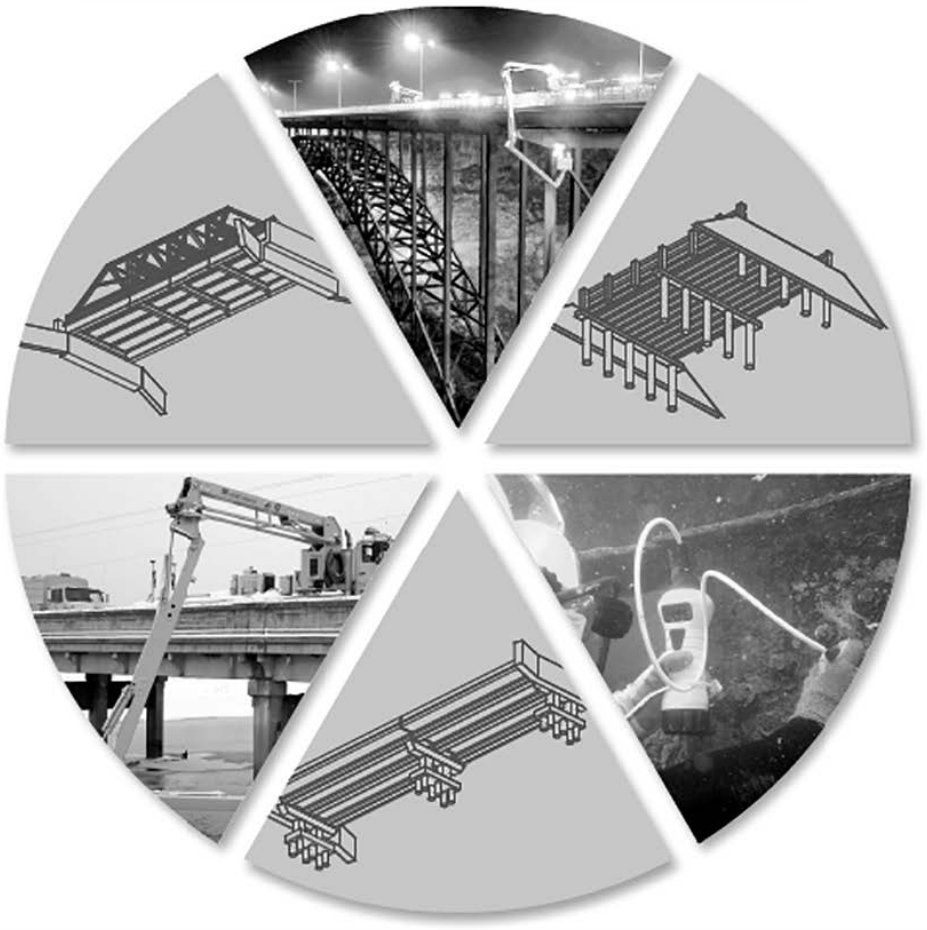
Manual for Bridge Element Inspection | 2



Second Edition, 2019

American Association of State Highway and Transportation Officials

AASHTO

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PREFACE

This Manual incorporates suggested changes that were submitted by many inspecting agencies, consultant inspection firms, and training instructors that helped improve this updated version. AASHTO would like to thank member agencies for their continued dedication to improving bridge inspection in the United States.

AASHTO also would like to recognize the dedication and tireless efforts of the following technical team members who worked together to develop the First Edition of this Manual:

Name	Agency	Role
Michael B. Johnson	California Department of Transportation (Caltrans)	Team Lead
Wade Casey	Federal Highways Administration (FHWA)	Technical Team Member
Larry O'Donnell	FHWA	Technical Team Member
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Paula Allec	Caltrans	Technical Support
Allen R. Marshall	Allen R. Marshall Consulting LLC	Manual Development Consultant

As a result of NCHRP 12-104, Guidelines to Improve the Quality of Element-Level Bridge Inspection, a new *Manual for Bridge Element Inspection* (MBEI), 2nd Ed. was developed. Section 3 of the MBEI was reorganized to list elements by material. Other revisions include:

