Manual for Bridge Element Inspection 2

Second Edition, 2019

American Association of State Highway and Transportation Officials

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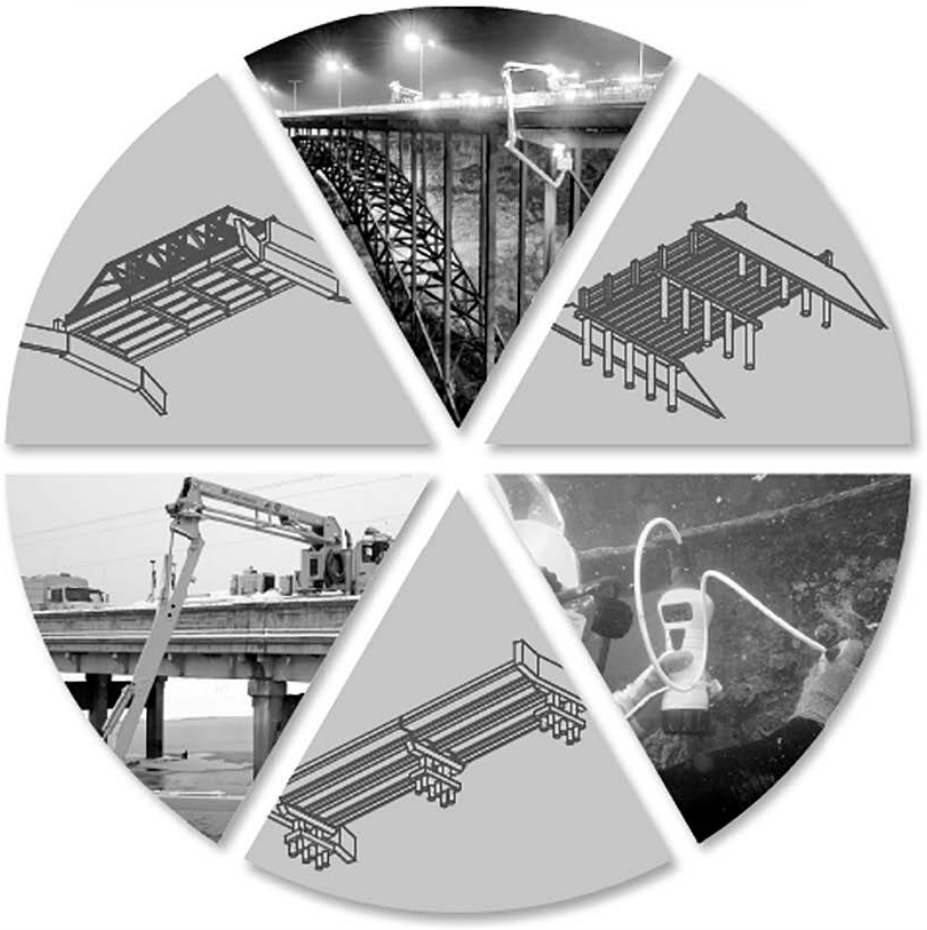

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AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
AASHTO

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Cover Photos: Clockwise from top: 1) Perrine Bridge, Twin Falls, ID. Courtesy of Dave Tuttle, Idaho Department of Transportation. **2)** Drawing courtesy of Montana Department of Transportation. **3)** Blue Creek Bay Bridge on I-90 in Northern Idaho. Courtesy of Collins Engineers, Inc. **4)** Drawing courtesy of Montana Department of Transportation. **5)** Old South Cascade Bridge, Cascade, ID. Courtesy of Idaho Department of Transportation. **6)** Drawing courtesy of Montana Department of Transportation.

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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
Derek Soden	FHWA	Technical Team Member
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.

- 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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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.

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

SECTION 2: ELEMENT LOCATION MATRIX

This Section is designed to give Inspectors a quick reference guide to the defined elements. The matrix of elements is grouped into National Bridge Elements (NBEs) and Bridge Management Elements (BMEs), then by general element type, material, and in accordance to their physical location on the bridge to facilitate ease of use by bridge Inspectors in the field.

2.1—NATIONAL BRIDGE ELEMENTS

2.1.1—Decks and Slabs

Element	Units	Decks	Slab	Other
Reinforced Concrete Deck/Slab	area, ft^2	12	38	
Prestressed Concrete Deck	area, ft^2	13		
Prestressed Concrete Top Flange	area, ft^2	15		
Reinforced Concrete Top Flange	area, ft^2	16		
Steel Deck—Open Grid	area, ft^2	28		
Steel Deck—Concrete Filled Grid	area, ft^2	29		
Steel Deck—Corrugated/ Orthotropic/Etc.	area, ft^2	30		
Timber Deck/Slab	area, ft^2	31	54	
Other Material Deck/Slab	area, ft^2	60	65	

2.1.2—Railings

Element	Units	Steel	Prestressed Concrete	Reinforced Concrete	Timber	Masonry	Other
Metal Bridge Railing	length, ft	330					
Reinforced Concrete Bridge Railing	length, ft			331			
Timber Bridge Railing	length, ft				332		
Other Bridge Railing	length, ft						333
Masonry Bridge Railing	length, ft					334	

2.1.3—Superstructure

Element	Units	Steel	Prestressed Concrete	Reinforced Concrete	Timber	Masonry	Other
Girder/Beam	length, ft	107	109	110	111		112
Closed Web/Box Girder	length, ft	102	104	105			106
Stringer	length, ft	113	115	116	117		118
Truss	length, ft	120			135		136
Arch	length, ft	141	143	144	146	145	142
Floor Beam	length, ft	152	154	155	156		157
Cable—Primary	length, ft	147					
Cable—Secondary	each	148					149
Gusset Plate	each	162					
Pin, Pin and Hanger Assembly, or Both	each	161					

2.1.4—Bearings

Element	Units	Element Number
Elastomeric	each	310
Movable (roller, sliding, etc.)	each	311
Enclosed/Concealed	each	312
Fixed	each	313
Pot	each	314
Disk	each	315
Other	each	316

2.1.5—Substructure

Element	Units	Steel	Prestressed Concrete	Reinforced Concrete	Timber	Masonry	Other
Columns	each	202	204	205	206		203
Column Tower (Trestle)	length, ft	207			208		
Pier Wall	length, ft			210	212	213	211
Abutment	length, ft	219		215	216	217	218
Pile	each	225	226	227	228		229
Pier Cap	length, ft	231	233	234	235		236
Pile Cap/Footing	length, ft			220			

2.1.6—Culverts

Element	Units	Steel	Prestressed Concrete	Reinforced Concrete	Timber	Masonry	Other
Culvert	length, ft	240	245	241	242	244	243

2.2—BRIDGE MANAGEMENT ELEMENTS

2.2.1—Joints

Element	Units	Element Number
Strip Seal Expansion Joint	length, ft	300
Pourable Joint Seal	length, ft	301
Compression Joint Seal	length, ft	302
Assembly Joint/Seal (Modular)	length, ft	303
Open Expansion Joint	length, ft	304
Assembly Joint without Seal	length, ft	305
Other Joint	length, ft	306

2.2.2—Approach Slabs

Element	Units	Element Number
Prestressed Concrete Approach Slab	area, ft^2	320
Reinforced Concrete Approach Slab	area, ft^2	321

2.2.3—Wearing Surfaces, Protective Coatings, and Concrete Reinforcing Steel Protective System

Element	Units	Element Number
Wearing Surfaces	area, ft^2	510
Steel Protective Coating	area, ft^2	515
Concrete Reinforcing Steel Protective System	area, ft^2	520
Concrete Protective Coating	area, ft^2	521

SECTION 3: DETAILED ELEMENT DESCRIPTIONS

Section 3 provides detailed element and defect descriptions. Article 3.1 provides a comprehensive listing of all elements. This listing is organized according to the material from which the element is formed. The element name, number, classification (NBE or BME), and units of measure are shown. Guidance on the appropriate quantity calculation for each element is provided. Notes applying to specific elements are included in the element listing.

Article 3.2 provides element commentary that includes supplemental information for identifying elements and additional considerations for the Inspector to be aware of during data collection. The element commentary is organized according to bridge components and sub-components, i.e., decks and slabs, railings, superstructure, etc.

Articles 3.3 thru 3.11 includes defect listings and guidance on how to determine the condition state (CS) for each defect. This section is organized according to the material from which an element is formed, listing appropriate defects for each material. Text descriptions defining each CS are provided. A visual guide is included for certain defects that provides a standard for determining the appropriate CS.

Article 3.12 provides visual guides for estimating area and length. These guides are intended to assist an Inspector in determining the quantity of damage in the field.

The elements described in this Section are included in the standard set of National Bridge Elements (NBEs) except where noted for Bridge Management Elements (BMEs), such as joints and approach slabs.

3.1—ELEMENT LISTING BY MATERIAL

3.1.1—Reinforced Concrete

DECKS AND SLABS						
12	**Reinforced Concrete Deck**		Classification	**NBE**	Unit of Measure	**ft²**
	Description:	All reinforced concrete bridge decks regardless of the wearing surface or protection systems used.				
	Quantity Calculation:	Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.				
38	**Reinforced Concrete Slab**		Classification	**NBE**	Unit of Measure	**ft²**
	Description:	All reinforced concrete bridge slabs regardless of the wearing surface or protection systems used.				
	Quantity Calculation:	Area of the slab from edge to edge, including any median areas and accounting for any flares or ramps present.				
16	**Reinforced Concrete Top Flange**		Classification:	**NBE**	Unit of Measure:	**ft²**
	Description:	All reinforced concrete bridge girder top flanges where traffic rides directly on the structural element regardless of the wearing surface or protection systems used. These bridge types include tee-beams, box girders, and girders that require traffic to ride on the top flange.				
	Quantity Calculation:	Area of the top flange from edge to edge, including any median areas and accounting for any flares or ramps present. This quantity is for the top flange riding surface only. Girder web and bottom flange are to be evaluated by the appropriate girder element.				
RAILINGS						
331	**Reinforced Concrete Bridge Railing**		Classification:	**NBE**	Unit of Measure	**ft**
	Description	All types and shapes of reinforced concrete bridge railing. All elements of the railing must be concrete.				
	Quantity Calculation	Number of rows of bridge rail times the length of the bridge. The element quantity includes only the rail on the bridge.				
SUPERSTRUCTURE						
105	**Reinforced Concrete Closed Web/Box Girder**		Classification:	**NBE**	Unit of Measure:	**ft**
	Description:	All reinforced concrete box girders or closed web girders. For all box girders regardless of protective system.				
	Quantity Calculation:	Sum of all the length of each box girder section. This quantity can be determined by counting the visible web faces, dividing by two, and then multiplying by the appropriate length of the box section. Elements such as adjacent box girders are considered individual girders.				
110	**Reinforced Concrete Open Girder/Beam**		Classification:	**NBE**	Unit of Measure:	**ft**
	Description:	Mild steel reinforced concrete open web girders regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each girder.				
116	**Reinforced Concrete Stringer**		Classification:	**NBE**	Unit of Measure:	**ft**
	Description:	Mild steel reinforced concrete members that support the deck in a stringer floor beam system regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each stringer.				

144	**Reinforced Concrete Arch**		Classification:	**NBE**	Unit of Measure:	**ft**
	Description:	Only mild steel reinforced concrete arches regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each arch panel measured longitudinally along the travel way				
155	**Reinforced Concrete Floor Beam**		Classification:	**NBE**	Unit of Measure:	**ft**
	Description:	Mild steel reinforced concrete floor beams that typically support stringers regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each floor beam.				
	SUBSTRUCTURE					
205	**Reinforced Concrete Column**		Classification:	**NBE**	Unit of Measure:	**ea**
	Description:	All reinforced concrete columns regardless of protective system.				
	Quantity Calculation:	Sum of the number of columns.				
210	**Reinforced Concrete Pier Wall**		Classification:	**NBE**	Unit of Measure:	**ft**
	Description:	Reinforced concrete pier walls regardless of protective systems.				
	Quantity Calculation:	Sum of the lengths of the pier walls measured along the skew angle.				
215	**Reinforced Concrete Abutment**		Classification:	**NBE**	Unit of Measure:	**ft**
	Description:	Reinforced concrete abutments, including the material retaining the embankment and monolithic wingwalls and abutment extensions. For all reinforced concrete abutments regardless of protective systems.				
	Quantity Calculation:	Sum of the width of the abutment with monolithic wingwalls and abutment extensions measured along the skew angle.				
220	**Reinforced Concrete Pile Cap/Footing**		Classification:	**NBE**	Unit of Measure:	**ft**
	Description:	Reinforced concrete pile caps/footings that are visible for inspection, including pile caps/footings exposed from erosion or scour or visible during an underwater inspection. The exposure may be intentional or caused by erosion or scour.				
	Quantity Calculation:	**S**um of the length of footings or pile caps along the skew angle.				
227	**Reinforced Concrete Pile**		Classification:	**NBE**	Unit of Measure:	**ea**
	Description:	Reinforced concrete piles that are visible for inspection, including piles exposed from erosion or scour and piles visible during an underwater inspection. For all reinforced concrete piles regardless of protective system				
	Quantity Calculation:	Sum of the number of piles visible for inspection.				
234	**Reinforced Concrete Pier Cap**		Classification:	**NBE**	Unit of Measure:	**ft**
	Description:	Those reinforced concrete pier caps that support girders and transfer load into piles or columns. For all pier caps regardless of protective system.				
	Quantity Calculation:	Sum of the cap length measured along the skew angle.				

CULVERTS						
241	**Reinforced Concrete Culvert**		Classification:	**NBE**	Unit of Measure:	**ft**
	Description:	Reinforced concrete culverts, including box, arched, round, or elliptical shapes.				
	Quantity Calculation:	Flow line length of the barrel times the number of the barrels.				
APPROACH SLAB						
321	**Reinforced Concrete Approach Slab**		Classification:	**BME**	Unit of Measure:	**ft**
	Description:	Those structural sections between the abutment and the approach pavement that are constructed of mild steel reinforced concrete.				
	Quantity Calculation:	Area of the approach slab(s) from edge to edge including any median areas and accounting for any flares or ramps present.				

3.1.2—Prestressed Concrete

DECKS AND SLABS						
13	**Prestressed Concrete Deck**		Classification:	**NBE**	Unit of measure:	**ft²**
	Description:	All prestressed concrete bridge decks regardless of the wearing surface or protection systems used.				
	Quantity Calculation:	Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.				
15	**Prestressed Concrete Top Flange**		Classification:	**NBE**	Unit of measure:	**ft²**
	Description:	All prestressed bridge girder top flanges where traffic rides directly on the structural element regardless of the wearing surface or protection systems used. These bridge types include bulb-tees, box girders, and girders that require traffic to ride on the top flange.				
	Quantity Calculation:	Area of the top flange from edge to edge including any median areas and accounting for any flares or ramps present. This quantity is for the top flange riding surface only. Girder web and bottom flange are to be evaluated by the appropriate girder element.				
SUPERSTRUCTURE						
104	**Prestressed Concrete Closed Web/Box Girder**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	All pretensioned or post-tensioned concrete closed web girders or box girders For all box girders regardless of protective system.				
	Quantity Calculation:	Sum of all the length of each box girder section. This quantity can be determined by counting the visible web faces, dividing by two, and then multiplying by the appropriate length of the box section. Elements such as adjacent box girders are considered individual girders.				
109	**Prestressed Concrete Open Girder/Beam**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Pretensioned or post-tensioned concrete open web girders regardless of protective system.				
	Quantity Calculation:	Sum of all the lengths of each girder.				
	Notes:	Where traffic rides directly on the structural element, regardless of the wearing surface, evaluation of the top flange above the fillet is considered with Element 15.				
115	**Prestressed Concrete Stringer**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Pretensioned or post-tensioned concrete members that support the deck in a stringer floor beam system regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each stringer.				
143	**Prestressed Concrete Arch**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Only pretensioned or post-tensioned concrete arches regardless of protective system.				
	Quantity Calculation:	Sum of the length of each arch panel measured longitudinally along the travel way.				
154	**Prestressed Concrete Floor Beam**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Prestressed concrete floor beams that typically support stringers regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each floor beam.				

