bridge Joint Systems	19-11
19.5.4—Modular Bridge Joint Systems.....	19-11
19.5.4.1—Shipping and Handling	19-11
19.5.4.2—Preinstallation Inspection.....	19-12
19.5.4.3—Installation	19-12
19.5.4.3.1—Setting Gap Opening.....	19-12
19.5.4.3.2—Formwork	19-13
19.5.4.3.3—Supporting MBJS during Placing of Concrete	19-13
19.5.4.3.4—Placing the Concrete	19-13
19.5.4.3.5—Finished MBJS Tolerances	19-14
19.5.4.3.6—Bridging MBJS after Installation	19-14
19.5.4.3.7—Removal of Forms and Debris	19-14
19.5.4.3.8—Watertightness Test	19-14
19.5.4.3.9—Acceptance.....	19-15
19.6—MEASUREMENT AND PAYMENT	19-15
19.7—REFERENCES.....	19-15
APPENDIX A19—PROPOSED STANDARD TEST METHOD FOR MODULAR BRIDGE JOINT SYSTEMS	19-16

SECTION 20: RAILINGS

TABLE OF CONTENTS

20.1—GENERAL	20-1
20.1.1—Description	20-1
20.1.2—Materials	20-1
20.1.3—Construction	20-1
20.1.4—Line and Grade	20-1
20.2—METAL RAILING	20-1
20.2.1—Materials and Fabrication	20-1
20.2.1.1—Steel Railing	20-1
20.2.1.2—Aluminum Railing	20-1
20.2.1.3—Metal Beam Railing	20-2
20.2.1.4—Welding	20-2
20.2.2—Installation	20-2
20.2.3—Finish	20-2
20.3—CONCRETE RAILING	20-2
20.3.1—Materials and Construction	20-2
20.4—TIMBER RAILING	20-3
20.5—STONE AND BRICK RAILINGS	20-3
20.6—TEMPORARY RAILING	20-3
20.7—MEASUREMENT AND PAYMENT	20-3
20.7.1—Measurement	20-3
20.7.2—Payment	20-4
20.8—REFERENCES	20-4

SECTION 21: WATERPROOFING

TABLE OF CONTENTS

21.1—GENERAL	21-1
21.1.1—Waterproofing	21-1
21.1.2—Dampproofing	21-1
21.2—MATERIALS	21-1
21.2.1—Asphalt Membrane Waterproofing System	21-1
21.2.1.1—Asphalt	21-1
21.2.1.2—Primer	21-1
21.2.1.3—Fabric	21-1
21.2.2—Preformed Membrane Waterproofing Systems	21-2
21.2.2.1—Primer	21-2
21.2.2.2—Preformed Membrane Sheet	21-2
21.2.2.3—Mastic	21-3
21.2.3—Protective Covers	21-3
21.2.4—Dampproofing	21-3
21.2.5—Inspection and Delivery	21-3
21.3—SURFACE PREPARATION	21-4
21.4—APPLICATION	21-4
21.4.1—Asphalt Membrane Waterproofing	21-4
21.4.1.1—General	21-4
21.4.1.2—Installation	21-4
21.4.1.3—Special Details	21-5
21.4.1.4—Damage Patching	21-6
21.4.2—Preformed Membrane Waterproofing Systems	21-6
21.4.2.1—General	21-6
21.4.2.2—Installation on Bridge Decks	21-6
21.4.2.3—Installation on Other Surfaces	21-7
21.4.3—Protective Cover	21-7
21.4.4—Dampproofing	21-8
21.5—MEASUREMENT AND PAYMENT	21-8

