

The image shows a large-scale construction project for bridge temporary works. It features a complex network of steel beams, girders, and scaffolding. Two workers in orange safety gear are visible on a high platform. The structure is supported by a network of vertical and diagonal bracing. The background shows a clear sky and some distant structures.

# GUIDE DESIGN SPECIFICATIONS FOR BRIDGE TEMPORARY WORKS

2nd Edition | 2017

GSBTW-2 | ISBN 978-1-56051-642-2

AMERICAN ASSOCIATION  
OF STATE HIGHWAY AND  
TRANSPORTATION OFFICIALS

**AASHTO**

# GUIDE DESIGN SPECIFICATIONS FOR BRIDGE TEMPORARY WORKS

## TABLE OF CONTENTS

### SECTION 1—INTRODUCTION

1.1—SCOPE.....	1-1
1.2—RELATED PUBLICATIONS.....	1-1
1.3—DEFINITIONS.....	1-2
1.4—METRIC CONVERSIONS.....	1-3

### SECTION 2—FALSEWORK

2.1—FALSEWORK DRAWINGS.....	2-1
2.2—MATERIALS AND MANUFACTURED COMPONENTS.....	2-2
2.2.1—General.....	2-2
2.2.2—Structural Steel.....	2-2
2.2.2.1—Identification and Properties.....	2-2
2.2.2.2—Salvaged Steel.....	2-3
2.2.2.3—Welding.....	2-3
2.2.3—Wood.....	2-4
2.2.3.1—Allowable Stresses.....	2-4
2.2.3.2—Modification Factors.....	2-4
2.2.3.3—Used Lumber.....	2-4
2.2.4—Other Materials.....	2-5
2.2.5—Manufactured Components.....	2-5
2.2.5.1—General.....	2-5
2.2.5.2—Maximum Loadings and Deflection.....	2-5
2.2.5.3—Factor of Safety.....	2-6
2.3—LOADS.....	2-6
2.3.1—General.....	2-6
2.3.2—Loads and Load Combinations.....	2-6
2.3.2.1—Loads and Load Designation.....	2-6
2.3.2.2—Load Combinations and Load Factors.....	2-7
2.3.2.3—Load and Resistance Factored Design.....	2-8
2.3.2.4—Allowable Stress Design.....	2-10
2.3.3—Dead and Live Loads.....	2-10
2.3.3.1—Dead Load.....	2-10
2.3.3.2—Live Load.....	2-10
2.3.3.2.1—Construction Live Load.....	2-11
2.3.3.2.2—Impact.....	2-11
2.3.3.3—Minimum Vertical Load.....	2-11
2.3.4—Construction Loads.....	2-11
2.3.4.1—Construction Dead Load.....	2-11
2.3.4.2—Material Loads.....	2-12
2.3.4.3—Personnel and Equipment Load.....	2-12
2.3.4.3.1—General.....	2-12