SUPERSTRUCTURE						
204	**Prestressed Concrete Column**		Classification:	**NBE**	Unit of measure:	**ea**
	Description:	All prestressed concrete columns regardless of protective system.				
	Calculation:					
226	**Prestressed Concrete Pile**		Classification:	**NBE**	Unit of measure:	**ea**
	Description:	Prestressed concrete piles that are visible for inspection, including piles exposed from erosion or scour and piles visible during an underwater inspection. For all prestressed concrete piles regardless of protective system.				
	Quantity Calculation:	Sum of the number of piles visible for inspection.				
233	**Prestressed Concrete Pier Cap**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Those prestressed concrete pier caps that support girders and transfer load into piles or columns. For all caps regardless of protective system.				
	Quantity Calculation:	Sum of the cap lengths measured along the skew angle.				
SUPERSTRUCTURE						
245	**Prestressed Concrete Culvert**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	All prestressed concrete culverts.				
	Quantity Calculation:	Flow line length of the barrel times the number of barrels.				
320	**Prestressed Concrete Approach Slab**		Classification:	**NBE**	Unit of measure:	**ft²**
	Description:	Those structural sections between the abutment and the approach pavement that are constructed of prestressed (post-tensioned) reinforced concrete.				
	Quantity Calculation:	Area of the approach slab(s) from edge to edge including any median areas and accounting for any flares or ramps present.				

3.1.3—Steel

DECKS AND SLABS						
28	**Steel Deck with Open Grid**		Classification:	**NBE**	Unit of measure:	**ft²**
	Description:	All open grid steel bridge decks with no fill.				
	Quantity Calculation:	Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.				
	Note:	When the steel grid deck has concrete fill in the wheel tracks only, use Element 29 for the concrete filled portion and Element 28 for the unfilled portion of the deck.				
29	**Steel Deck with Concrete Filled Grid**		Classification:	**NBE**	Unit of measure:	**ft²**
	Description:	Steel bridge decks with concrete fill either in all of the openings or within the wheel tracks.				
	Quantity Calculation:	Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.				
	Note:	When the steel grid deck has concrete fill in the wheel tracks only, use Element 29 for the concrete filled portion and Element 28 for the unfilled portion of the deck.				
30	**Steel Deck Corrugated/Orthotropic/Etc.**		Classification:	**NBE**	Unit of measure:	**ft²**
	Description:	Those bridge decks constructed of corrugated metal filled with portland cement, asphaltic concrete, or other riding surfaces. Orthotropic steel decks are also included.				
	Quantity Calculation:	Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.				
RAILINGS						
330	**Metal Bridge Railing**		Classification:	**NBE**	Unit of measure:	**ft**
	Description	All types and shapes of metal bridge railing. Steel, aluminum, metal beam, rolled shapes, etc. will all be considered part of this element. Included in this element are posts of metal, timber, or concrete; blocking; and curb.				
	Quantity Calculation	Number of rows of bridge rail times the length of the bridge. The element quantity includes only the rail on the bridge.				
SUPERSTRUCTURE						
102	**Steel Closed Web/Box Girder**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	All steel box girders or closed web girders. For all box girders regardless of protective system.				
	Quantity Calculation:	Sum of all the lengths of each box girder section; can be determined by counting the visible web faces, dividing by two, and then multiplying by the appropriate length.				
107	**Steel Open Girder/Beam**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	All steel open girders regardless of protective system.				
	Quantity Calculation:	Sum of all the lengths of each girder.				
113	**Steel Stringer**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Steel members that support the deck in a stringer floor beam system regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each stringer.				

120	**Steel Truss**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	All steel truss elements, including all tension and compression members for through and deck trusses. For all trusses regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each truss panel measured longitudinally along the travel way.				
141	**Steel Arch**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Steel arches regardless of type or protective system.				
	Quantity Calculation:	Sum of all of the lengths of each arch panel measured longitudinally along the travel way.				
152	**Steel Floor Beam**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Steel floor beams that typically support stringers regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each floor beam.				
147	**Steel Main Cables**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	All steel main suspension or cable stay cables not embedded in concrete. For all cable groups regardless of protective systems.				
	Quantity Calculation:	Sum of all of the lengths of each main cable measured longitudinally along the travel way.				
	Note:	This element is intended for use on main cables in suspension bridges or main cable stays in cable stayed bridges. Suspender cables or other smaller cables shall be captured using Element 148.				
148	**Secondary Steel Cables**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	All steel suspender cables not embedded in concrete. For all individual or cable groups regardless of protective systems.				
	Quantity Calculation:	Sum of the individual cable or cable groups carrying the load from the superstructure to the main cable/arch elements.				
	Note:	This element is intended for use on suspender cables, other smaller cables, or groups of cables in one location acting as a system to carry loads from the superstructure to the main cable/arch. Suspension bridge main cables or cable stays shall be captured using Element 147.				
161	**Steel Pin and Pin & Hanger Assembly or both**		Classification:	**NBE**	Unit of measure:	**ea**
	Description:	Steel pins and pin and hanger assemblies regardless of protective system.				
	Quantity Calculation:	Sum of the number of pins, pin and hanger assemblies, or both.				
	Note:	Distress observed on either hanger assembly plate should be considered in the condition assessment.				
162	**Steel Gusset Plate**		Classification:	**NBE**	Unit of measure:	**ea**
	Description:	Only those steel gusset plate(s) connections that are on the main truss/arch panel(s). These connections can be constructed with one or more plates that may be bolted, riveted, or welded. For all gusset plates regardless of protective systems.				
	Quantity Calculation:	Sum of the number of primary load path gusset plate assemblies. For multiple-plate gusset connections at a single panel point, the quantity shall be one gusset plate regardless of the number of individual plates at the single connection point.				

SUBSTRUCTURE						
202	**Steel Column**		Classification:	**NBE**	Unit of measure:	**ea**
	Description:	All steel columns regardless of protective system.				
	Quantity Calculation:	Sum of the number of columns.				
207	**Steel Tower**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Steel built-up or framed tower supports regardless of protective system.				
	Quantity Calculation:	Sum of the heights of built-up or framed tower supports.				
	Notes:	This element is intended to be used for truss-framed tower supports or built-up steel towers. It is intended to capture large supports and towers associated with suspension bridges, cable stayed bridges, movable bridges, or similar structural configurations.				
219	**Steel Abutment**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Steel abutments, including the sheet material retaining the embankment, and monolithic wingwalls and abutment extensions. For all abutments regardless of protective systems.				
	Quantity Calculation:	Sum of the width of the abutment with monolithic wingwalls and abutment extensions measured along the skew angle.				
225	**Steel Pile**		Classification:	**NBE**	Unit of measure:	**ea**
	Description:	Steel piles that are visible for inspection, including piles exposed from erosion or scour and piles visible during an underwater inspection. For all steel piles regardless of protective system.				
	Quantity Calculation:	Sum of the number of piles visible for inspection.				
231	**Steel Pier Cap**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Those steel pier caps that support girders and transfer load into piles or columns. For all steel pier caps regardless of protective system.				
	Quantity Calculation:	Sum of the cap lengths measured along the skew angle.				
CULVERTS						
240	**Steel Culvert**		Classification:	**NBE**	Unit of measure:	**ft**
	Description:	Steel culverts, including arched, round, or elliptical pipes.				
	Quantity Calculation:	Flow line length of the barrel times the number of barrels.				

3.1.4—Timber

DECKS AND SLABS						
31	**Timber Deck**		Classification	**NBE**	Unit of measure:	**ft²**
	Description:	All timber bridge decks, regardless of the wearing surface or protection systems used.				
	Quantity Calculation:	Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.				
54	**Timber Slab**		Classification	**NBE**	Unit of measure:	**ft²**
	Description:	All timber bridge slabs, regardless of the wearing surface or protection systems used.				
	Quantity Calculation:	Area of the slab from edge to edge, including any median areas and accounting for any flares or ramps present.				
RAILINGS						
332	**Timber Bridge Railing**		Classification	**NBE**	Unit of measure:	**ft**
	Description	All types and shapes of timber bridge railing. Included in this element are posts of timber, metal, or concrete; blocking; and curb.				
	Quantity Calculation	Number of rows of bridge rail times the length of the bridge; includes only the rail on the bridge.				
SUPERSTRUCTURE						
111	**Timber Open Girder/Beam**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	All timber open girders, regardless of protection system.				
	Quantity Calculation:	Sum of all the lengths of each girder/beam.				
117	**Timber Stringer**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Timber members that support the deck in a stringer floor beam system, regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each stringer.				
135	**Timber Truss**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	All timber truss elements, including all tension and compression members for through and deck trusses. For all trusses, regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each truss panel measured longitudinally along the travel way.				
146	**Timber Arch**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Only timber arches, regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each arch panel measured longitudinally along the travel way.				
156	**Timber Floor Beam**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Timber floor beams that typically support stringers, regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each floor beam.				

SUBSTRUCTURE						
206	**Timber Column**		Classification	**NBE**	Unit of measure:	**ea**
	Description:	All timber columns, regardless of protective system.				
	Quantity Calculation:	Number of columns.				
208	**Timber Trestle**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Framed timber supports. For all timber trestle/towers, regardless of protective system.				
	Quantity Calculation:	Sum of the heights of built-up or framed tower supports.				
	Notes	This element is intended to be used for truss framed trestle or towers. It is intended to capture large supports and towers associated with large deck truss bridges.				
212	**Timber Pier Wall**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Those timber pier walls that include pile, timber sheet material, and filler. For all pier walls regardless of protective systems.				
	Quantity Calculation:	Sum of the length of the pier walls measured along the skew angle.				
216	**Timber Abutment**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Timber abutments, including the sheet material retaining the embankment, integral wingwalls, and abutment extensions. For all abutments, regardless of protective systems.				
	Quantity Calculation:	Sum of the width of the abutment with integral wingwalls and abutment extensions measured along the skew angle.				
228	**Timber Pile**		Classification	**NBE**	Unit of measure:	**ea**
	Description:	Timber piles that are visible for inspection, including piles exposed from erosion or scour and piles visible during an underwater inspection. For all timber piles, regardless of protective system				
	Quantity Calculation:	Sum of the number of piles visible for inspection.				
235	**Timber Pier Cap**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Those timber pier caps that support girders that transfer load into piles, or columns. For all timber pier caps, regardless of protective system.				
	Quantity Calculation:	Sum of the pier cap lengths measured along the skew angle.				
CULVERTS						
242	**Timber Culvert**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	All timber culverts.				
	Quantity Calculation:	Flow line length of the barrel times the number of barrels.				

3.1.5—Masonry

RAILINGS						
334	**Masonry Bridge Railing**		Classification	**NBE**	Unit of measure:	**ft**
	Description	All types and shapes of masonry block or stone bridge railing. All elements of the railing must be masonry block or stone.				
	Quantity Calculation	Number of rows of bridge rail times the length of the bridge; includes only the rail on the bridge.				
SUPERSTRUCTURE						
145	**Masonry Arch**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Masonry or stacked stone arches, regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each arch section measured longitudinally along the travel way.				
SUBSTRUCTURE						
213	**Masonry Pier Wall**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Those pier walls constructed of block or stone. The block or stone may be placed with or without mortar. For all pier walls, regardless of protective systems.				
	Quantity Calculation:	Sum of the wall lengths measured along the skew angle.				
217	**Masonry Abutment**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Those abutments constructed of block or stone, including integral wingwalls and abutment extensions. The block or stone may be placed with or without mortar. For all abutments, regardless of protective systems.				
	Quantity Calculation:	Sum of the width of the abutment with integral wingwalls and abutment extensions measured along the skew angle.				
CULVERTS						
244	**Masonry Culvert**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Masonry block or stone culverts.				
	Quantity Calculation:	Flow line length of the barrel times the number of barrels.				

3.1.6—Other Materials

DECKS AND SLABS						
60	**Other Deck**		Classification	**NBE**	Unit of measure:	**ft²**
	Description:	All bridge decks constructed of materials not covered by other elements, regardless of the wearing surface or protection systems used.				
	Quantity Calculation:	Area of the deck from edge to edge, including any median areas and accounting for any flares or ramps present.				
65	**Other Slab**		Classification	**NBE**	Unit of measure:	**ft²**
	Description:	All slabs constructed of materials not covered by other elements, regardless of the wearing surface or protection systems used.				
	Quantity Calculation:	Area of the slab from edge to edge, including any median areas and accounting for any flares or ramps present.				
RAILINGS						
333	**Other Bridge Railing**		Classification	**NBE**	Unit of measure:	**ft**
	Description	All types and shapes of bridge railing, except those defined as metal, concrete, timber, or masonry.				
	Quantity Calculation	Number of rows of bridge rail times the length of the bridge; includes only the rail on the bridge.				
SUPERSTRUCTURE						
106	**Other Closed Web/Box Girder**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	All box girders or closed web girders constructed of materials not covered by other elements. For all other material box girders, regardless of protective system.				
	Quantity Calculation:	Sum of all the length of each box girder section. This quantity can be determined by counting the visible web faces, dividing by two, and then multiplying by the appropriate length of the box section. Elements such as adjacent box girders are considered individual girders.				
112	**Other Open Girder/Beam**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	All girders constructed of materials not covered by other elements, regardless of protection system.				
	Quantity Calculation:	Sum of all the lengths of each girder.				
118	**Other Stringer**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	All stringers constructed of materials not covered by other elements, regardless of protection system.				
	Quantity Calculation:	Sum of all the lengths of each stringer.				
136	**Other Truss**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	All truss elements constructed of materials not covered by other elements, including all tension and compression members, and through and deck trusses. For all other material trusses, regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each truss panel measured longitudinally along the travel way.				

142	**Other Arch**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Arches constructed of materials not covered by other elements, regardless of type or protective system				
	Quantity Calculation:	Sum of all of the lengths of each arch panel measured longitudinally along the travel way.				
157	**Other Floor Beam**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Floor beams constructed of materials not covered by other elements, that typically support stringers, regardless of protective system.				
	Quantity Calculation:	Sum of all of the lengths of each floor beam.				
149	**Other Secondary Cable**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	All cables constructed of materials not covered by other elements and not embedded in concrete. For all individual other material cables or cable groups, regardless of protective systems.				
	Quantity Calculation:	Sum of the individual cable or cable groups carrying the load from the superstructure to the main cable/arch elements.				
	Note:	This element is intended for use on suspender cables, other smaller cables, or groups of cables in one location acting as a system to carry loads from the superstructure to the main cable/arch. Suspension bridge main cables or cable stays shall be captured using Element 147.				
SUBSTRUCTURE						
203	**Other Column**		Classification	**NBE**	Unit of measure:	**ea**
	Description:	All columns constructed of materials not covered by other elements, regardless of protective system.				
	Quantity Calculation:	Sum of the number of columns.				
	Notes:	This element is intended for columns constructed of composite materials, or other materials that cannot be classified using any other elements.				
211	**Other Pier Wall**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Those pier walls constructed of materials not covered by other elements, regardless of protective systems.				
	Quantity Calculation:	Sum of the lengths of the pier walls measured along the skew angle.				
218	**Other Abutments**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Abutment systems, including the sheet material retaining the embankment, and integral wingwalls and abutment extensions, constructed of materials not covered by other elements. For all abutments, regardless of protective systems.				
	Quantity Calculation:	Sum of the width of the abutment with integral wingwalls and abutment extensions measured along the skew angle.				
229	**Other Pile**		Classification	**NBE**	Unit of measure:	**ea**
	Description:	Piles that are visible for inspection, including piles exposed from erosion or scour and piles visible during an underwater inspection, constructed of materials not covered by other elements. For all other material piles, regardless of protective system.				
	Quantity Calculation:	Sum of the number of piles visible for inspection.				

236	Other Pier Cap		Classification	NBE	Unit of measure:	ft
	Description:	Pier caps constructed of materials not covered by other elements that support girders that transfer load into piles or columns. For all such pier caps, regardless of protective system.				
	Quantity Calculation:	Sum of the pier cap lengths measured along the skew angle.				
CULVERTS						
243	**Other Culvert**		Classification	**NBE**	Unit of measure:	**ft**
	Description:	Culverts constructed of materials not covered by other elements, including arches, or round or elliptical pipes.				
	Quantity Calculation:	Flow line length of the barrel times the number of barrels.				