- A new introduction was developed for Section 3.
- Visual guide sections were added to defect tables for Concrete, Prestressed Concrete, Steel, Joints, and Bearings.
- The "Condition State" header was removed from the tables and replaced with CS 1, CS 2, CS 3, and CS 4 nomenclature in the tables showing defects and defect descriptions.
    - The defect descriptions themselves were not changed in any way.
- Crack pattern and crack width measurement guides were added to Article 3.3.
- Spatial estimating guides were added in Article 3.12. These guides provide assistance to an Inspector for estimating areas (ft^2) and length (ft) of damage.
- Element commentary (Article 3.2) was revised as follows:
    - The element commentary was previously included with each element, resulting in repetition. For example, every concrete element included commentary regarding the width of cracks, meaning the same element commentary appeared in at least 17 places in Section 3. Element commentary has been consolidated into a single section to reduce repetition. In some cases, this required minor rewording to make the element commentary more general. For example, the "Other" elements each had a unique description that indicates the element type (e.g., "other deck" or "other column"). This was reworded to remove the specific reference such that one explanation of the "other" materials was applicable to all elements so described.
    - The concrete and prestressed concrete commentary regarding crack widths were stated in a table to improve readability.
    - Element commentary that was unique to a single element was maintained with the element in the listing of Article 3.1, and stated as a note. Typically, these notes are enhancements to the element description.
    - There were no intentional changes to the element commentary, although some rewording was done for grammatical purposes.
- A single, comprehensive listing of all elements documenting the element description, quantity calculation, unit of measure, and classification was developed and included in Article 3.1. This section was organized by material. Within each material, components and subcomponents are identified (such as deck, railing, superstructure, substructure, joints, etc.)
    - Subsections within general classes of components that did not provide different information than the subsection heading were eliminated. For example, the subsection 3.5.1 Columns/pier walls read "(1) This article covers supporting elements of the structure. (2) These items include columns and pier walls." (1) is redundant with the main heading, and (2) is a repeat of the subsection heading. In cases like these, the subsection text was omitted. This included Articles 3.5.1, 3.5.2, 3.5.3, and others.

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- Section 3 has gone from 186 pages to 76 pages. This number of pages would increase with the inclusion of additional visual guides, but still be reduced relative to the previous versions of the MBEI.

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TABLE OF CONTENTS

AASHTO EXECUTIVE COMMITTEE, 2018–2019 ii

AASHTO COMMITTEE ON BRIDGES AND STRUCTURES, 2018 iii

PREFACE v

INTRODUCTION xi

SECTION 1: BACKGROUND 1-1
- 1.1—Condition Assessment Philosophy: Multipath and Defect Concepts 1-1
- 1.2—National Bridge Elements 1-1
- 1.3—Bridge Management Elements 1-1
- 1.4—Agency-Developed Elements 1-1
- 1.5—How to Use This Manual 1-2
- 1.6—Organization 1-2

SECTION 2: ELEMENT LOCATION MATRIX 2-1
- 2.1—National Bridge Elements 2-1
  - 2.1.1—Decks and Slabs 2-1
  - 2.1.2—Railings 2-1
  - 2.1.3—Superstructure 2-2
  - 2.1.4—Bearings 2-2
  - 2.1.5—Substructure 2-3
  - 2.1.6—Culverts 2-3
- 2.2—Bridge Management Elements 2-3
  - 2.2.1—Joints 2-3
  - 2.2.2—Approach Slabs 2-4
  - 2.2.3—Wearing Surfaces, Protective Coatings, and Concrete Reinforcing Steel Protective System 2-4