2.3.4.3.2—Individual Personnel Load .....	2-12
2.3.4.3.3—Uniformly Distributed Loads .....	2-13
2.3.4.3.4—Concentrated Loads.....	2-13
2.3.4.4—Horizontal Construction Load, $C_h$ .....	2-14
2.3.4.5—Equipment Reactions, $C_R$ .....	2-14
2.3.4.5.1—Rated Equipment.....	2-14
2.3.4.5.2—Non-Rated Equipment.....	2-14
2.3.4.5.3—Impact .....	2-15
2.3.5—Environmental Loads.....	2-15
2.3.5.1—Risk Category .....	2-15
2.3.5.2—Wind.....	2-15
2.3.5.2.1—Design Wind Speed.....	2-15
2.3.5.2.2—Frameworks without Cladding .....	2-15
2.3.5.2.3—Accelerated Wind Region .....	2-16
2.3.5.3—Snow.....	2-16
2.3.5.4—Earthquake.....	2-16
2.3.5.4.1—Applicability .....	2-16
2.3.5.4.2—Use of ASCE 7.....	2-17
2.3.5.4.3—Other Standards for Earthquake Resistant Design .....	2-17
2.3.5.5—Stream Flow .....	2-17
2.3.5.6—Ice Loads .....	2-18
2.4—DESIGN .....	2-18
2.4.1—General .....	2-18
2.4.2—Deflection .....	2-19
2.4.3—Slenderness.....	2-19
2.4.4—Overturning and Sliding .....	2-19
2.4.5—Steel Beam Grillages .....	2-20
2.4.6—Proprietary Shoring Systems .....	2-20
2.4.7—Traffic Openings.....	2-21
2.5—FOUNDATIONS.....	2-22
2.5.1—General .....	2-22
2.5.2—Footings.....	2-22
2.5.3—Pile Foundations .....	2-24
2.5.4—Foundations for Heavy Duty Shoring Systems .....	2-24
 SECTION 3—FORMWORK	
3.1—MATERIALS AND FORM ACCESSORIES.....	3-1
3.1.1—General .....	3-1
3.1.2—Sealing.....	3-1
3.1.3—Structural Supports .....	3-3
3.1.4—Prefabricated Formwork .....	3-3
3.1.5—Cast-in-Place Formwork.....	3-3
3.1.6—Form Accessories .....	3-3
3.2—LOADS.....	3-4
3.2.1—Vertical Loads .....	3-4
3.2.2—Lateral Pressure of Fluid Concrete .....	3-4
3.2.2.1—Form Pressure.....	3-4
3.2.2.2—Form Pressure—Reduced Hydrostatic Head.....	3-5
3.2.3—Horizontal Loads .....	3-6

3.3—DESIGN .....	3-6
3.3.1—General .....	3-6
3.3.2—Allowable Stresses.....	3-7
3.3.3—Deflection .....	3-7
3.3.4—Safety Factors for Form Accessories.....	3-7

SECTION 4—TEMPORARY RETAINING STRUCTURES

4.1—GENERAL.....	4-1
4.2—TYPES OF RETAINING STRUCTURES.....	4-1
4.3—LATERAL EARTH PRESSURES.....	4-1
4.3.1—Cantilever Walls .....	4-2
4.3.1.1—Wall Movement Necessary for Active Pressures .....	4-2
4.3.1.2—Active Pressures .....	4-2
4.3.1.3—At-Rest Pressures .....	4-3
4.3.1.4—Passive Pressures.....	4-4
4.3.2—Braced Excavations .....	4-5
4.3.3—Surcharge Pressures.....	4-13
4.4—STABILITY.....	4-13
4.5—COFFERDAMS.....	4-13
4.5.1—Cantilever Walls .....	4-13
4.5.2—Braced Cofferdams .....	4-14

APPENDICES

APPENDIX A—MAXIMUM DESIGN VALUES FOR UNGRADED STRUCTURAL LUMBER.....	A-1
APPENDIX B—AISC PROVISIONS FOR WEBS AND FLANGES WITH CONCENTRATED FORCES.....	B-1
B.1—Flange Local Bending.....	B-1
B.2—Web Local Yielding.....	B-1
B.3—Web Local Crippling .....	B-2
B.4—Web Sideway Buckling.....	B-3
B.5—Web Compression Buckling.....	B-4
B.6—Web Panel Zone Shear.....	B-4
B.7—Unframed Ends of Beams and Girders .....	B-5
B.8—Additional Stiffener Requirements for Concentrated Forces.....	B-5
B.9—Additional Doubler Plate Requirements for Concentrated Forces.....	B-6
APPENDIX C—SELECT ASCE 7 WIND PROVISIONS.....	C-1
C.1—Basic Wind Speed, $V$ .....	C-1
C.2—Design Wind Force, $F$ .....	C-1
C.3—Velocity Pressure Exposure Coefficient, $K_z$ .....	C-2
C.4—Topographic Factor, $K_{zt}$ .....	C-2
C.5—Wind Directionality Factor, $K_d$ .....	C-3
C.6—Gust Effect Factor, $G$ .....	C-3
C.7—Force Coefficient, $C_f$ .....	C-3
C.8—Projected Area, $A_f$ .....	C-3
APPENDIX D—SELECT ASCE 7 SEISMIC PROVISIONS.....	D-1
D.1—Risk-Targeted Maximum Considered Earthquake, $MCE_R$ .....	D-1
D.2—Site Class and Site Coefficients, $F_a$ and $F_v$ .....	D-1
D.3—Design Spectral Acceleration Parameters, $S_{DS}$ and $S_{D1}$ .....	D-2
D.4—Estimate Fundamental Period of Falsework, $T_a$ .....	D-2
D.5—Seismic Response Coefficient, $C_s$ .....	D-2