3.1.7—Bearings

310	Elastomeric Bearing		Classification	NBE	Unit of measure:	ea
	Description:	Bridge bearings that are constructed primarily of elastomers, with or without fabric or metal reinforcement.				
	Quantity Calculation:	Sum of each bearing of this type.				
311	**Movable Bearing**		Classification	**NBE**	Unit of measure:	**ea**
	Description:	Bridge bearings that provide for both rotation and longitudinal movement by means of roller, rocker, or sliding mechanisms.				
	Quantity Calculation:	Sum of each bearing of this type.				
312	**Enclosed/Concealed Bearing**		Classification	**NBE**	Unit of measure:	**ea**
	Description:	Bridge bearings that are enclosed so that they are not open for detailed inspection.				
	Quantity Calculation:	Sum of each bearing of this type.				
	Notes:	This element should be used for box girder hinges. In cases where the bearing material is not visible, the Inspector shall assess the condition based on alignment, grade across the joint, persistence of debris, or other indirect indicators of the condition.				
313	**Fixed Bearing**		Classification	**NBE**	Unit of measure:	**ea**
	Description:	Bridge bearings that provide for rotation only (no longitudinal movement).				
	Quantity Calculation:	Sum of each bearing of this type.				
314	**Pot Bearing**		Classification	**NBE**	Unit of measure:	**ea**
	Description:	Those high load bearings with confined elastomer. The bearing may be fixed against horizontal movement, guided to allow sliding in one direction, or floating to allow sliding in any direction.				
	Quantity Calculation:	Sum of each bearing of this type.				

315	**Disk Bearing**		Classification	**NBE**	Unit of measure:	**ea**
	Description:	Those high load bearings with a hard plastic disk. This bearing may be fixed against horizontal movement, guided to allow movement in one direction, or floating to allow sliding in any direction.				
	Quantity Calculation:	Sum of each bearing of this type.				
316	**Other Bearing**		Classification	**NBE**	Unit of measure:	**ea**
	Description:	All bridge bearings constructed of materials not covered by other elements, regardless of translation or rotation constraints.				
	Quantity Calculation:	Sum of each bearing of this type.				
	Notes	This element is intended for bearings constructed of materials that cannot be classified using any other bearing element.				

3.1.8—Joints

This Article covers expansion joints, pourable joints, compression joints, and assembly joints

300	**Strip Seal Expansion Joint**		Classification	**BME**	Unit of measure:	**ft**
	Description:	Those expansion joint devices which utilize a neoprene type waterproof gland with some type of metal extrusion or other system to anchor the gland.				
	Quantity Calculation:	Sum of all the lengths of the joint measured along the skew angle.				
301	**Pourable Joint Seal**		Classification	**BME**	Unit of measure:	**ft**
	Description:	Those joints filled with a pourable seal with or without a backer.				
	Quantity Calculation:	Sum of all the lengths of the joint measured along the skew angle.				
302	**Compression Joint Seal**		Classification	**BME**	Unit of measure:	**ft**
	Description:	Those joints filled with a preformed compression type seal. This joint may or may not have an anchor system to confine the seal.				
	Quantity Calculation:	Sum of all the lengths of the joint measured along the skew angle.				
303	**Assembly Joint with Seal**		Classification	**BME**	Unit of measure:	**ft**
	Description:	Those joints filled with an assembly mechanism that has a seal.				
	Quantity Calculation:	Sum of all the lengths of the joint measured along the skew angle.				
304	**Open Expansion Joint**		Classification	**BME**	Unit of measure:	**ft**
	Description:	Those joints that are open and not sealed.				
	Quantity Calculation:	Sum of all the lengths of the joint measured along the skew angle.				
	Note: This element is intended for joints designed as open joints, not for those joints that were designed to have a seal that is currently missing.					
305	**Assembly Joint without Seal**		Classification	**BME**	Unit of measure:	**ft**
	Description:	Those assembly joints that are open and not sealed, including finger and sliding plate joints.				
	Quantity Calculation:	Sum of all the lengths of the joint measured along the skew angle.				
	Notes: This element shall include open joints with or without a drainage trough below the joint.					

306	Other Joint		Classification	BME	Unit of measure:	ft
	Description:	Those joints that are not defined by any other joint element.				
	Quantity Calculation:	Sum of all the lengths of the joint measured along the skew angle.				

3.1.9—Wearing Surfaces, Protective Coatings, and Concrete Reinforcing Steel Protective Systems

510	Wearing Surfaces		Classification	BME	Unit of measure:	ft^2
	Description:	All decks/slabs that have overlays made with flexible (asphaltic concrete), semi-rigid (epoxy and polyester material), and rigid (portland cement) materials; and timber running planks.				
	Quantity Calculation:	Should include the area of the deck/slab that is protected by this wearing surface.				
515	**Steel Protective Coating**		Classification	BME	Unit of measure:	ft^2
	Description:	Steel elements that have a protective coating such as paint, galvanization, weathering steel patina, or other top coat steel corrosion inhibitor.				
	Quantity Calculation:	Should include the entire protected surface of the steel element.				
	Notes:	This element shall describe all coating systems. This includes paint systems, oxide on weathering steel, and galvanization. Assess protective coatings based upon the defects that would apply.				
521	**Concrete Protective Coating**		Classification	BME	Unit of measure:	ft^2
	Description:	Concrete elements that have a protective coating applied to them. These coatings include silane/siloxane water proofers, crack sealers such as High Molecular Weight Methacrylate (HMWM), or any top coat barrier that protects concrete from deterioration and reinforcing steel from corrosion.				
	Quantity Calculation:	Should include the entire protected surface of the concrete element.				
520	**Concrete Reinforcing Steel Protective System**		Classification	BME	Unit of measure:	ft^2
	Description:	All types of protective systems used to protect reinforcing steel in concrete elements from corrosion.				
	Quantity Calculation:	Should include the entire surface area of the protected element.				
	Notes: This protection system element is intended to capture situations where the concrete element may be expected to deteriorate at a rate that is slower than unprotected situations. Protection systems may include rebar coatings, cathodic protection, or other similar protection methods. Wearing surfaces are addressed under Element 510 and not this element.					

3.2—ELEMENT COMMENTARY

3.2.1—General Commentary

3.2.1.1

Condition evaluation for open elements includes the web face and the top and bottom faces of the flange.

3.2.1.2

Box girder evaluation is three-dimensional in nature, with the defects observed including exterior and interior surfaces being used to capture the condition states.

3.2.1.3

Cracking in Reinforced and Prestressed Concrete Elements: The Inspector should use judgment when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the Inspector should consider width, spacing, location, orientation, and structural or nonstructural nature of the cracking. The Inspector should consider exposure and environment when evaluating crack width. Table 3.2.1.3-1 provides quantitative crack widths describing insignificant, moderate, and wide cracking.

Table 3.2.1.3-1 Crack width commentary for reinforced and prestressed concrete elements.

Material	Insignificant cracking, defect not warranted (in.)	Moderate cracking (in.)	Wide cracking (in.)
Reinforced Concrete	Less than 0.012 wide	0.012 to 0.05 wide	Greater than 0.05 wide
Prestressed Concrete	Less than 0.004 wide	0.004 to 0.009 wide	Greater than 0.009 wide

3.2.1.4

Elements identified as “other” materials are intended for elements formed of composite materials or other materials that cannot be classified using any other defined element or material.

3.2.2—Decks and Slabs

These elements describe the component that is transferring load from the vehicle to the bridge. This does not include secondary deck elements such as joints, deck/slab protection systems, or wearing surfaces. Deck elements transmit the loads into superstructure elements. Slab elements transmit the load into the substructure elements. Structures that include slab elements typically do not have superstructure elements. These elements transmit traffic loads directly into the substructure. All deck or slab elements can be supplemented with one or more associated protection systems or wearing surface elements.

3.2.2.1

Deck, slab, and flange evaluation is three-dimensional in nature with the defects observed on the top and bottom surface, edges, or all; and captured using the condition states defined. Top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

3.2.2.2

Where traffic rides directly on the structural element regardless of the wearing surface, evaluation of the top flange above the fillet is considered with the appropriate deck element.

3.2.3—Railings

These elements cover bridge rail, which may be fabricated from steel, other metal, concrete, masonry, and other materials.

3.2.3.1

The number of rows of rail on a bridge is commonly two, one on each side of the traveled way. In some cases, there may be more than two rows when the bridge has a center median or protected pedestrian/bicycle lanes.

3.2.3.2

For assessing the condition of posts, blocking, and curbs that are formed from a different material than the railing, refer to the appropriate bridge railing material elements (i.e., metal, concrete, timber, masonry, or other) for specific defects.

3.2.4—Superstructure

Superstructure elements transmit load from decks into the substructure. These elements include girders, trusses, arches, and floor systems. The floor systems include floor beams and stringers. Additional elements in this group include cables, gusset plates, and pin or pin and hanger assemblies. These elements do not include bracing members such as diaphragms, cross bracing, or portal sway bracing.

3.2.4.1

Where traffic rides directly on the structural element regardless of the wearing surface, evaluation of the top flange above the fillet is considered with the appropriate deck element. See Article Description and Notes for Elements 15 and 109 for reference.

3.2.4.2 Girders

These elements transmit the loads from the deck into the substructure. Elements listed include closed web (boxes) and open girders (I-sections). The materials include steel, reinforced and prestressed concrete, and timber.

3.2.4.3 Stringers

These superstructure elements are part of a floor system and transmit load from the deck into the floor system, such as floor beams.

3.2.4.4 Trusses and Arches

These superstructure elements include materials of steel, concrete, timber, and masonry; they are the main load-carrying members for the span.

3.2.4.4.1

Observed distress in diagonal and vertical members (including spandrel columns and walls) shall be reported as the projected length along the element length.

3.2.4.4.2

For filled arches, the arch quantity shall be measured from spring line to spring line. The length below the spring line is considered substructure.

3.2.4.5 Floor Beams

These elements are the intermediate transverse load carrying members; these elements can be constructed from steel, concrete, or timber.

3.2.4.6 Miscellaneous Superstructure Elements

These superstructure elements include steel pin or pin and hanger assemblies, steel gusset plates, and main and secondary cables.

3.2.4.6.1

For built-up gusset plates, distress observed on any plate should be considered in the condition assessment.

3.2.5—Bearings

There is no element commentary for bearings.

3.2.6—Substructure Elements

Substructure elements transmit the load from the superstructure into the ground. These elements include **columns**, **piles**, **pile caps/footings**, pile extensions, **pier/bent caps**, **pier walls**, and **abutments**. These elements include elements of steel, concrete, timber, masonry, and other materials.

3.2.6.1

Monolithic wingwalls, up to the first construction joint (cold joint, water stop, etc.), shall be considered in the quantity and assessment of the abutment element. Wingwalls that are not monolithic with the abutment shall not be included in the quantity or assessment of the abutment element.

3.2.6.2

Integral wingwalls, up to the first construction joint (cold joint, water stop, etc.), shall be considered in the quantity and assessment of the abutment element. Wingwalls that are not monolithic with the abutment shall not be included in the quantity or assessment of the abutment element.

3.2.7—Culverts

These elements cover steel, prestressed and reinforced concrete, timber, masonry, and other types of culverts.

3.2.7.1

The distortion defect is contingent on a number of factors such as site, wall thickness, and fill depth. The Inspector shall use such factors to assess the proper condition state.

3.2.8—Joints

These elements cover expansion joints, pourable joints, compression joints, and assembly joints.

3.2.9—Wearing Surfaces, Protective Coatings, and Concrete Reinforcing Steel Protective Systems

These elements are wearing surfaces, steel and concrete protective coatings, and concrete reinforcing steel protection systems such as cathodic protection. These systems will influence the deterioration and condition of the underlying structural element.

3.2.10—Approach Slabs

Approach slabs are constructed with concrete and mild or prestressed (post-tension) reinforcement. Approach slabs are Bridge Management Elements (BMEs) and are not included in the standard set of National Bridge Elements (NBEs).

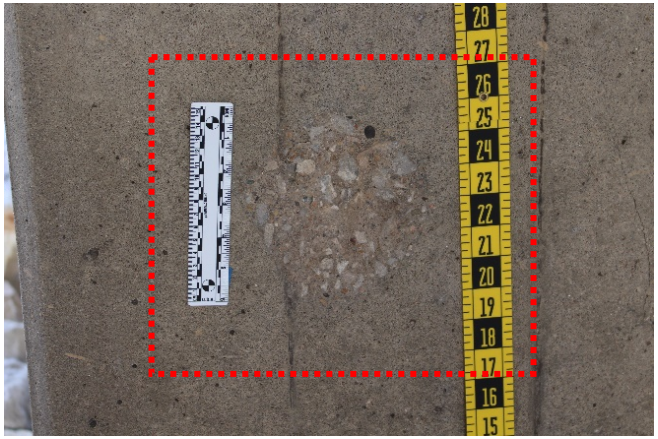
3.3—REINFORCED CONCRETE ELEMENTS

Element No.	Element Name	Classification	Units of Measurement
Deck			
12	Reinforced Concrete Deck	NBE	ft^2
16	Reinforced Concrete Top Flange	NBE	ft^2
38	Reinforced Concrete Slab	NBE	ft^2
Superstructure			
105	Reinforced Concrete Closed Web/Box Girder	NBE	ft
110	Reinforced Concrete Open Girder/Beam	NBE	ft
116	Reinforced Concrete Stringer	NBE	ft
144	Reinforced Concrete Arch	NBE	ft
155	Reinforced Concrete Floor Beam	NBE	ft
Culvert			
241	Reinforced Concrete Culvert	NBE	ft
Substructure			
205	Reinforced Concrete Column	NBE	ea
210	Reinforced Concrete Pier Wall	NBE	ft
215	Reinforced Concrete Abutment	NBE	ft
220	Reinforced Concrete Pile Cap/Footing	NBE	ft
227	Reinforced Concrete Pile	NBE	ea
234	Reinforced Concrete Cap	NBE	ft
Other			
321	Reinforced Concrete Approach Slab	BME	ft^2
331	Reinforced Concrete Bridge Rail	NBE	ft

Defects for Reinforced Concrete

Defects	CS 1 GOOD	CS 2 FAIR	CS 3 POOR	CS 4 SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks, or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in CS 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in CS 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in CS 4 under the appropriate material defect entry.

Defect 1080—Delamination/Spall/Patched Area

Condition State 1	Condition State 2	Condition State 3
None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.
		
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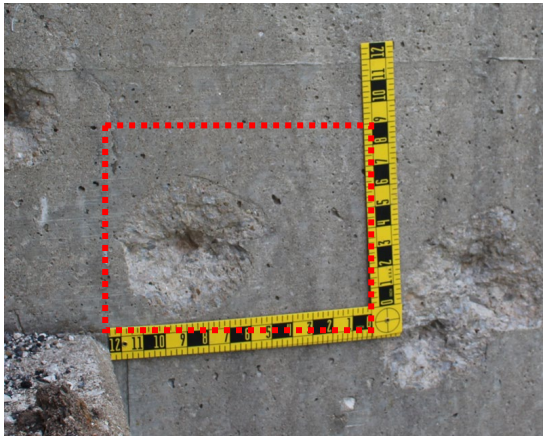
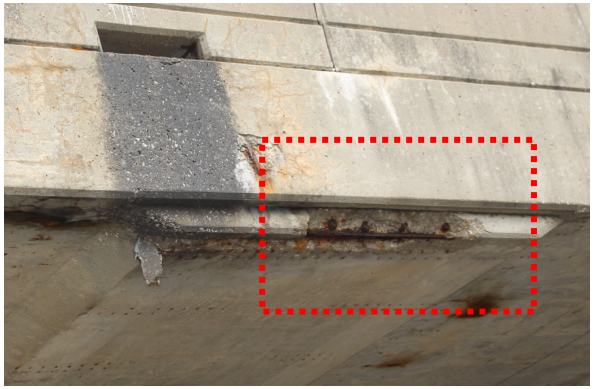
		

Defect 1090—Exposed Rebar

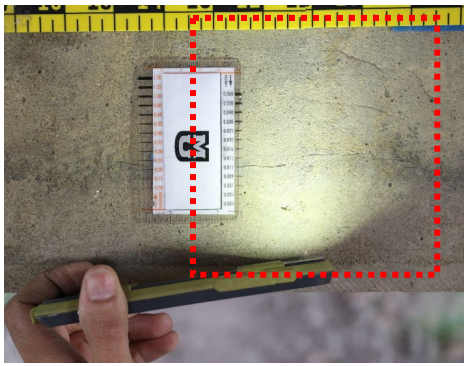
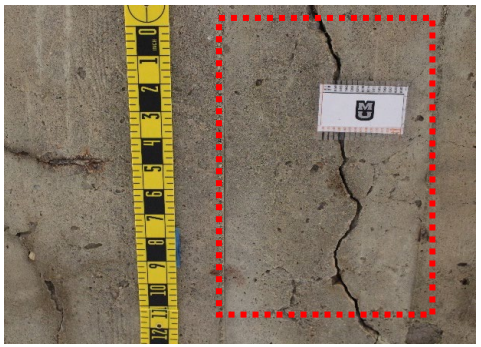
Condition State 1	Condition State 2	Condition State 3
None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.
		