TABLE OF CONTENTS

22.1—GENERAL	22-1
22.2—WORKING DRAWINGS	22-1
22.3—MATERIALS	22-2
22.3.1—Aggregate	22-2
22.3.2—Wire-Enclosed Riprap (Gabions)	22-2
22.3.3—Filter Fabric	22-2
22.3.4—Grout	22-2
22.3.5—Sacked Concrete Riprap	22-2
22.3.6—Portland Cement Concrete	22-2
22.3.7—Pneumatically Applied Mortar	22-3
22.3.8—Precast Portland Cement Concrete Blocks and Shapes	22-3
22.3.9—Reinforcing Steel	22-3
22.3.10—Geocomposite Drain	22-3
22.4—CONSTRUCTION	22-4
22.4.1—Preparation of Slopes	22-4
22.4.2—Bedding	22-4
22.4.3—Filter Fabric	22-4
22.4.4—Geocomposite Drain	22-4
22.4.5—Hand-Placing Stones	22-5
22.4.6—Machine-Placed Stones	22-5
22.4.6.1—Dry Placement	22-5
22.4.6.2—Underwater Placement	22-5
22.4.7—Wire-Enclosed Riprap (Gabions)	22-5
22.4.7.1—Fabrication	22-5
22.4.7.2—Installation	22-6
22.4.8—Grouted Riprap	22-7
22.4.9—Sacked Concrete Riprap	22-7
22.4.10—Concrete Slope Paving	22-8
22.4.10.1—General	22-8
22.4.10.2—Cast-in-Place Slope Paving	22-8
22.4.10.3—Precast Slope Paving	22-9
22.5—MEASUREMENT AND PAYMENT	22-9
22.5.1—Method of Measurement	22-9
22.5.1.1—Stone Riprap and Filter Blanket	22-9
22.5.1.2—Sacked Concrete Riprap	22-9
22.5.1.3—Wire-Enclosed Riprap (Gabions)	22-10
22.5.1.4—Cast-in-Place Concrete Slope Paving	22-10
22.5.1.5—Precast Concrete Slope Paving	22-10
22.5.1.6—Filter Fabric	22-10
22.5.2—Payment	22-10
22.5.2.1—General	22-10
22.5.2.2—Stone Riprap	22-10
22.5.2.3—Sacked Concrete Riprap	22-11
22.5.2.4—Wire-Enclosed Riprap (Gabions)	22-11
22.5.2.5—Cast-in-Place Concrete Slope Paving	22-11
22.5.2.6—Precast Concrete Slope Paving	22-11
22.5.2.7—Filter Blanket	22-11
22.5.2.8—Filter Fabric	22-11
22.5.2.9—Geocomposite Drain System	22-12
22.6—REFERENCES	22-12

SECTION 23: MISCELLANEOUS METAL

TABLE OF CONTENTS

23.1—DESCRIPTION.....	23-1
23.2—MATERIALS.....	23-1
23.3—FABRICATION.....	23-1
23.4—GALVANIZING.....	23-1
23.5—MEASUREMENT	23-2
23.6—PAYMENT	23-2
23.7—REFERENCE.....	23-2

SECTION 24: PNEUMATICALLY APPLIED MORTAR

TABLE OF CONTENTS

24.1—DESCRIPTION	24-1
24.2—MATERIALS	24-1
24.2.1—Cement, Aggregate, Water, and Admixtures	24-1
24.2.2—Reinforcing Steel	24-1
24.2.3—Anchor Bolts or Studs	24-1
24.3—PROPORTIONING AND MIXING	24-2
24.3.1—Proportioning	24-2
24.3.2—Mixing	24-2
24.4—SURFACE PREPARATION	24-2
24.4.1—Earth	24-2
24.4.2—Forms	24-2
24.4.3—Concrete or Rock	24-3
24.5—INSTALLATION	24-3
24.5.1—Placement of Reinforcing	24-3
24.5.2—Placement of Mortar	24-4
24.5.2.1—Weather Limitations	24-5
24.5.2.2—Protection of Adjacent Work	24-5
24.5.3—Finishing	24-5
24.5.4—Curing and Protecting	24-5
24.6—MEASUREMENT AND PAYMENT	24-5
24.7—REFERENCES	24-6

SECTION 25: STEEL AND CONCRETE TUNNEL LINERS

TABLE OF CONTENTS

25.1—SCOPE	25-1
25.2—DESCRIPTION	25-1
25.3—MATERIALS AND FABRICATION	25-1
25.3.1—General	25-1
25.3.2—Forming and Punching of Steel Liner Plates	25-2
25.4—INSTALLATION	25-2
25.4.1—Steel Liner Plates	25-2
25.4.2—Precast Concrete Liner Plates	25-2
25.4.3—Grouting	25-3
25.5—MEASUREMENT	25-3
25.6—PAYMENT	25-3
25.7—REFERENCES	25-3