SECTION 3: DETAILED ELEMENT DESCRIPTIONS 3-1
- 3.1—Element Listing by Material 3-2
  - 3.1.1—Reinforced Concrete 3-2
  - 3.1.2—Prestressed Concrete 3-5
  - 3.1.3—Steel 3-10
  - 3.1.4—Timber 3-11
  - 3.1.5—Masonry 3-12
  - 3.1.6—Other Materials 3-13
  - 3.1.7—Bearings 3-15
  - 3.1.8—Joints 3-16
  - 3.1.9—Wearing Surfaces, Protective Coatings, and Concrete Reinforcing Steel Protective Systems 3-17
- 3.2—Element Commentary 3-18
  - 3.2.1—General Commentary 3-18
  - 3.2.2—Decks and Slabs 3-18
  - 3.2.3—Railings 3-18
  - 3.2.4—Superstructure 3-19
  - 3.2.5—Bearings 3-19
  - 3.2.6—Substructure Elements 3-20

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3.2.7—Culverts 3-20
3.2.8—Joints 3-20
3.2.9—Wearing Surfaces, Protective Coatings, and Concrete Reinforcing Steel Protective Systems 3-20
3.2.10—Approach Slabs 3-20
3.3—Reinforced Concrete Elements 3-21
Defects for Reinforced Concrete 3-22
Defect 1080—Delamination/Spall/Patched Area 3-23
Defect 1090—Exposed Rebar 3-24
Defect 1120—Efflorescence/Rust Staining 3-25
Defect 1130—Cracking (RC and Other) 3-26
Crack Pattern Guide 3-28
Crack Width Guide 3-29
Defect 1190—Abrasion/Wear 3-30
3.4—Prestressed Concrete Elements 3-31
Defects for Prestressed Concrete Elements 3-32
Defect 1110—Cracking (PSC) 3-33
3.5—Steel Elements 3-34
Defects for Steel Elements 3-35
Defect 1000—Corrosion 3-36
Defect 1010—Cracking 3-37
Defect 1020—Connection 3-38
3.6—Timber Elements 3-39
Defects for Timber Elements 3-40
Defect 1140—Decay/Section Loss 3-41.1
Defect 1150—Check/Shake (Check) 3-41.2
Defect 1150—Check/Shake (Shake) 3-41.3
Defect 1160—Crack (Timber) 3-41.4
Defect 1170—Split/Delamination (Timber) 3-41.5
Defect 1180—Abrasion/Wear (Timber) 3-41.6
3.7—Masonry Elements 3-42
Defects for Masonry Elements 3-43
Defect 1610—Mortar Breakdown (Masonry) 3-44.3
Defect 1620—Split/Spall (Masonry) 3-44.4
Defect 1630—Patched Area (Masonry) 3-44.5
Defect 1640—Masonry Displacement 3-44.6
3.8—Other Material Elements 3-45
Defects for Other Material Elements 3-46
3.9—Bearings 3-48
Defects for Bearings 3-49
Defect 2220—Alignment 3-50
Defect 2230—Bulging, Splitting, or Tearing 3-50-1
Defect 2240—Loss of Bearing Area 3-51
3.10—Joints 3-52
Defects for Joints 3-53
Defect 2310—Leakage 3-53.1
Defect 2320—Seal Adhesion 3-53.2
Defect 2330—Seal Damage 3-54

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Defect 2340—Seal Cracking 3-54.1
Defect 2350—Debris Impaction 3-55
Defect 2360—Adjacent Deck or Header 3-55.1
Defect 2370—Metal Deterioration or Damage 3-55.2
3.11—Wearing Surfaces, Protective Coatings, and Concrete Reinforcing Steel Protective Systems 3-56
Defects for Wearing Surfaces 3-57
Defect 3210—Delamination/Spall/Patched Area (Wearing Surface) 3-57.1
Defect 3220—(Crack Wearing Surface) 3-57.2
Defect 3230—Effectiveness (earing Surface) 3-57.3
Defects for Steel Protective Coating 3-58
Defect 3410—Chalking (Steel Protective Coating) 3-59
Defect 3420—Peeling/Bubbling/Cracking (Steel Protective Coating) 3-60
Defect 3430—Oxide Film Degradation 3-61
Defect 3440—Effectiveness (Steel Protective Coating) 3-62
Defects for Concrete Protective Coating 3-63
Defect 3510—Wear (Concrete Protective Coating) 3-63.1
Defect 3540—Effectivenesss (Concrete Protective Coating) 3-63.2
Defects for Concrete Reinforcing Steel Protective System 3-64
3.12—Spatial Area Estimates Diagrams 3-65
3.13—Environmental Factors (Service Environments) 3-76