D.6—Seismic Base Shear and Equivalent Lateral Force, $V$ and $F_{eq}$ .....	D-2
APPENDIX E—SAMPLE WIND AND SEISMIC CALCULATIONS .....	E-1
APPENDIX F—FOUNDATION INVESTIGATION AND DESIGN .....	F-1
F.1—Subsurface Investigation .....	F-1
F.2—Relative Density of Granular Deposits .....	F-1
F.3—Consistency of Cohesive Soils .....	F-2
F.4—Unified Soil Classification System .....	F-3
F.5—Potential Problem Soils .....	F-4
F.6—Extended Foundation .....	F-5
F.7—AASHTO and ASTM Reference Standards .....	F-5
APPENDIX G—CONVERSION OF EQUATIONS FROM US CUSTOMARY UNITS TO SI METRIC UNITS .....	G-1
REFERENCES .....	R-1

**GUIDE DESIGN SPECIFICATION FOR BRIDGE TEMPORARY WORKS**

**LIST OF FIGURES**

Figure 4.3.2-1—Apparent Earth Pressure Distributions for Anchored Walls Constructed from the Top Down in Cohesionless Soils .....	4-6
Figure 4.3.2-2—Apparent Earth Pressure Distributions for Anchored Walls Constructed from the Top Down in Soft to Medium Stiff Cohesive Soils .....	4-7
Figure 4.3.2-3—Unfactored Simplified Earth Pressure Distributions for Permanent Non-Gravity Cantilevered Walls with Discrete Vertical Wall Elements .....	4-8
Figure 4.3.2-4—Unfactored Simplified Earth Pressure Distribution and Design Procedures for Permanent Non-Gravity Cantilevered Walls with Continuous Vertical Wall Elements Embedded in Granular Soil Modified after Teng (1962) .....	4-9
Figure 4.3.2-5—Unfactored Simplified Earth Pressure Distributions for Temporary Non-Gravity Cantilevered Walls with Discrete Vertical Wall Elements .....	4-10
Figure 4.3.2-6—Unfactored Simplified Earth Pressure Distributions for Temporary Non-Gravity Cantilevered Walls with Continuous Vertical Wall Elements .....	4-11
Figure C.1(a)—Basic Wind Speeds for Occupancy Category II Buildings and Other Structures .....	C-6
Figure C.1(b)—Basic Wind Speeds for Occupancy Category III and IV Buildings and Other Structures .....	C-8
Figure C.2—Topographic Multipliers for Exposure C .....	C-10
Figure D.1(a)— $S_I$ Risk-Adjusted Maximum Considered Earthquake ( $MCE_R$ ) Ground Motion Parameter for the Conterminous United States for 1.0 sec Spectral Response Acceleration (5 Percent of Critical Damping), Site Class B .....	D-3
Figure D.1(b)— $S_I$ Risk-Adjusted Maximum Considered Earthquake ( $MCE_R$ ) Ground Motion Parameter for the Conterminous United States for 1.0 sec Spectral Response Acceleration (5 Percent of Critical Damping), Site Class B .....	D-4
Figure D.2— $S_I$ Risk-Adjusted Maximum Considered Earthquake ( $MCE_R$ ) Ground Motion Parameter for Alaska for 1.0 sec Spectral Response Acceleration (5 Percent of Critical Damping), Site Class B .....	D-5
Figure D.3— $S_I$ Risk-Adjusted Maximum Considered Earthquake ( $MCE_R$ ) Ground Motion Parameter for Hawaii for 1.0 sec Spectral Response Acceleration (5 Percent of Critical Damping), Site Class B .....	D-6
Figure D.4— $S_I$ Risk-Adjusted Maximum Considered Earthquake ( $MCE_R$ ) Ground Motion Parameter for Puerto Rico and the United States Virgin Islands for 1.0 sec Spectral Response Acceleration (5 Percent of Critical Damping), Site Class B .....	D-7
Figure E.1—Falsework Tower Elevation .....	E-2
Figure E.2—Falsework Tower Elevation .....	E-7