SECTION 26: METAL CULVERTS

TABLE OF CONTENTS

26.1—GENERAL	26-1
26.1.1—Description	26-1
26.2—WORKING DRAWINGS	26-1
26.3—MATERIALS	26-1
26.3.1—Corrugated Metal Pipe	26-1
26.3.2—Structural Plate	26-1
26.3.3—Nuts and Bolts	26-2
26.3.4—Mixing of Materials	26-2
26.3.5—Fabrication	26-2
26.3.6—Welding	26-2
26.3.7—Protective Coatings	26-2
26.3.8—Bedding and Backfill Materials	26-3
26.3.8.1—General	26-3
26.3.8.2—Long-Span Structures	26-3
26.3.8.3—Box Culverts	26-3
26.3.8.4—Deep Corrugated Structures	26-3
26.3.9—Steel-Reinforced Thermoplastic Culverts	26-3
26.4—ASSEMBLY	26-4
26.4.1—General	26-4
26.4.2—Joints	26-4
26.4.2.1—Field Joints	26-4
26.4.2.2—Joint Types	26-5
26.4.2.3—Soil Conditions	26-5
26.4.2.4—Joint Properties	26-5
26.4.2.5—Steel-Reinforced Thermoplastic Culvert Joints	26-7
26.4.3—Assembly of Long-Span Structures	26-7
26.5—INSTALLATION	26-8
26.5.1—General	26-8
26.5.2—Foundation	26-8
26.5.3—Bedding	26-11
26.5.4—Structure Backfill	26-12
26.5.4.1—General	26-12
26.5.4.2—Arches	26-13
26.5.4.3—Long-span Structures	26-13
26.5.4.4—Box Culverts	26-14
26.5.4.5—Deep Corrugated Structural Plate Structures	26-14
26.5.5—Bracing	26-15
26.5.6—Arch Substructures and Headwalls	26-16
26.5.7—Inspection Requirements for CMP	26-16
26.5.7.1—Visual Inspection	26-16
26.5.7.2—Installation Deflection	26-17
26.5.7.2.1—Installation Deflection for CMP and Structural Plate Structures	26-17
26.5.7.2.2—Installation Deflection for Steel-reinforced Thermoplastic Culverts	26-18
26.6—CONSTRUCTION PRECAUTIONS	26-19
26.7—MEASUREMENT	26-20
26.8—PAYMENT	26-20
26.9—REFERENCES	26-20

SECTION 27: CONCRETE CULVERTS

TABLE OF CONTENTS

27.1—GENERAL	27-1
27.1.1—Abbreviations	27-1
27.2—WORKING DRAWINGS	27-1
27.3—MATERIALS	27-1
27.3.1—Reinforced Concrete Culverts	27-1
27.3.2—Surface Finish	27-2
27.3.3—Joint Sealants	27-2
27.3.3.1—General	27-2
27.3.3.2—Cement Mortar	27-2
27.3.3.3—Flexible Watertight Gaskets	27-2
27.3.3.4—Other Joint Sealant Materials	27-3
27.3.4—Bedding Material and Backfill	27-3
27.4—ASSEMBLY	27-3
27.4.1—General	27-3
27.4.2—Joints	27-3
27.5—INSTALLATION	27-3
27.5.1—General	27-3
27.5.2—Foundation Bedding and Backfill	27-4
27.5.2.1—General	27-4
27.5.2.2—Precast Reinforced Concrete Circular Arch and Elliptical Pipe	27-4
27.5.2.3—Precast Reinforced Concrete Box Sections	27-10
27.5.3—Placing Culvert Sections	27-11
27.5.4—Haunch, Lower Side, and Backfill or Overfill	27-12
27.5.4.1—Precast Reinforced Concrete Circular Arch and Elliptical Pipe	27-12
27.5.4.2—Precast Reinforced Concrete Box Sections	27-12
27.5.4.3—Placing of Haunch, Lower Side, and Backfill or Overfill	27-12
27.5.4.4—Cover over Culvert During Construction	27-12
27.6—FIELD INSPECTION	27-13
27.6.1—General	27-13
27.6.2—Misalignment	27-13
27.6.3—Joint Defects	27-14
27.6.4—Longitudinal Cracks	27-14
27.6.5—Transverse Cracks	27-15
27.6.6—Spalls	27-15
27.6.7—Slabbing	27-15
27.6.8—End Section Drop-Off	27-15
27.6.9—Follow Up	27-16
27.7—MEASUREMENT	27-16
27.8—PAYMENT	27-16
27.9—REFERENCES	27-16