APPENDIX A: AGENCY-DEFINED ELEMENTS (ADES) A-1
A1—Agency-Defined Subsets of the National Bridge Elements A-1
A2—Agency-Defined Subsets of the Bridge Management Elements A-1
A3—Independent Agency-Defined Elements A-2
A3.1—Example Element Definition: Concrete Tunnel Ancillary Structure A-2
A3.1.1—Element 600—Concrete Tunnel (Example) A-3

APPENDIX B: INSPECTION EXAMPLES B-1
B1—Timber Bridge B-1
B1.1—Element Quantities B-1
B1.1.1—Deck B-1
B1.1.2—Superstructure B-1
B1.1.3—Substructure B-2
B1.2—Element Condition States B-2
B1.2.1—Defect #1, Timber Open Girder/Beam (Element 111) B-2
B1.2.2—Defect #2, Timber Pier Cap (Element 235) B-2
B1.2.3—Defect #3, Timber Pile (Element 228) B-3
B1.2.4—Defect #4, Metal Bridge Railing (Element 330) B-3
B1.3—Element Quantity and Condition State Summary B-4
B2—Prestressed Concrete Girder Bridge B-5
B2.1—Element Quantities B-5
B2.1.1—Deck B-5
B2.1.2—Superstructure B-5
B2.1.3—Substructure B-6
B2.2—Element Condition States B-6

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B2.2.1—Defect #1, Reinforced Concrete Deck (Element 12) B-6
B2.2.2—Defect #2, Reinforced Concrete Deck (Element 12) B-6
B2.2.3—Defect #3, Reinforced Concrete Deck (Element 12) B-7
B2.2.4—Defect #4, Compression Joint Seal (Element 302) and Reinforced Concrete Deck (Element 12) B-7
B2.2.5—Defect #5, Reinforced Concrete Pier Cap (Element 234) B-7
B2.2.6—Defect #6, Reinforced Concrete Pier Cap (Element 234) B-8
B2.2.7—Defect #7, Reinforced Concrete Column (Element 205) B-8
B2.3—Element Quantity and Condition State Summary B-10
B3—Steel Truss Bridge B-11
B3.1—Element Quantities B-11
B3.1.1—Deck B-11
B3.1.2—Superstructure B-12
B3.1.3—Substructure B-12
B3.2—Element Condition States B-12
B3.2.1—Defect #1, Reinforced Concrete Deck (Element 12) B-13
B3.2.2—Defect #2, Steel Truss (Element 120) B-13
B3.2.3—Defect #3, Steel Truss (Element 120), Steel Gusset Plate (Element 162), and Steel Protective Coating (Element 515) B-13
B3.2.4—Defect #4, Steel Floor Beam (Element 152) and Steel Protective Coating (Element 515) B-14
B3.2.5—Defect #5, Steel Stringer (Element 113) B-14
B3.2.6—Defect #6, Steel Stringer (Element 113) B-15
B3.2.7—Defect #7, Pier Wall (Element 210) B-15
B3.3—Element Quantity and Condition State Summary B-16

APPENDIX C: ELEMENT GROUPINGS C-1

APPENDIX D: MATERIALS AND FEASIBLE ACTIONS BY MATERIAL TYPE D-1
D1—Steel (100) D-1
D2—Prestressed Concrete (300) D-1
D3—Reinforced Concrete (400) D-1
D4—Timber (500) D-1
D5—Other Materials (600) D-2
D6—Masonry (650) D-2
D7—Wearing Surfaces (800) D-2
D8—Concrete Reinforcing Steel Protective Systems (820) D-2
D9—Steel Protective Coatings (850) D-2
D10—Concrete Protective Coatings (880) D-2