	Boundary Image CS 2–3	
		

Defect 1120—Efflorescence/Rust Staining

Condition State 1	Condition State 2	Condition State 3
None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.
		

Boundary Image CS 1–2	Boundary Image CS 2–3
	

Defect 1130—Cracking (RC and Other)

Condition State 1	Condition State 2	Condition State 3
Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.
Width less than 0.012 in.	*Width 0.012–0.05 in.*	*Width greater than 0.05 in.*
		

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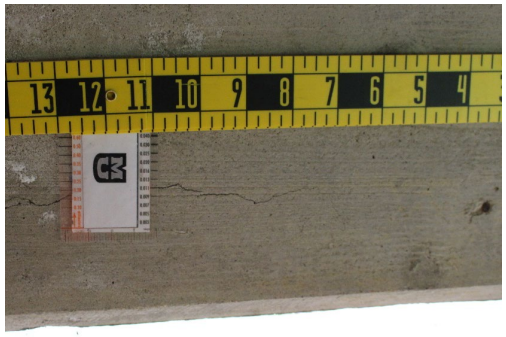
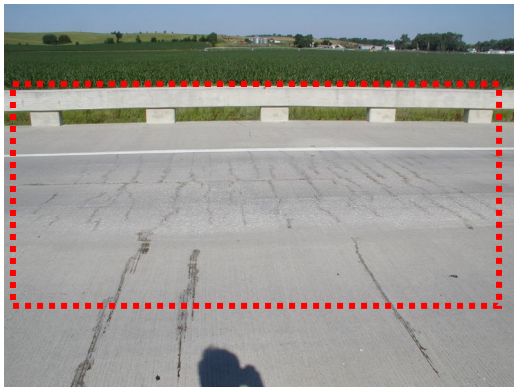
	

Defect 1130—Cracking (RC and Other)

Condition State 1	Condition State 2	Condition State 3
Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.
Spacing greater than 3.0 ft.	*Spacing of 1.0—3.0 ft.*	*Spacing of less than 1 ft.*
		

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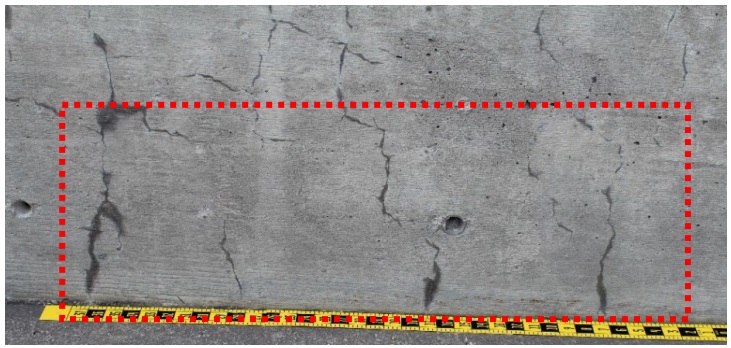
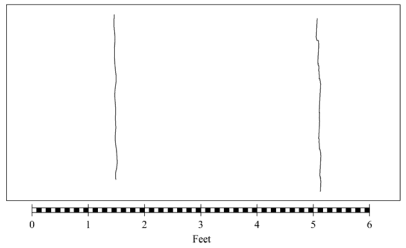
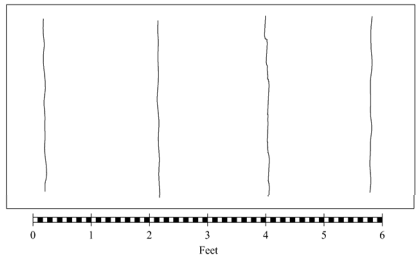
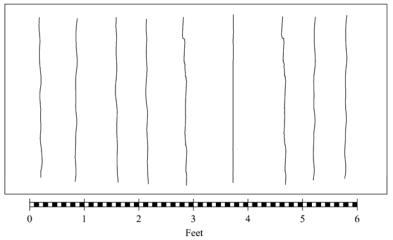
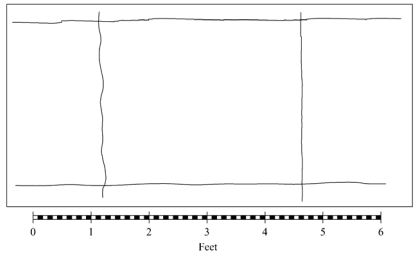
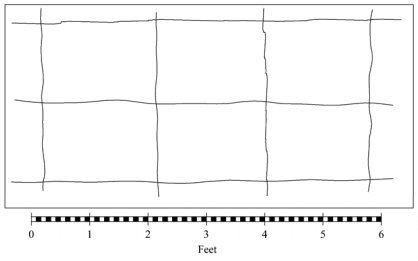
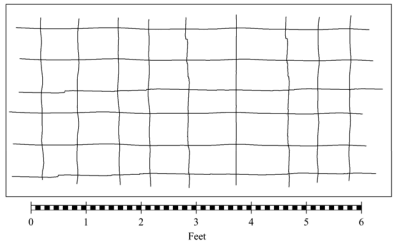
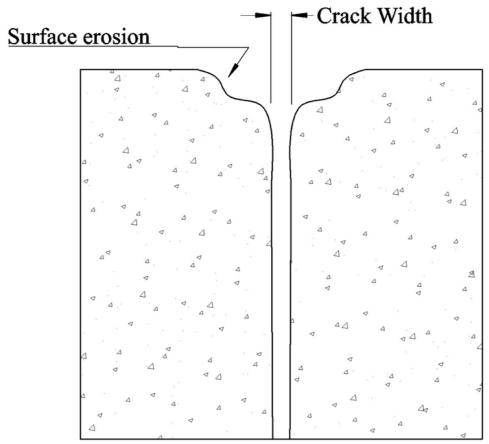
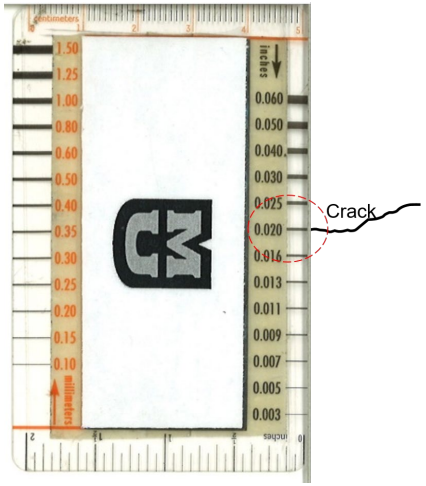
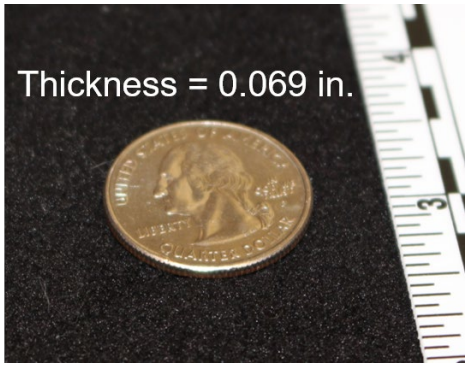
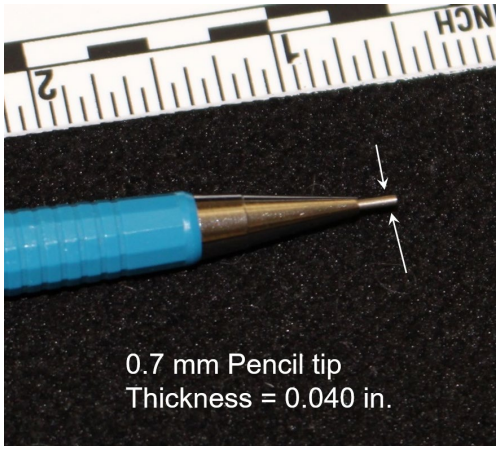
	

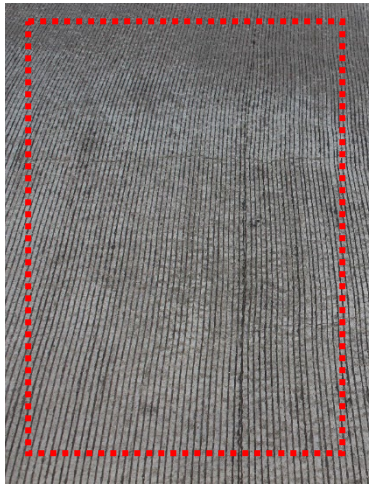
Crack Pattern Guide

Condition State 1	Condition State 2	Condition State 3
Spacing >3 ft.	Moderate pattern (map) cracking, spacing 1–3 ft.	Heavy pattern (map) cracking, spacing less than 1 ft.
		
		

Crack Width Guide

Crack Width Measurement	Crack Measurement	Width Measures
The surface of concrete erodes at a crack, making the crack appear wider at the surface. Crack width measurements should describe the actual crack width, not the eroded surface.	Crack widths can be measured using a crack comparator.	• 1/32 in. = 0.0313 in. • 1/16 in. = 0.0625 in. • 3/32 in. = 0.0938 in. • 1/8 in. = 0.1250 in. • 3/16 in. = 0.1875 in.
		
		

Defect 1190—Abrasion/Wear

Condition State 1	Condition State 2	Condition State 3
No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate, but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.
		
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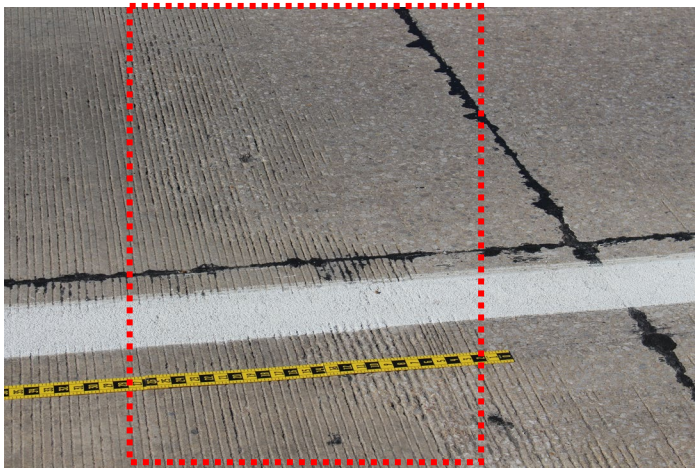
		

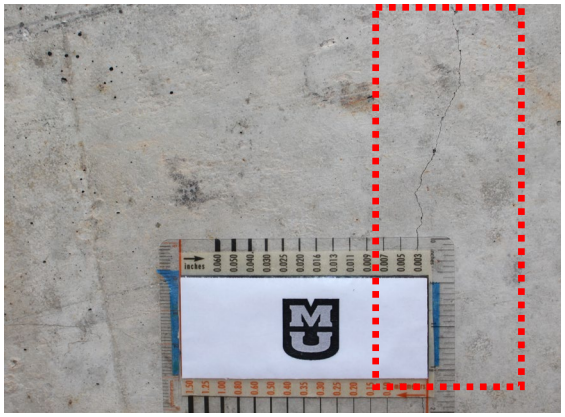
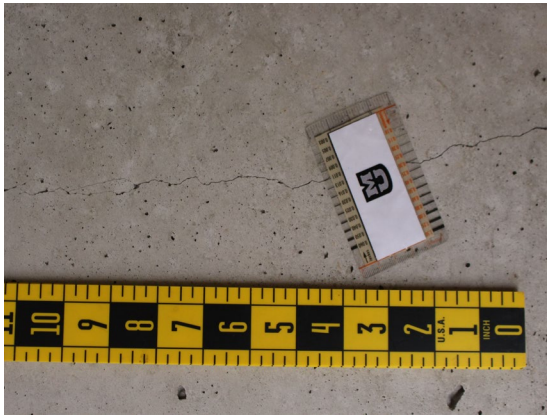
3.4—PRESTRESSED CONCRETE ELEMENTS

Element No.	Element Name	Classification	Units of Measurement
Deck			
13	PSC Deck	NBE	ft^2
15	PSC Top Flange	NBE	ft^2
Superstructure			
104	PSC Closed Web/Box Girder	NBE	ft
109	PSC Open Girder/Beam	NBE	ft
115	PSC Stringer	NBE	ft
143	PSC Arch	NBE	ft
154	PSC Floor Beam	NBE	ft
Substructure			
204	PSC Column	NBE	ea
226	PSC Pile	NBE	ea
233	PSC Pier Cap	NBE	ft
Culvert			
245	PSC culvert	NBE	ft
Other			
320	PSC Approach Slab	BME	ft^2

Defects for Prestressed Concrete Elements

Defects	CS 1 GOOD	CS 2 FAIR	CS 3 POOR	CS 4 SEVERE
Delamination/Spalls/ Patch Areas (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining	Heavy build-up with rust staining.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in CS 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in CS 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in CS 4 under the appropriate material defect entry.

Defect 1110—Cracking (PSC)

Condition State 1	Condition State 2	Condition State 3
Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.
Width less than 0.004 in. or spacing greater than 3 ft.	*Width 0.004–0.009 in. or spacing1.0–3.0 ft.*	*Width greater than 0.009 in. or spacing less than 1 ft.*
		
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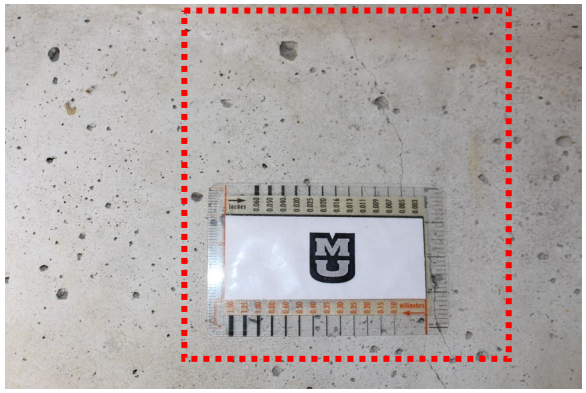		

3.5—STEEL ELEMENTS

Element No.	Element Name	Classification	Units of Measurement	Element No.	Element Name	Classification	Units of Measurement
Steel Decks				**Substructure**			
28	Steel Deck with Open Grid	NBE	ft^2	202	Steel Column	NBE	ea
29	Steel Deck Concrete Filled Grid	NBE	ft^2	207	Steel Tower	NBE	ft
30	Steel Deck Corrugated/Orthotropic /Etc.	NBE	ft^2	219	Steel Abutment	NBE	ft
Superstructure				225	Steel Pile	NBE	ea
102	Steel Closed Web/Box Girder	NBE	ft	231	Steel Pier Cap	NBE	ft
107	Steel Open Girder/Beam	NBE	ft				
113	Steel Stringer	NBE	ft	**Culvert**			
120	Steel Truss	NBE	ft	240	Steel Culvert	NBE	ft
141	Steel Arch	NBE	ft	**Other**			
147	Steel Main Cables	NBE	ft	330	Metal Bridge Railing	NBE	ft
148	Secondary Steel Cables	NBE	ea				
152	Steel Floor Beam	NBE	ft				
161	Steel Pin, Pin & Hanger Assembly or both	NBE	ea				
162	Steel Gusset Plate	NBE	ea				

Defects for Steel Elements

Defects	CS 1 GOOD	CS 2 FAIR	CS 3 POOR	CS 4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in CS 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in CS 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in CS 4 under the appropriate material defect entry.