SECTION 28: WEARING SURFACES

TABLE OF CONTENTS

28.1—DESCRIPTION	28-1
28.2—LATEX-MODIFIED CONCRETE TYPE WEARING SURFACE	28-1
28.2.1—General	28-1
28.2.2—Materials	28-1
28.2.2.1—Portland Cement	28-1
28.2.2.2—Aggregate	28-2
28.2.2.3—Water	28-2
28.2.2.4—Latex Emulsion	28-2
28.2.2.5—Latex-Modified Concrete	28-2
28.2.3—Surface Preparation	28-3
28.2.3.1—New Decks	28-3
28.2.3.2—Existing Decks	28-4
28.2.4—Proportioning and Mixing	28-4
28.2.5—Installation	28-5
28.2.5.1—Weather Restrictions	28-5
28.2.5.2—Equipment	28-5
28.2.5.3—Placing and Finishing	28-6
28.2.5.3.1—Construction Joints	28-6
28.2.5.3.2—Placing	28-6
28.2.5.3.3—Finishing	28-7
28.2.6—Curing	28-7
28.2.7—Acceptance Testing	28-7
28.2.8—Measurement and Payment	28-8
28.3—REFERENCE	28-8

SECTION 29: CONCRETE ANCHORS

TABLE OF CONTENTS

SECTION 29.1—SCOPE AND RESPONSIBILITIES	29-1
SECTION 29.2—MATERIALS AND PREQUALIFICATION.....	29-2
29.2.1—Materials	29-2
29.2.2—Prequalification, Working Drawings, and Submittals for Post-Installed Anchors.....	29-4
SECTION 29.3—INSTALLATION AND INSPECTION.....	29-4
29.3.1—General.....	29-4
29.3.2—Installation	29-5
29.3.3—Inspection.....	29-6
29.3.3.1—Demonstration Testing	29-6
29.3.3.2—Production Anchor Proof Testing	29-7
SECTION 29.4—MEASUREMENT	29-7
SECTION 29.5—PAYMENT	29-8
SECTION 29.6—REFERENCES	29-8

SECTION 30: THERMOPLASTIC CULVERTS

TABLE OF CONTENTS

30.1—GENERAL	30-1
30.1.1—Description	30-1
30.1.2—Importance of Construction Procedures	30-1
30.1.3—Terminology	30-1
30.2—WORKING DRAWINGS	30-4
30.3—MATERIALS	30-4
30.3.1—Thermoplastic Culverts	30-4
30.3.2—Bedding Material and Backfill	30-5
30.3.2.1—General	30-5
30.3.2.2—Control of Particle Migration	30-5
30.3.2.3—Controlled Low-Strength Material	30-6
30.4—ASSEMBLY	30-6
30.4.1—General	30-6
30.4.2—Joints	30-6
30.5—INSTALLATION	30-6
30.5.1—General	30-6
30.5.2—Excavation and Groundwater Control	30-7
30.5.3—Groundwater Control	30-7
30.5.4—Trench Widths	30-8
30.5.5—Foundations	30-8
30.5.6—Bedding	30-9
30.5.7—Placing Culvert Sections	30-9
30.5.8—Structural Backfill	30-9
30.5.8.1—General	30-9
30.5.8.2—Backfilling under the Haunch	30-10
30.5.8.3—Sidefill	30-10
30.5.8.4—Topfill	30-11
30.6—MINIMUM COVER	30-11
30.7—INSPECTION REQUIREMENTS	30-12
30.7.1—Visual Inspection	30-12
30.7.2—Installation Deflection	30-13
30.7.3—Compaction Control	30-13
30.7.4—Use of Reduced Installation Factor	30-14
30.8—MEASUREMENT	30-14
30.9—PAYMENT	30-14
30.10—REFERENCES	30-15