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INTRODUCTION

The proper assessment of the condition of bridge elements is the cornerstone of sound bridge management. The introduction of element inspection condition methods in the early 1990s represented a significant advancement in bridge inspection practice and has been adopted by the vast majority of the state transportation departments in the United States. Bridge Owners nationwide have recognized the benefits of detailed condition assessments through the use of the raw inspection information, expanded performance measures, and bridge management system deterioration forecasting and evaluation. As the use of element-level inspection techniques has proliferated, the need for updates and enhancements to the standard element specification has been identified. This Manual incorporates improvements to the AASHTO Commonly Recognized (CoRe) Structural Elements through changes in the measurement units of decks and slabs, the development of a wearing surface element, the standardization of the number of element states, and the development of protective coating elements for concrete and steel, as well as deck protection systems. Elements constructed of innovative materials are also identified. The goal of this Manual is to completely capture the condition of bridges in a simple, effective way that can be standardized across the nation while providing the flexibility to be adapted to both large- and small-agency settings.

This manual is not intended to supplant proper bridge and element inspection training or the exercise of engineering judgment by the Inspector or Professional Engineer.

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SECTION 1: BACKGROUND

1.1—CONDITION ASSESSMENT PHILOSOPHY: MULTIPATH AND DEFECT CONCEPTS

The *Manual for Bridge Element Inspection* (this Manual) builds on the element-level condition assessment methods developed in the *AASHTO Guide for Commonly Recognized Structural Elements*. Improvements have been made to fully capture the condition of the elements by reconfiguring the element language to utilize multiple distress paths within the defined condition states. The multipath distress language provides the means to fully incorporate all possible defects within the overall condition assessment of the element. The overall condition of an element can be utilized in this aggregate form, or broken down into specific defects present as desired by the agency for Bridge Management System (BMS) use.

This manual provides a comprehensive set of bridge elements that is designed to be flexible in nature to satisfy the needs of all agencies. The complete set of elements captures the components necessary for an agency to manage all aspects of the bridge inventory utilizing the full capability of a BMS.

The element set presented within includes two element types identified as National Bridge Elements (NBEs) or Bridge Management Elements (BMEs). The combination of these two element types comprise the full AASHTO element set. All of the elements, whether they are NBEs or BMEs, have the same general condition assessment characteristics:

1. The standard number of condition states (CS) is four.
2. The standard condition states are Good (Condition State 1), Fair (Condition State 2), Poor (Condition State 3), and Severe (Condition State 4) general descriptions.
3. Units of measure are length in feet, area in square feet, and each for enumerated elements.

1.2—NATIONAL BRIDGE ELEMENTS

The National Bridge Elements (NBEs) represent the primary structural components of bridges necessary to determine the overall condition and safety of the primary load carrying members. The NBEs are a refinement of the deck, superstructure, substructure, and culvert condition ratings defined in the Federal Highway Administration's *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*. Additional elements included in this category are bridge rail and bearings. The NBEs are designed to remain consistent from agency to agency across the country in order to facilitate and standardize the capture of bridge element conditions at the national level. In order to capture the diversity of new element design types and materials, many elements in this category have an "other" element type defined.

1.3—BRIDGE MANAGEMENT ELEMENTS

Bridge Management Elements (BMEs) include components of bridges such as joints, wearing surfaces, and protective coating systems and deck/slab protection systems that are typically managed by agencies utilizing Bridge Management Systems (BMSs). The BMEs are defined with a recommended set of condition assessment language that can be modified to suit the agencies' needs as these elements are not intended to be utilized for the purposes of national policy-making. The BMEs defined in this Manual were purposefully left fairly general in nature to provide the flexibility to develop agency-specific elements that best suit the local bridge management practices. Agencies may choose to develop additional BMEs as necessary following the agency-developed element conventions discussed in Appendix A. When considering additional elements, the agency should consider such factors as element performance, deterioration rates, feasible actions, and preservation costs, as well as the practical considerations of training and inspection costs.