Defect 1000—Corrosion

Condition State 1	Condition State 2	Condition State 3
None.	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.
		
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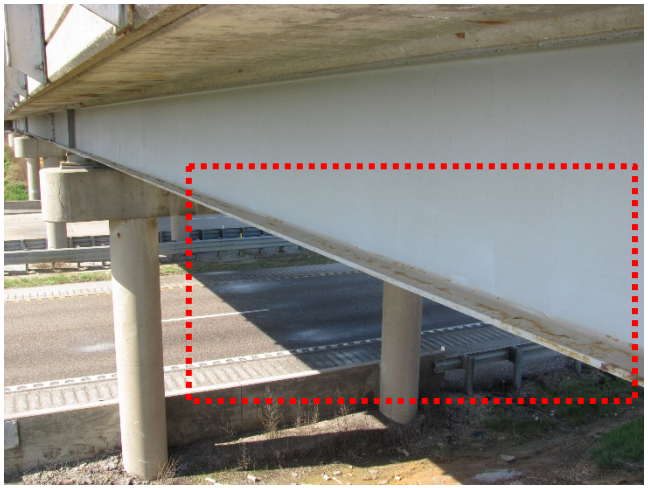
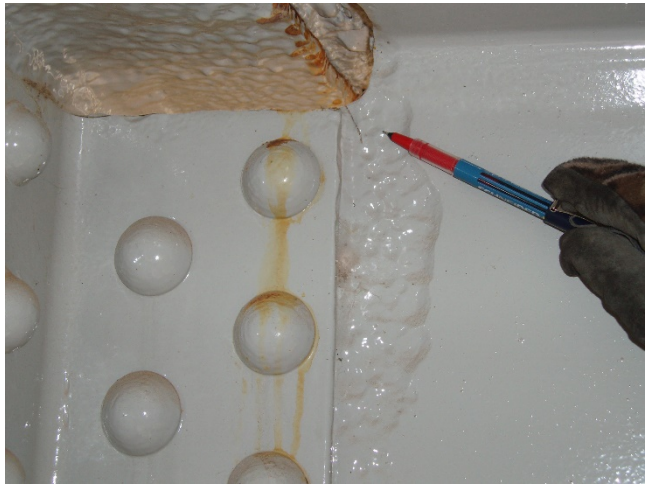
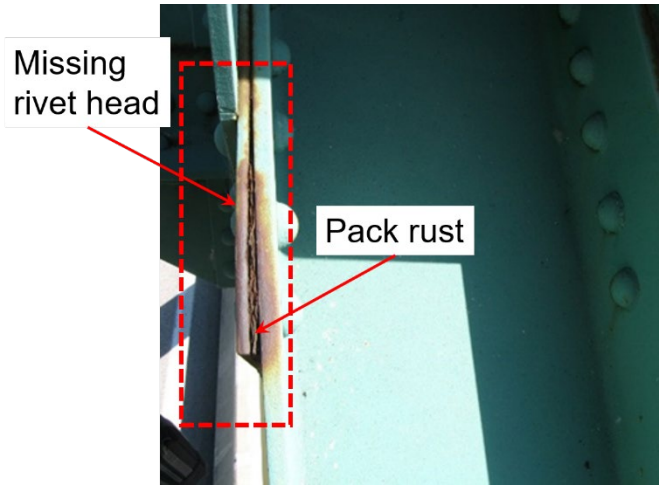
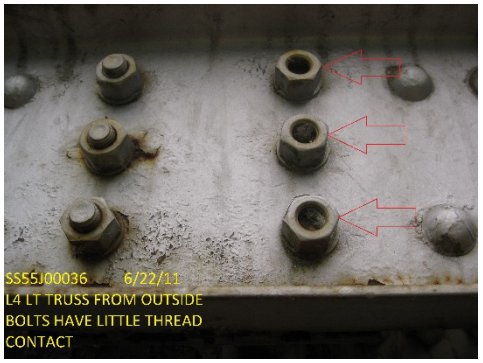
		

Defect 1010—Cracking

Condition State 1	Condition State 2	Condition State 3
None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.
		
Condition State 1	**Condition State 2**	**Condition State 3**
		

Defect 1020—Connection

Condition State 1	Condition State 2	Condition State 3
	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.
		
Boundary Image CS 1–2	Boundary Image CS 2–3	Boundary Image CS 3–4
		

3.6—TIMBER ELEMENTS

Element No.	Element Name	Classification	Units of Measurement
Deck			
31	Timber Deck	NBE	ft^2
54	Timber Slab	NBE	ft^2
Superstructure			
111	Timber Open Girder/Beam	NBE	ft
117	Timber Stringer	NBE	ft
135	Timber Truss	NBE	ft
146	Timber Arch	NBE	ft
156	Timber Floor Beam	NBE	ft
Substructure			
206	Timber Column	NBE	ea
208	Timber Trestle	NBE	ea
212	Timber Pier Wall	NBE	ft
216	Timber Abutment	NBE	ft
228	Timber Pile	NBE	ea
235	Timber Pier Cap	NBE	ft
Culvert			
242	Timber Culvert	NBE	ft
Other			
332	Timber Bridge Railing	NBE	ft

Defects for Timber Elements

Defects	CS 1	CS 2	CS 3	CS 4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or penetrates more than 5% of the thickness of the member in the tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	

Defects	CS 1	CS 2	CS 3	CS 4
	GOOD	FAIR	POOR	SEVERE
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

3.7—MASONRY ELEMENTS

Element No.	Element Name	Classification	Units of Measurement	Element No.	Element Name	Classification	Units of Measurement
Superstructure				**Culvert**			
145	Masonry Arch	NBE	ft	244	Masonry Culvert	NBE	ft
Substructure				**Other**			
213	Masonry Pier Wall	NBE	ft	334	Masonry Bridge Railing	NBE	ft
217	Masonry Abutment	NBE	ft				

Defects for Masonry Elements

Defects	CS 1	CS 2	CS 3	CS 4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Mortar Breakdown (Masonry) (1610)	None.	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	
Split/Spall (Masonry) (1620)	None.	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Area (Masonry) (1630)	None.	Sound patch.	Unsound patch.	
Masonry Displacement (1640)	None.	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits, but is less than the critical limits determined by scour evaluation and does not warrant structural review.	

Defects	CS 1	CS 2	CS 3	CS 4
	GOOD	FAIR	POOR	SEVERE
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

3.8—OTHER MATERIAL ELEMENTS

Element No.	Element Name	Classification	Units of Measurement	Element No.	Element Name	Classification	Units of Measurement
Deck				**Substructure**			
60	Other Deck	NBE	ft^2	203	Other Column	NBE	ea
65	Other Slab	NBE	ft^2	211	Other Pier Wall	NBE	ft
Superstructure				218	Other Abutment	NBE	ft
106	Other Closed Web/Box Girder	NBE	ft	229	Other Pile	NBE	ea
112	Other Open Girder/Beam	NBE	ft	236	Other Pier Cap	NBE	ft
118	Other Stringer	NBE	ft				
136	Other Truss	NBE	ft	**Culvert**			
142	Other Arch	NBE	ft	244	Other Culvert	NBE	ft
149	Other Secondary Cable	NBE	ea	**Other**			
157	Other Floor Beam	NBE	ft	332	Other Bridge Railing	NBE	ft

Defects for Other Material Elements

Defects	CS 1	CS 2	CS 3	CS 4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

Defects	CS 1	CS 2	CS 3	CS 4
	GOOD	FAIR	POOR	SEVERE
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

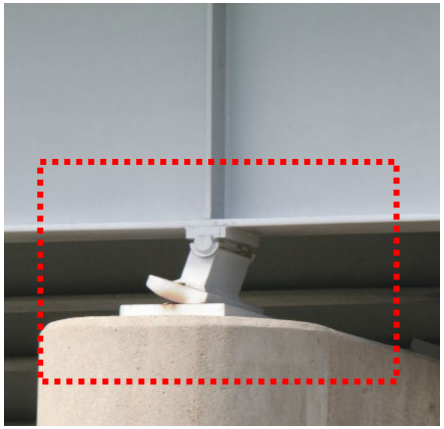
3.9—BEARINGS

Element No.	Element Name	Classification	Units of Measurement	Element No.	Element Name	Classification	Units of Measurement
310	Elastomeric Bearing	NBE	ea	314	Pot Bearing	NBE	ea
311	Movable Bearing	NBE	ea	315	Disk Bearing	NBE	ea
312	Enclosed/Concealed Bearing	NBE	ea	316	Other Bearing	NBE	ea
313	Fixed Bearing	NBE	ea				

Defects for Bearings

Defect	CS 1 GOOD	CS 2 FAIR	CS 3 POOR	CS 4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	
Movement (2210)	Free to move.	Minor restriction.	Restricted, but not warranting structural review.	
Alignment (2220)	Lateral and vertical alignment is as expected for the temperature conditions.	Tolerable lateral or vertical alignment that is inconsistent with the temperature conditions.	Approaching the limits of lateral or vertical alignment for the bearing but does not warrant a structural review.	
Bulging, Splitting, or Tearing (2230)	None.	Bulging less than 15% of the thickness.	Bulging 15% or more of the thickness. Splitting or tearing. Bearing's surfaces are not parallel. Does not warrant structural review.	
Loss of Bearing Area (2240)	None.	Less than 10%.	10% or more but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in CS 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in CS 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in CS 4 under the appropriate material defect entry.

Defect 2220—Alignment

Condition State 1	Condition State 2	Condition State 3
Lateral and vertical alignment is as expected for the temperature conditions.	Tolerable lateral or vertical alignment that is inconsistent with the temperature conditions.	Approaching the limits of lateral or vertical alignment for the bearing but does not warrant a structural review.
		
Boundary Image CS 1–2	Boundary Image CS 2–3	Boundary Image CS 3–4
		

Defect 2240—Loss of Bearing Area

Condition State 1	Condition State 2	Condition State 3
None.	Less than 10%.	10% or more, but does not warrant structural review.
		
Boundary Image CS 1–2		Boundary Image CS 2–3
		

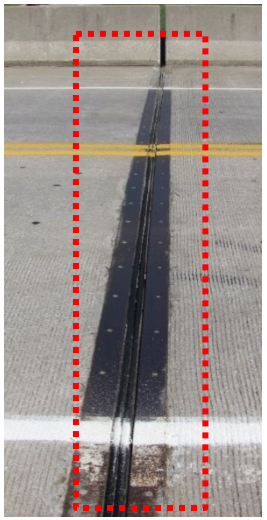
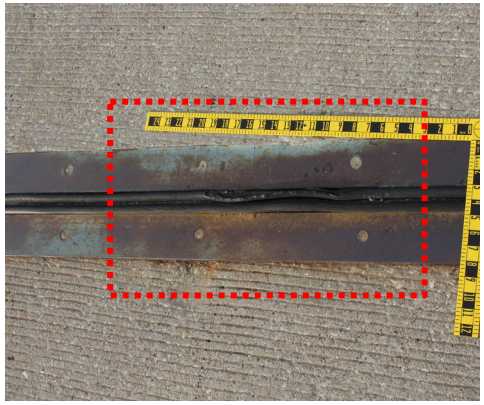
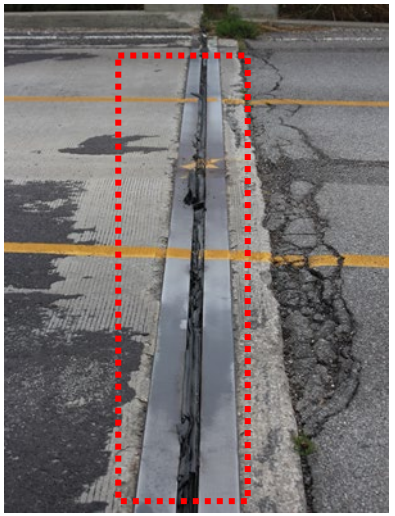
3.10—JOINTS

Element No.	Element Name	Classification	Units of Measurement	Element No.	Element Name	Classification	Units of Measurement
300	Strip Seal Expansion Joint	BME	ft	304	Open Expansion Joint	BME	ft
301	Pourable Joint Seal	BME	ft	305	Assembly Joint without Seal	BME	ft
302	Compression Joint Seal	BME	ft	306	Other Joint	BME	ft
303	Assembly Joint with Seal	BME	ft				

Defects for Joints

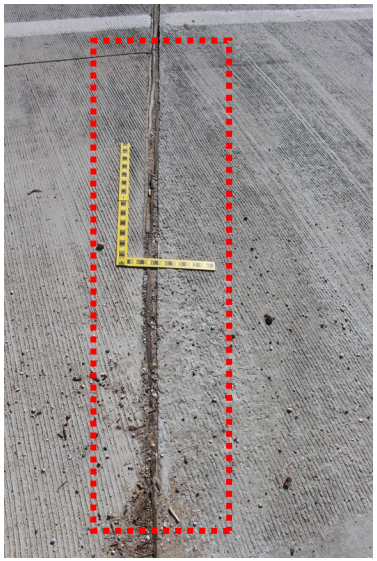
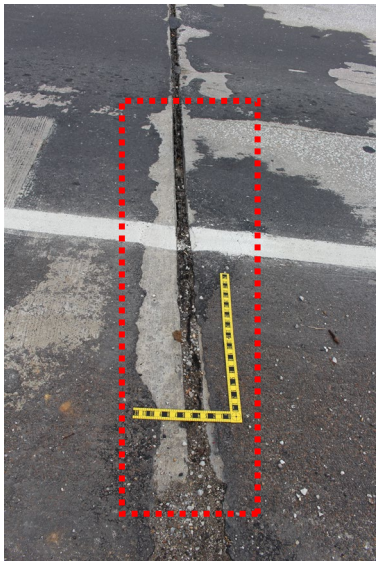
Defects	CS 1	CS 2	CS 3	CS 4
	GOOD	FAIR	POOR	SEVERE
Leakage (2310)	None.	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion (2320)	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of joint height, but still some adhesion.	Complete loss of adhesion.
Seal Damage (2330)	None.	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal Cracking (2340)	None.	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction (2350)	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area, or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage (2370)	None.	Freckled rust; metal has no cracks or impact damage. Connection may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal, or impact damage but joint still functioning.	Metal cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Defect 2330—Seal Damage

Condition State 1	Condition State 2	Condition State 3	Condition State 4
None.	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
			

Boundary Image CS 1–2	Boundary Image CS 2–3	Boundary Image CS 3–4
N.A.	N.A.	N.A.