TABLE OF CONTENTS

31.1—GENERAL	31-1
31.1.1—Description	31-1
31.1.2—Notice of Beginning of Work	31-1
31.1.3—Inspection	31-1
31.1.4—Inspector's Authority	31-2
31.2—WORKING DRAWINGS	31-2
31.2.1—Shop Drawings	31-2
31.2.2—Erection Drawings	31-2
31.2.3—Camber Diagram	31-3
31.3—MATERIALS	31-3
31.3.1—Structural Aluminum	31-3
31.3.1.1—General	31-3
31.3.1.2—Aluminum Plate	31-3
31.3.1.3—Aluminum Extrusions	31-3
31.3.2—Fasteners	31-3
31.3.2.1—High-Strength Steel Fasteners	31-3
31.3.2.1.1—Material	31-3
31.3.2.1.2—Identifying Marks	31-4
31.3.2.1.3—Dimensions	31-4
31.3.2.1.4—Galvanizing	31-4
31.3.2.1.5—Alternative Fasteners	31-4
31.3.2.2—Aluminum Rivets	31-5
31.3.2.3—Stainless Steel Bolts	31-5
31.3.2.4—Lock-Pin and Collar Fasteners	31-5
31.3.3—Welded Stud Shear Connectors	31-5
31.3.4—Aluminum Forgings	31-5
31.3.5—Aluminum Castings	31-6
31.4—FABRICATION	31-6
31.4.1—Identification of Aluminum Alloys during Fabrication	31-6
31.4.2—Storage of Materials	31-6
31.4.3—Plates	31-7
31.4.3.1—Direction of Rolling	31-7
31.4.3.2—Plate Edges	31-7
31.4.3.3—Bent Plates	31-7
31.4.3.3.1—General	31-7
31.4.3.3.2—Cold Bending	31-7
31.4.4—Fit of Stiffeners	31-7
31.4.5—Abutting Joints	31-8
31.4.6—Facing of Bearing Surfaces	31-8
31.4.7—Straightening Material	31-8
31.4.8—Holes	31-8
31.4.8.1—General	31-8
31.4.8.2—Reamed or Drilled Holes	31-8
31.4.8.3—Accuracy of Hole Groups	31-9
31.4.8.3.1—Accuracy before Reaming	31-9
31.4.8.3.2—Accuracy after Reaming or Drilling	31-9
31.4.8.4—Locating Holes	31-9
31.4.9—Pins and Rollers	31-9
31.4.9.1—General	31-9
31.4.9.2—Pin Holes	31-9
31.4.10—Annealing and Stress Relieving	31-9
31.4.11—Aluminum Bridge Decks	31-10
31.4.11.1—General	31-10
31.4.11.2—Flatness of Panels	31-10
31.4.11.3—Straightness of Longitudinal Stiffeners Subject to Calculated Compressive Stress	31-10

31.4.11.4—Straightness of Transverse Web Stiffeners and Stiffeners Not Subject to Calculated Compressive Stress	31-11
31.4.12—Full-Size Tests	31-11
31.4.13—Marking and Shipping	31-11
31.4.14—Protection from Corrosion	31-11
31.4.14.1—General	31-11
31.4.14.2—Painting	31-12
31.5—ASSEMBLY	31-12
31.5.1—Bolted and Riveted Connections	31-12
31.5.1.1—Bolts	31-12
31.5.1.2—Lock-Pin and Collar Fasteners	31-12
31.5.1.3—Rivets	31-13
31.5.2—Welded Connections	31-13
31.5.3—Preassembly of Field Connections	31-13
31.5.3.1—General	31-13
31.5.3.2—Field Bolted Connections	31-13
31.5.3.3—Check Assemblies for Numerically-Controlled Fabrication	31-14
31.5.3.4—Field-Welded Connections	31-14
31.5.4—Match-Marking	31-14
31.5.5—Welding	31-14
31.6—ERECTION	31-14
31.6.1—General	31-14
31.6.2—Handling and Storing Materials	31-14
31.6.3—Bearings and Anchorages	31-15
31.6.4—Erection Procedure	31-15
31.6.4.1—Conformance to Erection Drawings	31-15
31.6.4.2—Erection Stresses	31-15
31.6.4.3—Maintaining Alignment and Camber	31-15
31.6.5—Field Assembly	31-15
31.6.6—Pin Connections	31-16
31.6.7—Misfits	31-16
31.7—MEASUREMENT AND PAYMENT	31-16
31.7.1—Method of Measurement	31-16
31.7.2—Basis of Payment	31-17
31.8—REFERENCES	31-17