1.4—AGENCY-DEVELOPED ELEMENTS

The Agency-Developed Elements (ADEs) presented in this Manual provide the flexibility for an agency to define custom elements in accordance with the defined element framework that may be sub-elements of NBEs or BMEs, or may be ADEs without ties to the other elements defined in this Manual.

By defining a comprehensive set of bridge elements necessary for robust bridge management and the minimum set of elements necessary to assess the condition of primary components of bridges, this Manual provides a flexible element set that can be tailored to the needs of all agencies. The identification numbers 800 and above are not used in this Manual for any elements and are reserved for Agency purposes.

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1.5—HOW TO USE THIS MANUAL

Bridge inspection based on this Manual consists of defining the elements (i.e., pieces of the bridge) and total quantities that exist at each bridge. The condition of each element is determined by performing a field inspection and recording quantities of the element that have identified defects that correlate to the severity of the defects defined in the particular condition state definition of this Manual. The condition assessment is complete when the appropriate portion of the total quantity is stratified over the defined condition states. For agencies utilizing BMSs, the appropriate element defects and environment shall be recorded for use in deterioration modeling.

In this Manual, the element represents the aggregate condition of the defined element inclusive of all defects. The specific listing of all defects is optional; however, the element condition must be inclusive of all defined defects. Element defects are typically to be used when the element reaches Condition State 2 or lower and they essentially act to break down the overall element condition into one or more specific observed problems. The defects defined within this Manual shall always assume the units of the element with which they are associated. For example, the scour defect may be applied to a column or a pier wall. The defect language is the same for both elements; however, the units for the column defect would be each and the units for the pier wall would be linear feet. In some cases, multiple defects may operate in the same defined space. In this case, the Inspector may report the defect in the most severe Condition State or report all defects, as determined by agency policy. If all defects are reported, the total in each Condition State reported for the parent element will not include overlapping defects. This means that in the case of overlapping defects, the quantity in the Condition State for the parent element will be less than the sum of the defects.

This manual attempts to cover the vast majority of all bridge elements found on highway bridges in the United States. During the course of an inspection, the Inspector may find materials or elements that are not defined. In these cases, the Inspector should use judgment to select the closest element match or use the “other” element type. In a similar vein, the Inspector should use judgment when utilizing the condition state defect definitions. There may be cases when the specific condition observed in the field is not defined in this Manual. In these cases, the Inspector should use the general description of the condition states to determine the appropriate condition.

The granularity of the defect details is typically not specified with defect descriptive language for Condition State 4, as this state is reserved for severe conditions that are beyond the specific defects defined for Condition States 1 through 3. Elements with a portion or all of the quantity in Condition State 4 may often have load capacity implications warranting a structural review. Within this Manual, the term “structural review” is defined as a review by a person qualified to evaluate the field-observed conditions and make a determination of the impacts of the conditions on the performance of the element. Structural reviews may include a review of the field inspection notes and photographs, review of as-built plans, or analysis as deemed appropriate to evaluate the performance of the element. Agencies may establish additional guidance to aid the Inspector in determining the field circumstances where structural review is warranted, taking into consideration the education, training, and experience of their inspection staff.

1.6—ORGANIZATION

Section 2 of this Manual presents a master location matrix of all the elements and identification numbers for quick reference. Each element is displayed within the NBE or BME category, then by major bridge assembly, element type, and material.

Section 3 presents a detailed definition of each element with its applicable defects. Guidelines for measurement and condition assessment are included, where appropriate.

The Appendices provide additional guidance and background on the use of this Manual. There are four appendices to aid an agency in the development of their data collection process.

These Appendices are as follows:

Appendix A—Agency-Defined Elements (ADEs)

Appendix B—Inspection Examples

Appendix C—Element Groupings

Appendix D—List of Feasible Actions by Material Type

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