**GUIDE DESIGN SPECIFICATION FOR BRIDGE TEMPORARY WORKS**

**LIST OF TABLES**

Table 2.1-1—Minimum Mechanical Properties of Structural Steel by Shape, Strength, and Thickness .....	2-2
Table C2.2.2.1—Early ASTM Steep Specifications.....	2-3
Table 2.3.2.2-1—Load Combinations and Load Factors.....	2-9
Table 2.3.4.3.3-1—Classes of Working Surfaces for Combined Uniformly Distributed Loads .....	2-13
Table 2.3.4.3.4-1—Minimum Concentrated Personnel and Equipment Loads .....	2-13
Table 2.5.2-1—Presumptive Soil-Bearing Values.....	2-23
Table 2.5.2-2—Ground Water-Level Modification Errors .....	2-23
Table C3.1.2-1—Form Materials with Data Sources for Design and Specification .....	3-2
Table 3.2.2.2-1—Chemistry Factor, $F_c$ .....	3-6
Table 3.2.2.2-2—Unit Weight Factor, $F_w$ .....	3-6
Table 3.3.4-1—Minimum Safety Factors of Formwork.....	3-7
Table A.1—Maximum Design Values for Ungraded Structural Lumber.....	A-1
Table C.1—Velocity Pressure Coefficient, $K_z$ .....	C-3
Table C.2—Wind Directionality Factor, $K_d$ .....	C-4
Table C.3—Force Coefficients for Trussed Towers, $C_f$ .....	C-4
Table C.4—Force Coefficients for Open Signs & Lattice Frameworks, $C_f$ .....	C-4
Table C.5—Force Coefficients for Solid Freestanding Walls and Signs.....	C-5
Table D.1— Site Coefficient, $F_a$ .....	D-1
Table D.2— Site Coefficient, $F_v$ .....	D-1
Table E.1—Velocity Pressure Exposure Coefficient.....	E-3
Table E.2—Velocity Pressure at Each Height Zone.....	E-3
Table E.3—Wind Pressure at Each Falsework Height Zone .....	E-4
Table E.4—Wind Load per Tower for Each Height Zone.....	E-5
Table F.1—Determination of Relative Density Based on Standard Penetration Resistance .....	F-2
Table F.2—CPT and SPT Values for Various Soils.....	F-2
Table F.3—Consistency of Cohesive Soils .....	F-3
Table F.4—Soil Classification According to the Unified Soil Classification System .....	F-4

## PREFACE

### Background

In 1991, a study was initiated by the Federal Highway Administration (FHWA) to identify the current state of practice in the United States and abroad for designing, constructing, and inspecting the temporary works used to construct highway bridge structures. This study was known as the FHWA Bridge Temporary Works Research Program. One of the documents produced from this study was FHWA Publication No. FHWA-RD-93-032, *Guide Design Specification for Bridge Temporary Works*, which was subsequently adopted by the American Association of State Highway and Transportation Officials (AASHTO) in 1995.

There have been several initiatives since original publication of the AASHTO *Guide Design Specifications for Bridge Temporary Works* that have advanced the design and construction of the temporary works used in bridge construction. The Structural Engineering Institute of the American Society of Civil Engineers (ASCE) developed SEI/ASCE 37-02, a standard for design loads on structures during construction. Based upon the period of time that has elapsed since the development of the original *Guide Design Specification*, and the development of other related standards over this period of time, the reassessment and updating of the guide design specification seemed appropriate and necessary.