SECTION 32: SHOCK TRANSMISSION UNITS

TABLE OF CONTENTS

32.1—GENERAL	32-1
32.2—WORKING DRAWINGS	32-1
32.3—MATERIALS	32-2
32.3.1—Steel	32-2
32.3.2—Internal Fluid.....	32-2
32.3.3—Packaging, Handling, and Storage	32-3
32.3.4—Manufacture/Fabrication	32-3
32.3.4.1—General.....	32-3
32.3.4.2—Connecting Hardware	32-3
32.3.4.3—Connection Tolerances.....	32-3
32.4—TESTING AND ACCEPTANCE	32-3
32.4.1—Prequalification Tests.....	32-4
32.4.2—Prototype Tests.....	32-4
32.4.2.1—General.....	32-4
32.4.2.2—Hydrostatic Pressure Test	32-4
32.4.2.3—Slow Movement Test (Thermal)	32-4
32.4.2.4—Fast Movement Test.....	32-4
32.4.2.5—Simulated Dynamic Test.....	32-5
32.4.2.6—Overload Test.....	32-5
32.4.2.7—Fatigue Load Test	32-5
32.4.3—Proof Testing (Quality Control)	32-6
32.4.3.1—General.....	32-6
32.4.3.2—Hydrostatic Pressure Test	32-6
32.4.3.3—Slow Movement Test (Thermal)	32-6
32.4.3.4—Fast Movement Test.....	32-6
32.5—MANUALS	32-7
32.5.1—Installation Manuals	32-7
32.5.2—Maintenance and Inspection Manual	32-7
32.6—MEASUREMENT AND PAYMENT	32-8
32.7—REFERENCES.....	32-8

TABLE OF CONTENTS

33.1—DESCRIPTION	33-1
33.2—SUBMITTALS	33-1
33.2.1—Experience and Personnel	33-2
33.2.2—Construction Submittals	33-2
33.2.3—Installation Records	33-4
33.3—MATERIALS	33-4
33.3.1—Water	33-4
33.3.2—Admixtures	33-5
33.3.3—Cement	33-5
33.3.4—Fillers	33-5
33.3.5—Bar Reinforcement	33-5
33.3.6—Pipe/Casing	33-5
33.3.7—Plates and Shapes	33-6
33.3.8—Centralizers	33-6
33.3.9—Corrosion Protection	33-6
33.4—CONSTRUCTION	33-7
33.4.1—Installation	33-7
33.4.2—Grouting	33-8
33.4.3—Pile Splices	33-9
33.4.4—Tolerances	33-9
33.5—LOAD TESTING	33-9
33.5.1—General	33-9
33.5.2—Verification Testing	33-10
33.5.3—Proof Testing	33-13
33.5.4—Lateral Loading	33-14
33.6—MEASUREMENT AND PAYMENT	33-14
33.6.1—Method of Measurement	33-14
33.6.1.1—Mobilization and Demobilization	33-14
33.6.1.2—Micropiles	33-14
33.6.1.3—Verification Load Tests	33-15
33.6.1.4—Proof Load Tests	33-15
33.6.1.5—Obstruction Drilling	33-15
33.6.2—Basis of Payment	33-15
33.6.2.1—Mobilization and Demobilization	33-15
33.6.2.2—Micropiles	33-15
33.6.2.3—Verification Load Tests	33-15
33.6.2.4—Proof Load Tests	33-16
33.6.2.5—Obstruction Drilling	33-16
33.7—REFERENCES	33-16

TABLE OF CONTENTS

34.1—DESCRIPTION.....	34-1
34.2—WORKING DRAWINGS.....	34-1
34.3—MATERIALS.....	34-2
34.3.1—Soil Nail Components	34-2
34.3.2—Grout	34-2
34.3.3—Corrosion Protection Elements.....	34-2
34.3.4—Centralizers	34-3
34.4—FABRICATION.....	34-3
34.4.1—Test Nails	34-3
34.4.2—Production Nails And Nail Head Assemblies.....	34-3
34.4.3—Tendon Storage And Handling.....	34-4
34.5—INSTALLATION	34-4
34.5.1—Drilling	34-4
34.5.2—Tendon Insertion	34-4
34.5.3—Grouting	34-5
34.5.4—Nail Head Assembly.....	34-5
34.5.5—Testing.....	34-5
34.5.5.1—Testing Equipment.....	34-6
34.5.5.2—Verification Test.....	34-6
34.5.5.3—Proof Test	34-7
34.5.5.4—Soil Nail Load Test Acceptance Criteria	34-9
34.6—MEASUREMENT AND PAYMENT	34-10
34.7—REFERENCES	34-10