Defect 2350—Debris Impaction

Condition State 1	Condition State 2	Condition State 3	Condition State 4
No debris to shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material but still allowing free movement of joint.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
			

3.11—WEARING SURFACES, PROTECTIVE COATINGS, AND CONCRETE REINFORCING STEEL PROTECTIVE SYSTEMS

Element No.	Element Name	Classification	Units of Measurement	Element No.	Element Name	Classification	Units of Measurement
510	Wearing Surfaces	BME	ft^2	521	Concrete Protective Coating	BME	ft^2(surface)
515	Steel Protective Coating	BME	ft^2(surface)	520	Concrete Reinforcing Steel Protective Coating	BME	ft^2

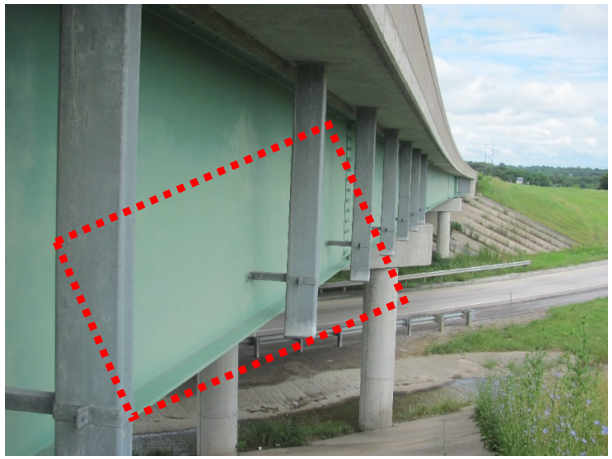
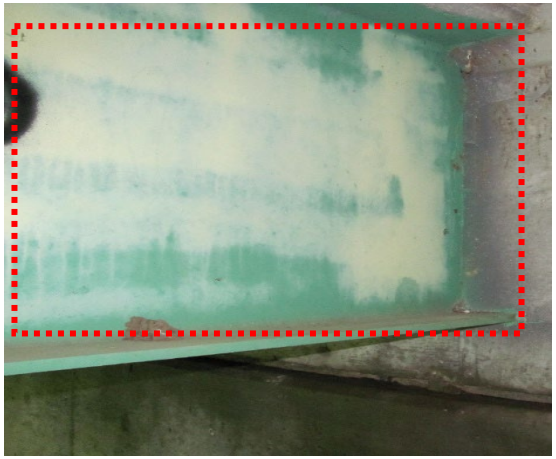
Defects for Wearing Surfaces

Defects	CS 1	CS 2	CS 3	CS 4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area/Pothole (Wearing Surfaces) (3210)	None.	Delaminated. Spall less than 1 in. deep or less than 6 in. diameter. Patched area that is sound. Partial-depth pothole.	Spall 1 in. deep or greater or 6 in. diameter or greater. Patched area that is unsound or showing distress. Full-depth pothole.	The wearing surface is no longer effective.
Crack (Wearing Surface) (3220)	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012–0.05 in. or spacing of 1.0–3.0 ft.	Width of more than 0.05 in. or spacing of less than 1.0 ft.	
Effectiveness (Wearing Surface) (3230)	Fully effective. No evidence of leakage or further deterioration of the protected element.	Substantially effective. Deterioration of the protected element has slowed.	Limited effectiveness. Deterioration of the protected element has progressed.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Defects for Steel Protective Coating

Defects	CS 1	CS 2	CS 3	CS 4
	GOOD	FAIR	POOR	SEVERE
Chalking (Steel Protective Coatings) (3410)	None.	Surface dulling.	Loss of pigment.	Not applicable.
Peeling/Bubbling/Cracking (Steel Protective Coatings) (3420)	None.	Finish coats only.	Finish and primer coats.	Exposure of bare metal.
Oxide Film Degradation Color/Texture Adherence (Steel Protective Coatings) (3430)	Yellow-orange or light brown for early development. Chocolate-brown to purple-brown for fully developed. Tightly adhered, capable of withstanding hammering or vigorous wire brushing.	Granular texture.	Small flakes, less than $^1/_2$-in. diameter.	Dark black color. Large flakes, $^1/_2$-in. diameter or greater, or laminar sheets or nodules.
Effectiveness (Steel Protective Coatings) (3440)	Fully effective.	Substantially effective.	Limited effectiveness.	Failed; no protection of the underlying metal.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Defect 3410—Chalking (Steel Protective Coating)

Condition State 1	Condition State 2	Condition State 3
None.	Surface dulling.	Loss of pigment.
		
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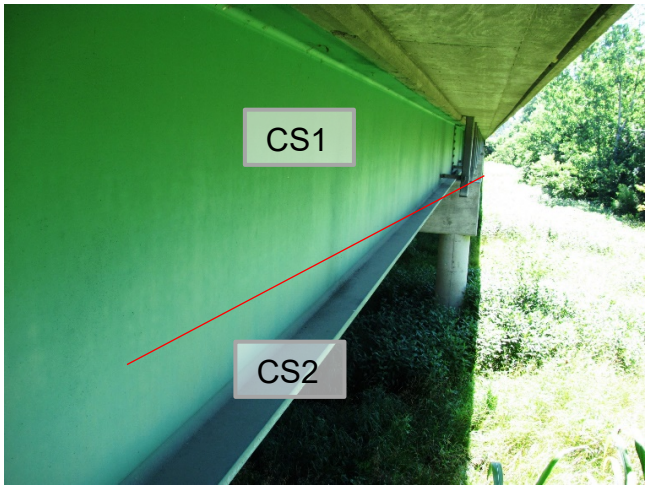
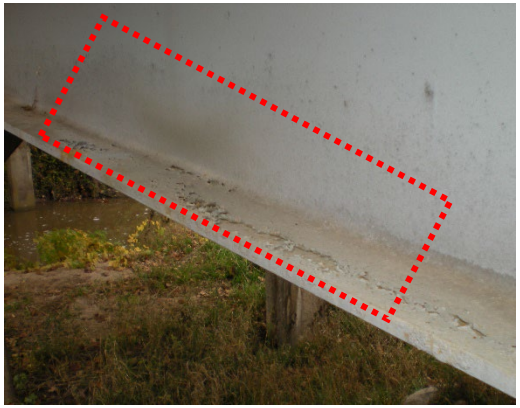
		

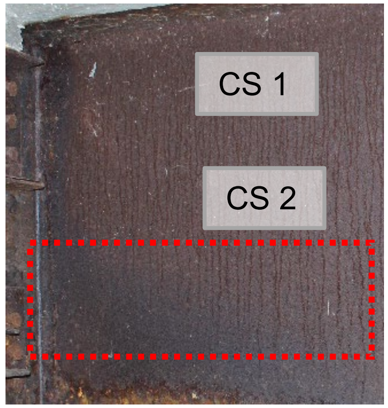
Defect 3420—Peeling/Bubbling/Cracking (Steel Protective Coating)

Condition State 1	Condition State 2	Condition State 3	Condition State 4
None.	Finish Coats only.	Finish and primer coats.	Exposure of bare metal.
			

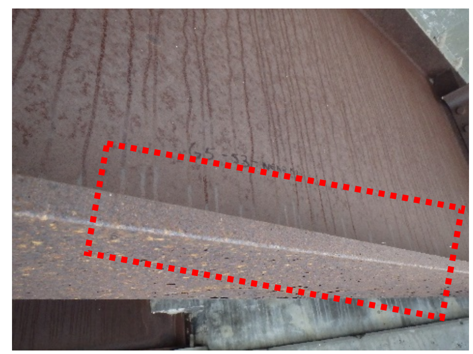
Boundary Image CS 1–2	Boundary Image CS 2–3	Boundary Image CS 3–4
	N.A.	N.A.

Defect 3430—Oxide Film Degradation

Condition State 1	Condition State 2	Condition State 3	Condition State 4
Yellow-orange or light brown for early development. Chocolate-brown to purple-brown for fully developed. Tightly adhered, capable of withstanding hammering or vigorous wire brushing.	Granular texture.	Small flakes, less than ½ in. diameter.	Dark black color. Large flakes ½ in. diameter or greater, or laminar sheets of nodules.



Boundary Image CS 1–2	Boundary Image CS 2–3	Boundary Image CS 3–4



Defect 3440—Effectiveness (Steel Protective Coating)

Condition State 1	Condition State 2	Condition State 3	Condition State 4
Fully effective.	Substantially effective.	Limited effectiveness.	Failed, no protection of underlying steel.
			

Boundary Image CS 1–2	Boundary Image CS 2–3	Boundary Image CS 3–4
		

Defects for Concrete Protective Coating

Defects	CS 1	CS 2	CS 3	CS 4
	GOOD	FAIR	POOR	SEVERE
Wear (Concrete Protective Coatings) (3510)	None.	Underlying concrete not exposed; coating showing wear from UV exposure; friction course missing.	Underlying concrete is not exposed; thickness of the coating is reduced.	Underlying concrete exposed. Protective coating no longer effective.
Effectiveness (Concrete Protective Coatings) (3540)	Fully effective.	Substantially effective.	Limited effectiveness.	The protective system has failed or is no longer effective.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Defects for Concrete Reinforcing Steel Protective System

Defects	CS 1	CS 2	CS 3	CS 4
	GOOD	FAIR	POOR	SEVERE
Effectiveness—Protective System (e.g. cathodic) (3600)	Fully effective.	Substantially effective.	Limited effectiveness.	The protective system has failed or is no longer effective.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

3.12—SPATIAL AREA ESTIMATES DIAGRAMS

This section includes diagrams that can be used to estimate the amount of damage in a particular CS. The area estimates are presented in terms of percentage of the total area shown in the diagram. The area of each diagram represents 4000 sq ft of surface area configured as a 40 ft × 100 ft scale diagram. The diagrams can be used to assist in estimating an area of damage by comparing the appearance of the diagram with conditions observed in the field.

Figures 3.12-1 through 3.12-6 illustrate areas of damage distributed in different configurations. For example, Figure 3.12-1a illustrates 1 percent damage that is widely distributed, Figure 3.12-1b illustrates 1 percent damage that is moderately distributed, and Figure 3.12-1c illustrates 1 percent damage in a single area. Areas of 1 percent, 3 precent, 5 percent, 10 percent, 25 percent, and 50 percent are illustrated in the diagrams.

Figures 3.12-7 and 3.12-8 illustrate areas of moderate and heavy pattern cracking, respectively. The diagrams in Figures 3.12-7 and 3.12-8 illustrate pattern cracking quantities of 5 percent, 10 percent, and 25 percent of the total area. Figure 3.12-9 illustrates isolated cracking representing 1 percent, 5 percent, and 10 percent of the deck area. In this diagram, 1 ft of crack is assigned as 1 sq ft of damage.

Figure 3.12-10 illustrates length quantity estimates for damage of 5 percent, 10 percent, 25 percent, and 50 percent of the total length.

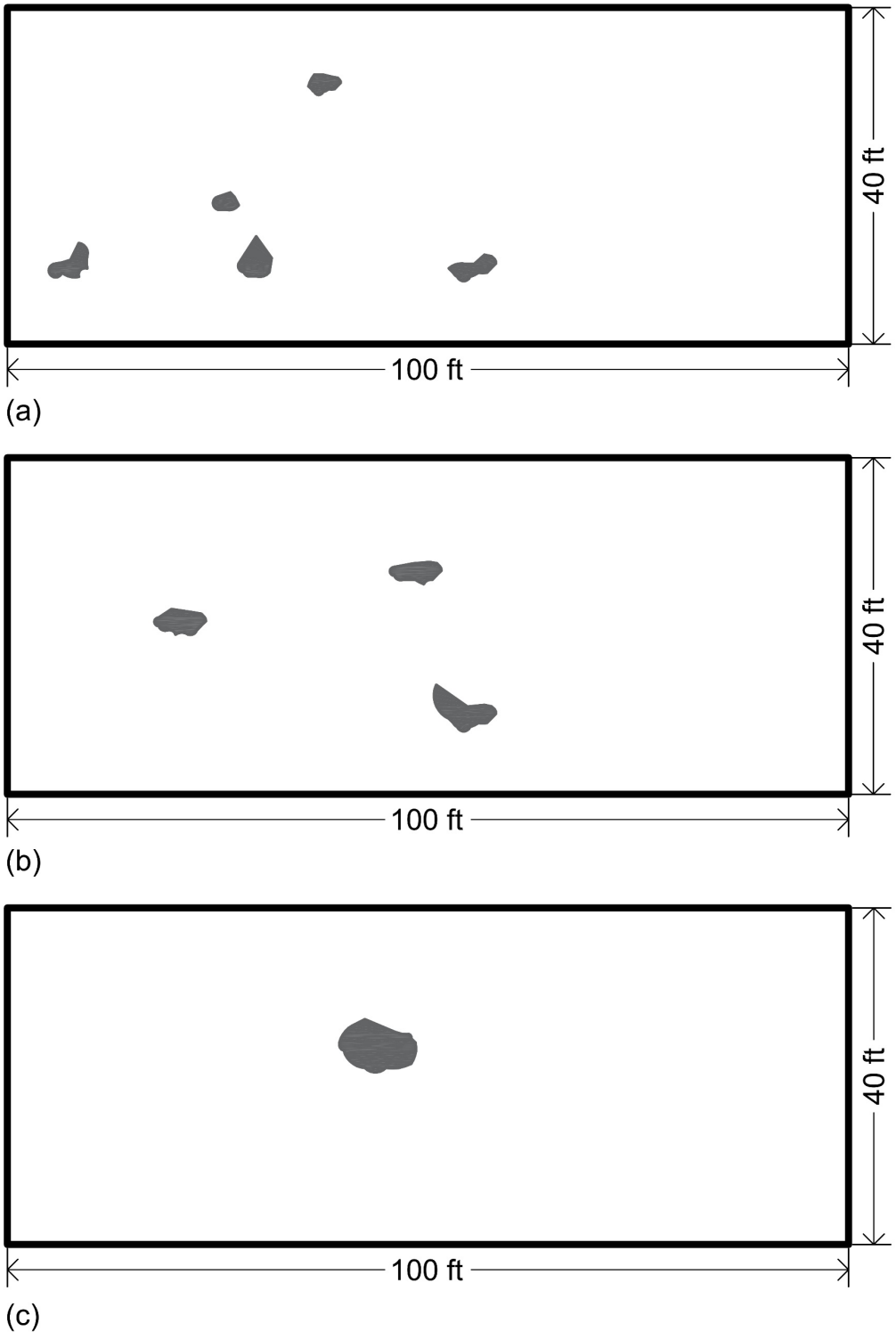


Figure 3.12-1. a), b), and c) area quantity estimate showing 1 percent of area damaged

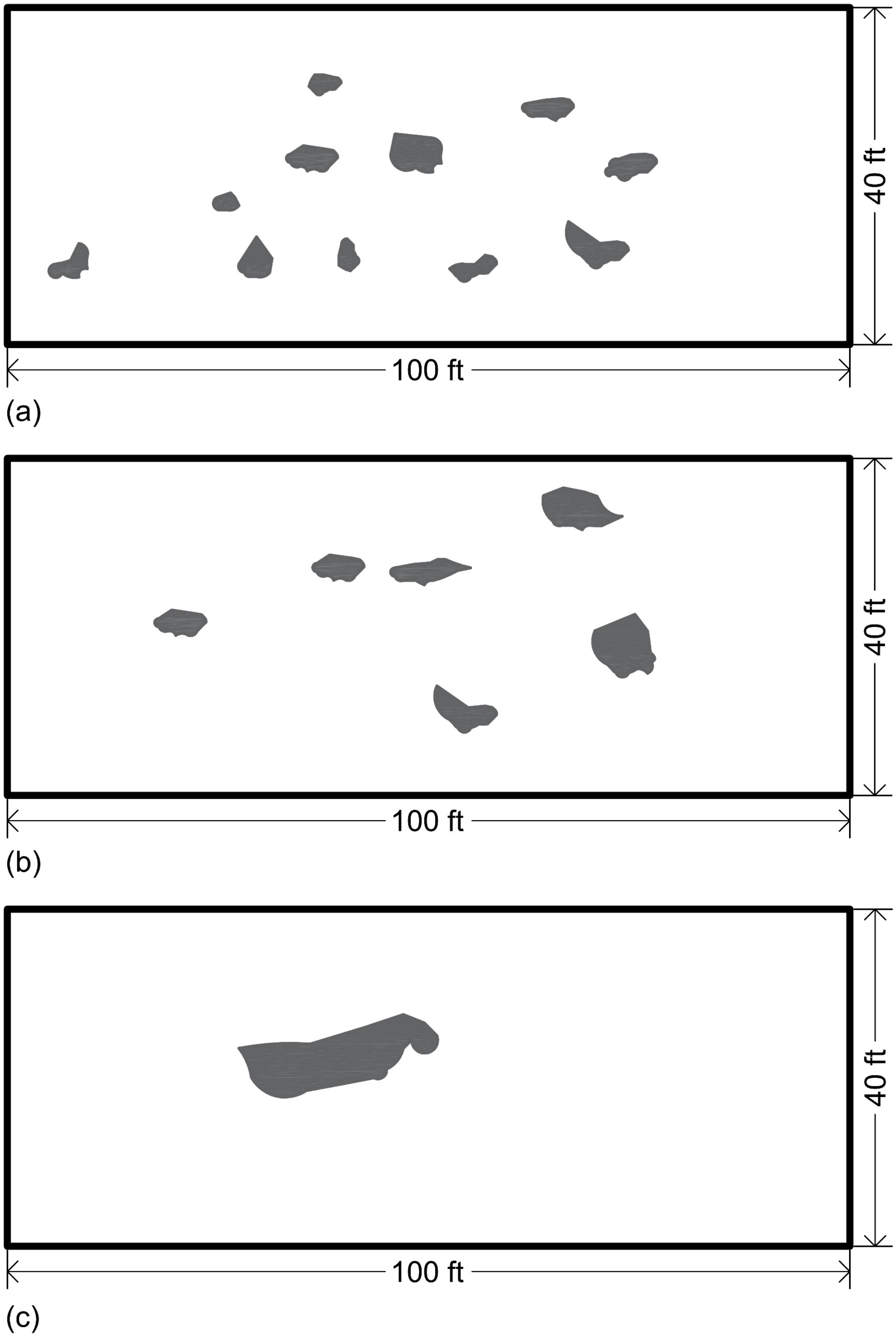


Figure 3.12-2. a), b), and c) area quantity estimate showing 3 percent of area damaged