### Summary of Changes

This 2017 Second Edition of the AASHTO *Guide Design Specifications for Bridge Temporary Works* has been updated to reflect current codes and practice. The organization is generally the same as the First Edition, but the construction provisions have been moved to the AASHTO *LRFD Bridge Construction Specifications*. The format was also changed so the commentary is adjacent to the specification (two column format) similar to the *AASHTO LRFD Bridge Construction Specifications*. The loads in Section 2—Falsework—have also been significantly revised and both ASD and LRFD design specifications are included.

### Acknowledgments

The AASHTO *Guide Design Specifications for Bridge Temporary Works* was revised under NCHRP Project 20-07/ Task 294 by Wiss, Janney, Elstner Associates, Inc., Northbrook, Illinois. John F. Duntemann was the Principal Investigator. This project was directed by the NCHRP Task Group, which consisted of the following representatives:

Arthur W. D'Andrea, *Louisiana Department of Transportation*  
Richard W. Dunne, *Michael Baker Jr., Inc.*  
Shoukry Elnahal, *Massachusetts Department of Transportation*  
Matthew Farrar, *Idaho Transportation Department*  
Kenneth F. Hurst, *Kansas Department of Transportation (Retired)*  
Paul V. Liles, Jr., *Georgia Department of Transportation*  
Carmen Swanwick, *Utah Department of Transportation*  
Sheila Rimal Duwadi, *Federal Highway Administration*  
Jeffrey Ger, *Federal Highway Administration*  
Waseem Dekelbab, *Transportation Research Board*  
Danna Powell, *Transportation Research Board*

The original guide design specification was developed under FHWA Contract No. DTFH61-91-C-00088. The project was directed by the Scaffolding, Shoring, and Formwork Task Group of the FHWA, which consisted of the following representatives:

James M. Stout, *California Department of Transportation*  
Donald Flemming, *Minnesota Department of Transportation*  
Nick Yaksich, *Associated General Contractors*  
Kent Starwalt, *American Road and Transportation Builders Association*  
Ramon Cook, *The Burke Company*  
Robert Desjardins, *Cianbro Corporation*

Richard F. Hoffman, *McLean Contracting*  
Robert T. Ratay, *Consulting Engineer*  
Sheila Rimal Duwadi, *Federal Highway Administration*  
James R. Hoblitzell, *Federal Highway Administration*  
Donald W. Miller, *Federal Highway Administration*  
William S. Cross, *Federal Highway Administration*  
Ian M. Friedland, *Transportation Research Board*

Special recognition is extended to Robert G. Lukas and Safdar Gill, Ground Engineering Consultants, Inc.; Robert T. Ratay, Consulting Engineer; Alan D. Fisher, Cianbro Corporation; William N. Nickas, Precast/Prestressed Concrete Institute; William F. McEleney, The National Steel Bridge Alliance; L. Edwin Dunn, California Department of Transportation (retired); Peter Courtois, Dayton-Superior Corporation (deceased); Mark K. Kaler, Dayton-Superior Corporation; and Donald F. Meinheit, Jon F. Sfura, Raymond H.R. Tide, Joseph M. Toniolo, Penny S. Symon, and Holly L. Ryan of Wiss, Janney, Elstner Associates, Inc. for their review comments, assistance with the research, and preparation of this document.

## INTRODUCTION

### 1.1—SCOPE

This Guide Design Specification has been developed for use by state agencies to include in their existing standard specifications for falsework, formwork, and related temporary construction used to construct highway bridge structures. The specification should also be useful to bridge engineers, falsework designers, contractors, and other engineers. Sections within this specification address falsework, formwork, and temporary retaining structures. Related publications and definitions are identified below.

### 1.2—RELATED PUBLICATIONS

American Association of State Highway and Transportation Officials, AASHTO *LRFD Bridge Construction Specifications*, Third Ed., with 2010, 2011, 2012, 2014, 2015, and 2016 Interim Revisions, Washington, DC, 2010.

American Association of State Highway and Transportation Officials, AASHTO *LRFD Bridge Design Specifications*, Seventh Ed., with 2015 and 2016 interim revisions, Washington, DC, 2014.

American Association of State Highway and Transportation Officials, *Construction Handbook for Bridge Temporary Works*, Second Edition, Washington, DC, 2017.