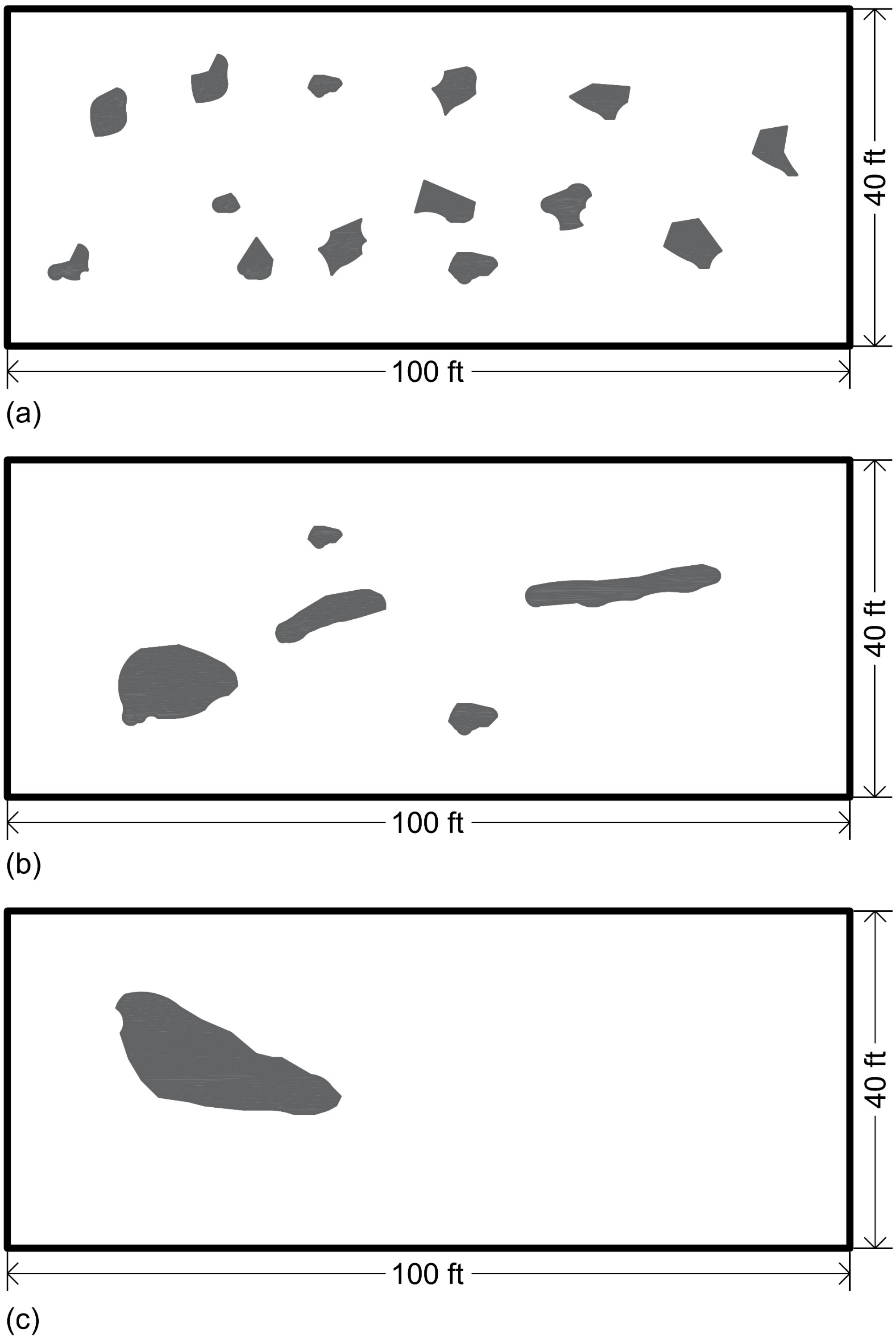


Figure 3.12-3. a), b), and c) area quantity estimate showing 5 percent of area damaged

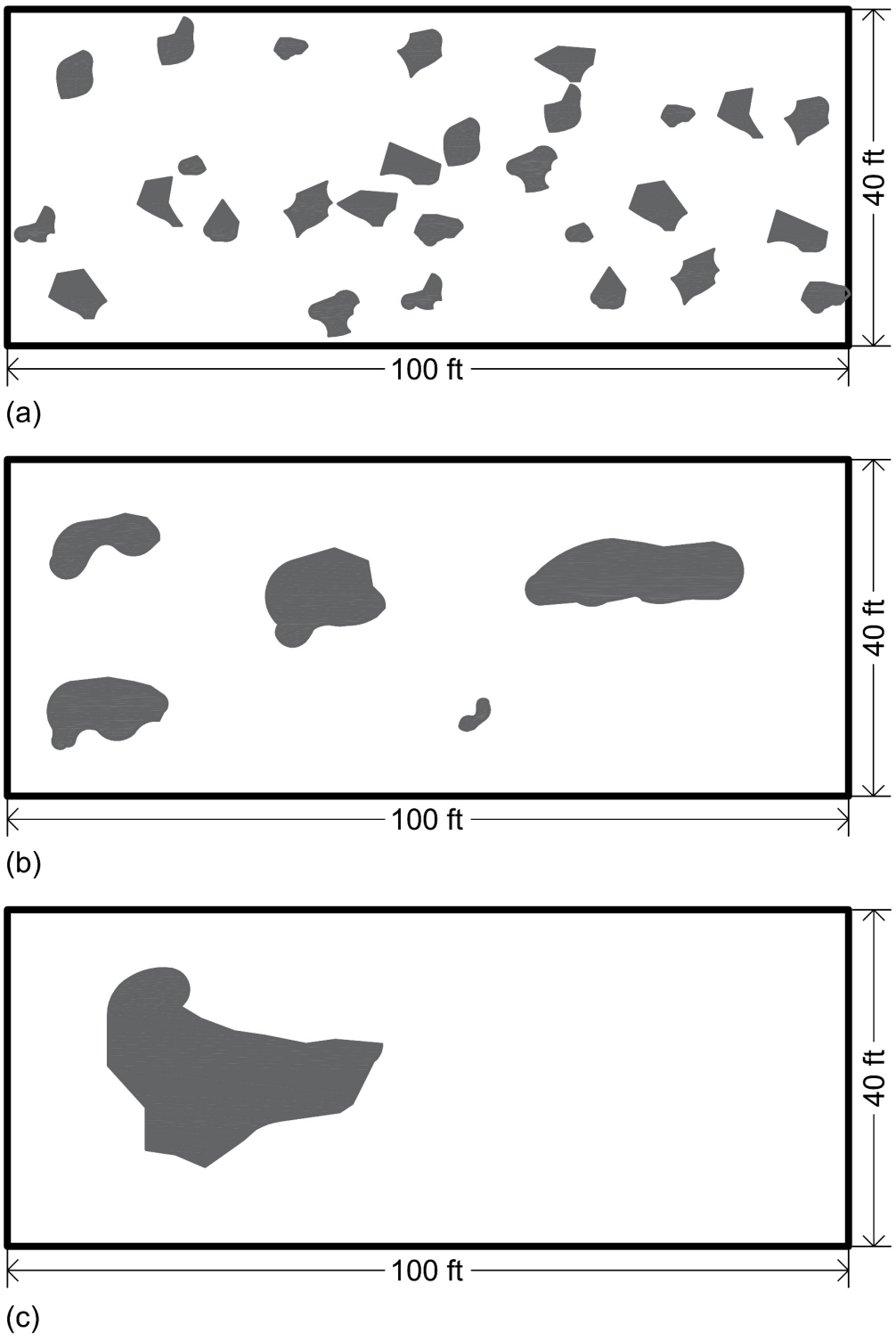


Figure 3.12-4. a), b) and c) area quantity estimate showing 10 percent of area damaged.

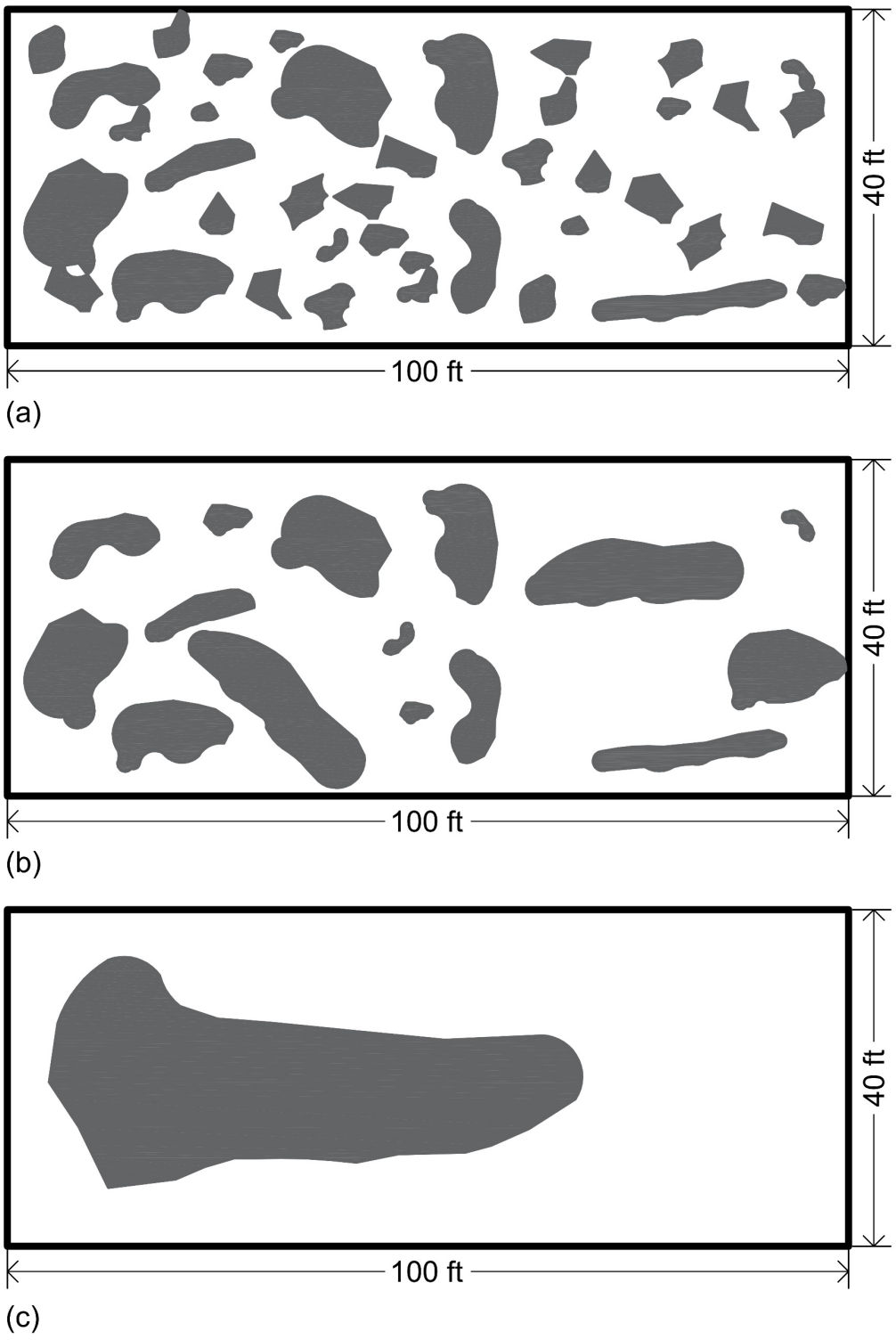


Figure 3.12-5. a), b), and c) area quantity estimate showing 25 percent of area damaged

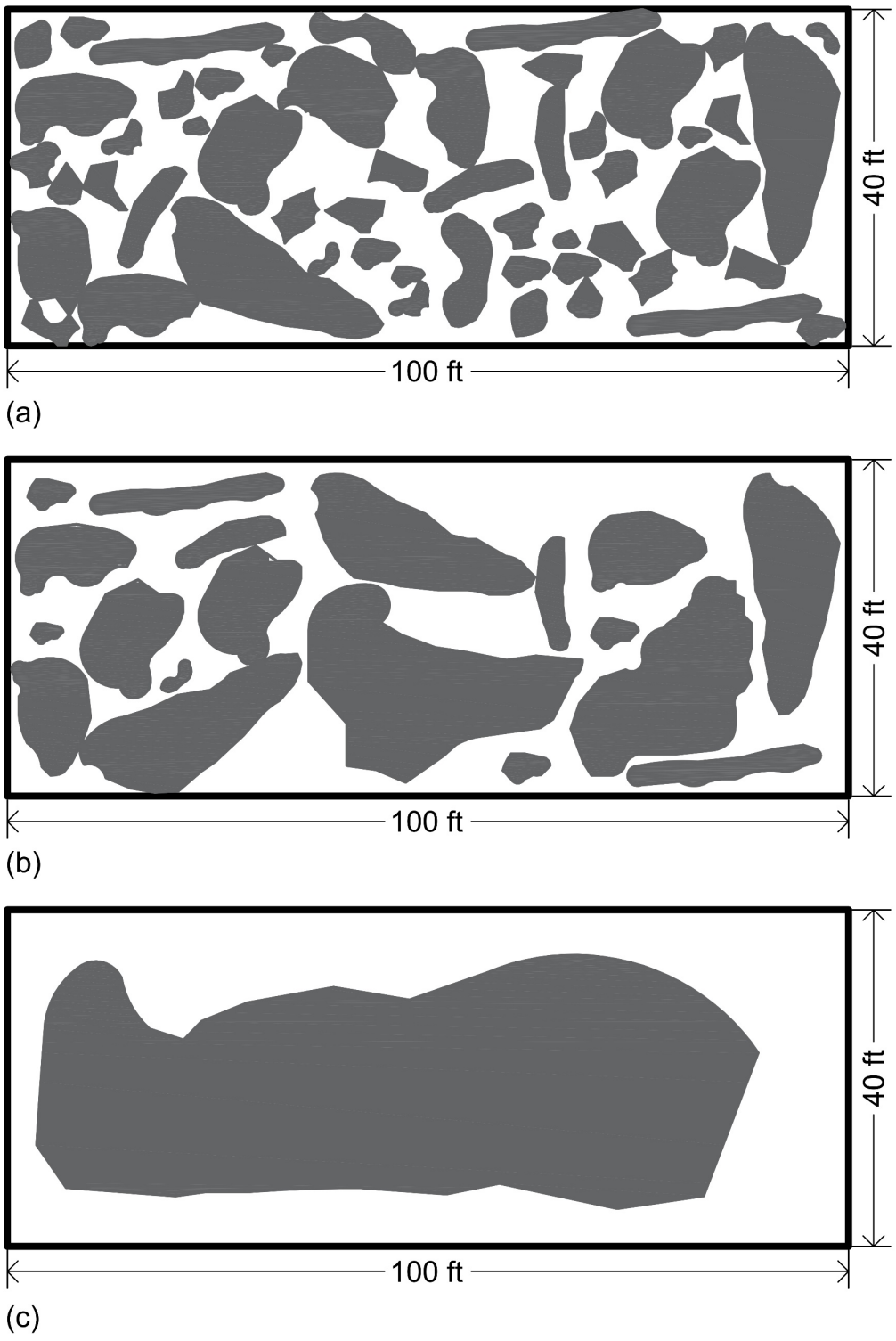


Figure 3.12-6. a), b), and c) area quantity estimate showing 50 percent of area damaged