American Association of State Highway and Transportation Officials, *Standard Specifications for Highway Bridges*, 17th Ed., Washington, DC, 2002.

### C1.1

The AASHTO *Guide Design Specification for Bridge Temporary Works* was first published in 1995. This specification was originally developed by Wiss, Janney, Elstner Associates, Inc., of Northbrook, Illinois with the FHWA and directed by the Scaffolding, Shoring and Formwork Task Group of the FHWA. These specifications provided unified design and construction criteria that reflected the best practices at the time the specifications were developed.

Since 1995, there have been several initiatives that have advanced the state of practice related to the design and construction of the temporary works used in bridge construction. ASCE developed SEI/ASCE 37, *Design Loads on Structures during Construction*.

This 2017 Second Edition of the AASHTO *Guide Design Specifications for Bridge Temporary Works* has been updated to reflect current codes and practice. The organization is generally the same as the First Edition, but the construction requirements have been moved to the AASHTO *LRFD Bridge Construction Specifications*. The loads in Section 2—Falsework have also been significantly revised and both ASD and LRFD design specifications are included. These documents—the design and construction specifications—complement each other. The AASHTO *Construction Handbook for Bridge Temporary Works* has also been updated and serves as a useful reference on this subject.

American Society of Civil Engineers, *Minimum Design Loads for Buildings and Other Structures* (ASCE 7-10), Reston, Virginia, 2010.

American Society of Civil Engineers, *Design Loads on Structures During Construction* (ASCE 37-02), American Society of Civil Engineers, Reston, VA, 2002.

Duntemann, J.F., Dunn, L.E., Gill, S., Lukas, R.G., and Kaler, M.D., *Guide Design Specification for Bridge Temporary Works*, Report No. FHWA-RD-93-032, Federal Highway Administration, Washington, DC, November 1993.

Duntemann, J.F., Calabrese, F., and Gill, S., *Construction Handbook for Bridge Temporary Works*, Report No. FHWA-RD-93-034, Federal Highway Administration, Washington, DC, November 1993.

Duntemann, J.F., Anderson, N.S., and Longinow, A., *Synthesis of Falsework, Formwork, and Scaffolding for Highway Bridge Structures*, Report No. FHWA-RD-91-062, Federal Highway Administration, Washington, DC, November 1991.

United States Department of Transportation, Federal Highway Administration, *Accelerated Bridge Construction—Experience in Design, Fabrication, and Erection of Prefabricated Bridge Elements and Systems*, Report No. FHWA-HIF-12-013, Federal Highway Administration, East Hartford, CT, 2011.

U.S. Department of Transportation, Federal Highway Administration, *Certification Program for Bridge Temporary Works* (FHWA-RD-93-033), Federal Highway Administration, Washington, DC, 1993.

U.S. Department of Transportation, Federal Highway Administration, *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects*, FP-03, Washington, DC, 2003.

### 1.3—DEFINITIONS

For the purposes of this specification, the following definitions apply:

**Cofferdam**—A watertight structure that allows foundations to be constructed under dry conditions.

**Engineer**—Used with a capital “E” refers to the owner’s engineer.

**Falsework**—Temporary construction used to support the permanent structure until it becomes self-supporting. Falsework includes steel or timber beams, girders, columns, piles, and foundations, and any proprietary equipment including modular shoring frames, post shores, and horizontal shoring.

**Formwork**—A temporary structure or mold used to retain the plastic or fluid concrete in its designated shape until it hardens. Formwork must have enough strength to resist the fluid

pressure exerted by plastic concrete and any additional fluid pressure effects generated by vibrations.

**Scaffolding**—An elevated work platform used to support workmen materials and equipment, but not intended to support the structure being constructed.

**Shoring**—A component of falsework such as horizontal, vertical, or inclined support members. For the purpose of this document, this term is used interchangeably with falsework.

**Temporary Retaining Structure**—For the purpose of this document, refers to both earth-retaining structures and cofferdams.

#### 1.4—METRIC CONVERSIONS

Conversion of equations from U.S. Customary units to S.I. units is provided in Appendix G.