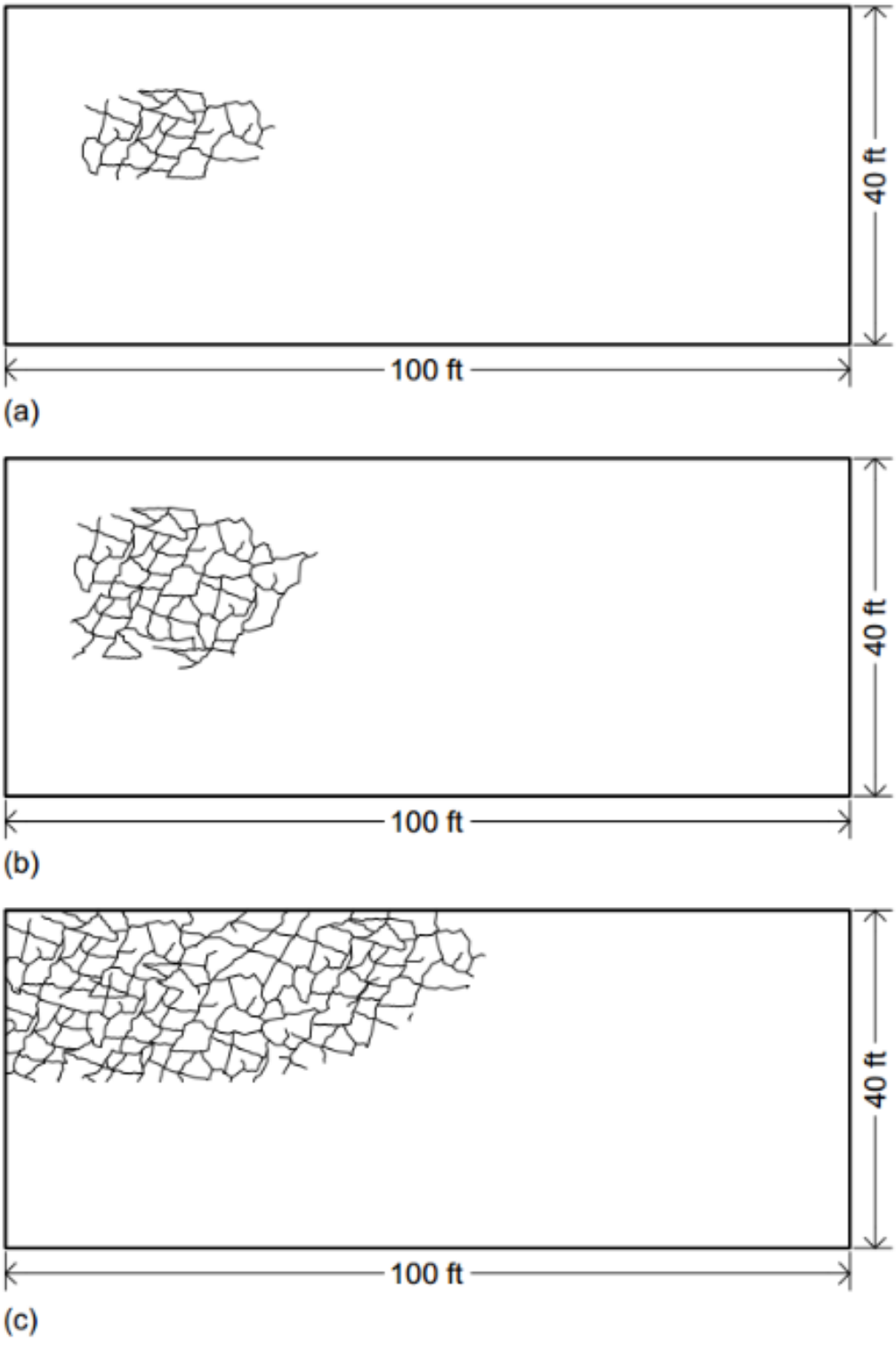


Figure 3.12-7. Moderate Pattern Cracking (Spacing between 1 and3 ft.) (a) 5 percent, (b) 10 percent, (c) 25 percent

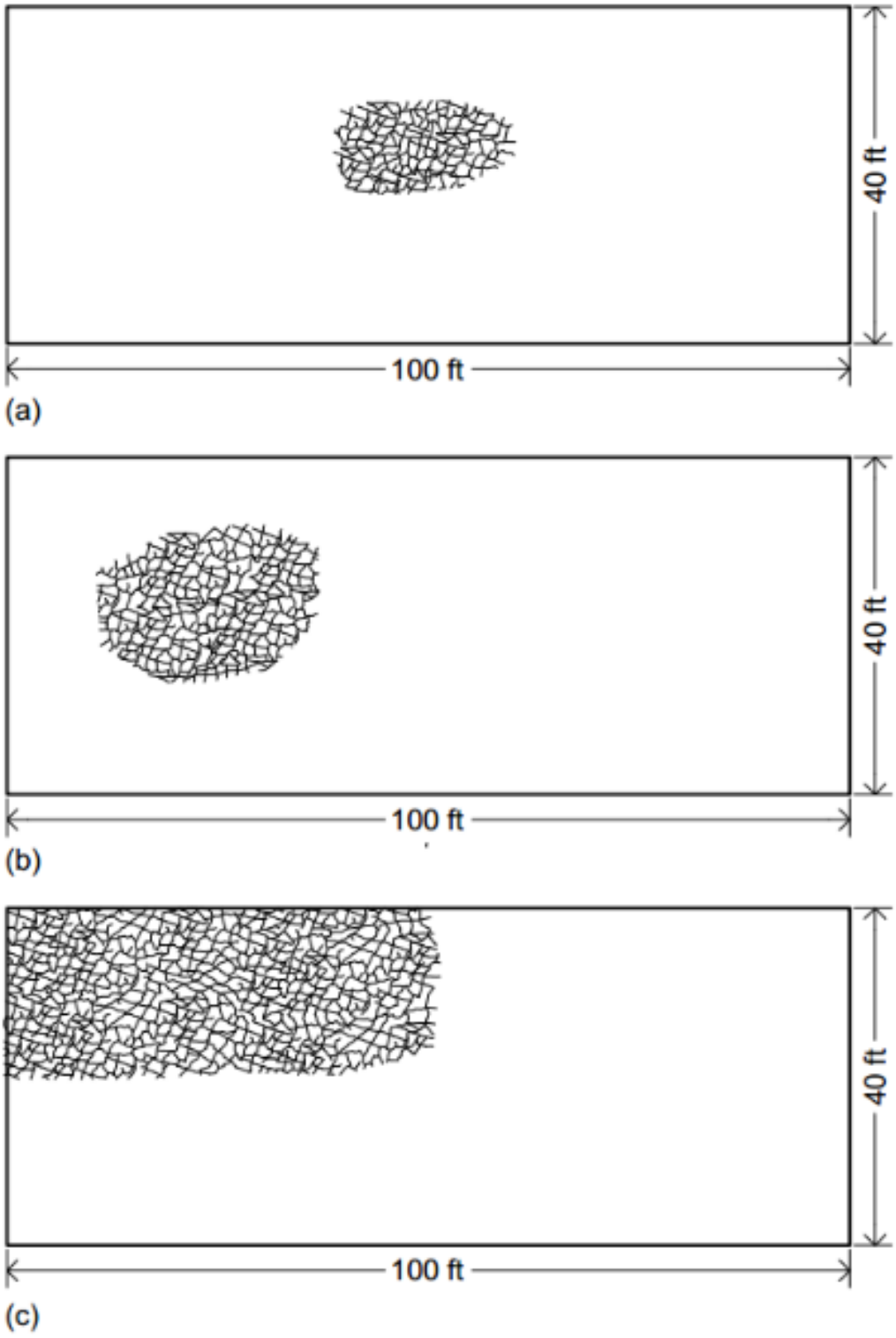


Figure 3.12-8. Heavy Pattern Cracking (spacing ≤ 1 ft.) (a) 5 percent, (b) 10 percent, (c) 25 percent

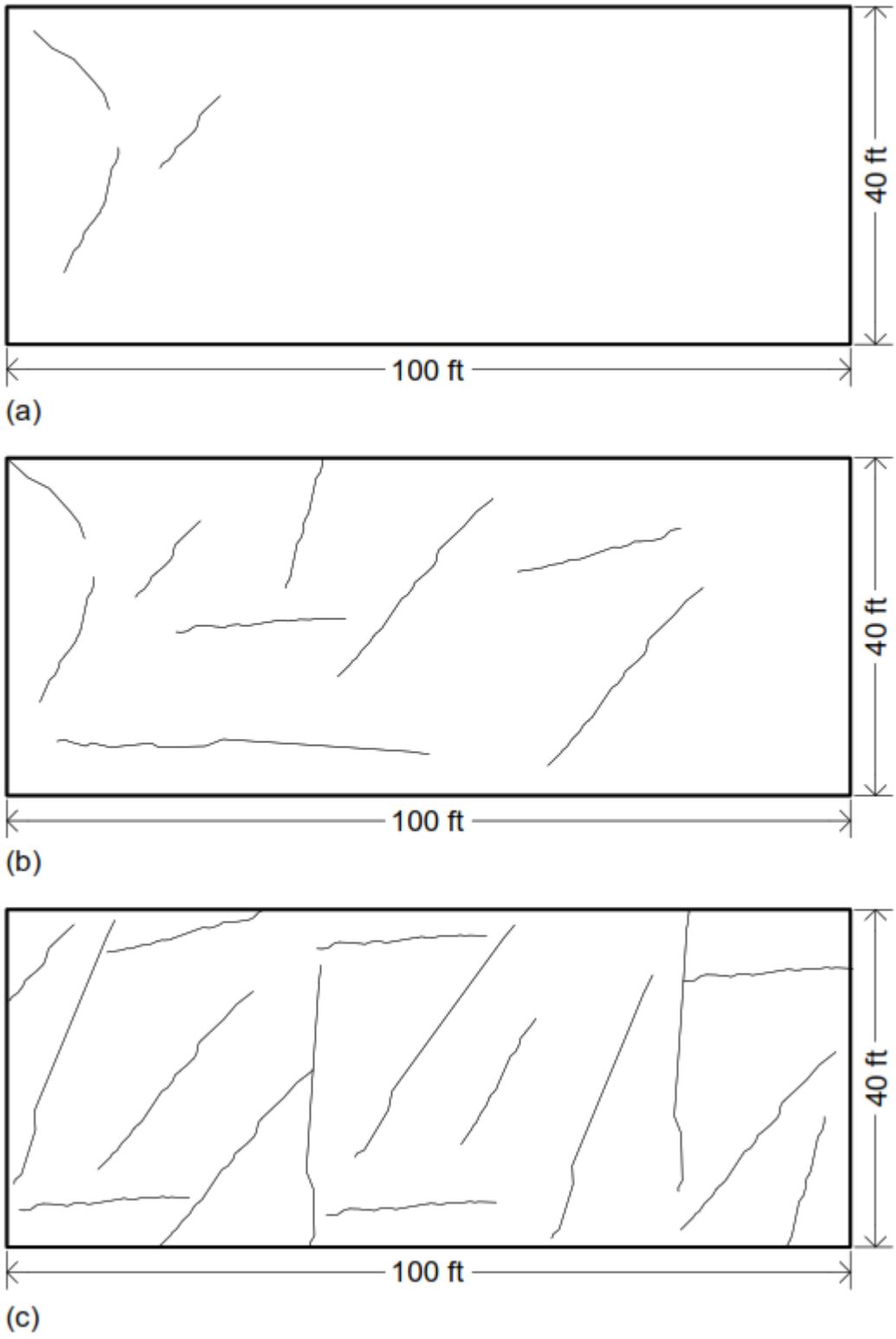


Figure 3.12-9. Isolated Cracking a) 1 percent, b) 5 percent, c) 10 percent.

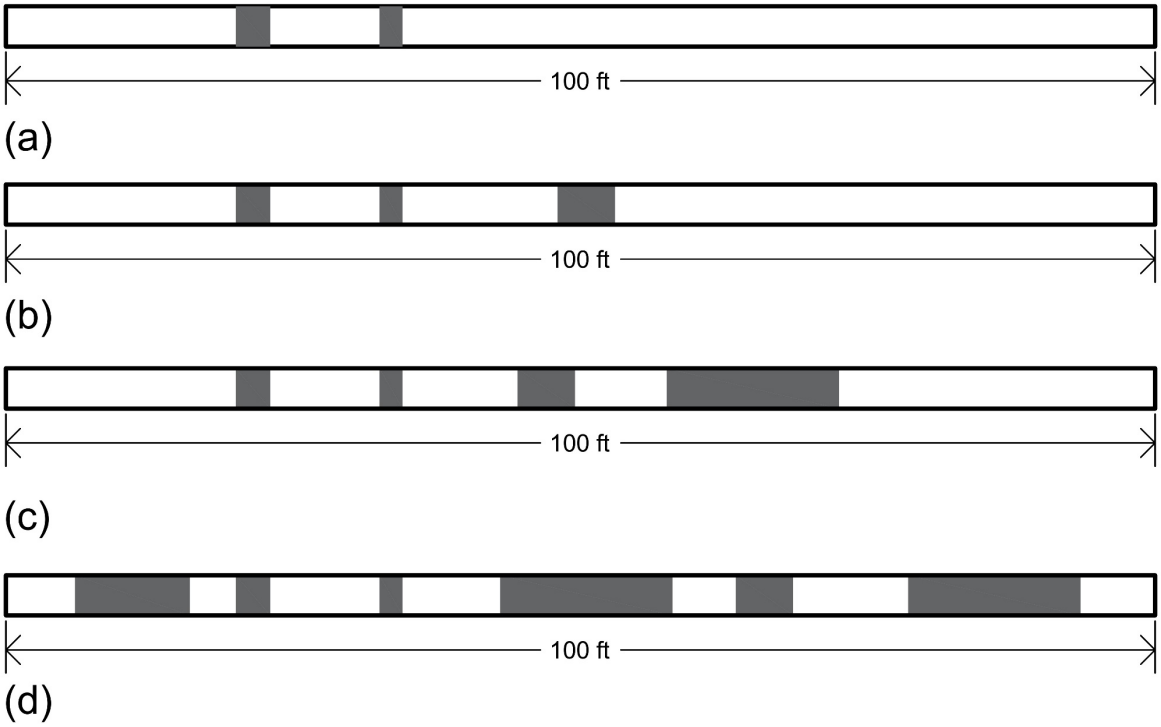


Figure 3.12-10. Linear quantity estimate a) 5 percent, b) 10 percent, c) 25 percent, d) 50 percent

3.13—ENVIRONMENTAL FACTORS (SERVICE ENVIRONMENTS)

Elements exposed to different environmental factors and service environments deteriorate differently. These factors may include:

- Operational activities from traffic volumes and truck movements,
- Exposure to water, road salt, and other corrosive materials,
- Condition of protective and water proofing systems, or
- Temperature extremes, either from nature or human activity.

When inventorying and assessing the condition of the elements, an inspector should consider the environment in which the element is operating. The environmental designation of an element can change over time; as it would, for example, if operating policies were changed to reduce the use of road salt. However, by definition, the environmental designation for any element cannot change as the result of maintenance work or deterioration.

Environment	Description
1—Benign	Neither environmental factors nor operating practices are likely to significantly change the condition of the element over time, or their effects have been mitigated by the presence of highly effective protective systems.
2—Low	Environmental factors, operating practices, or both either do not adversely influence the condition of the element, or their effects are substantially lessened by the application of effective protective systems.
3—Moderate	Any change in the condition of the element is likely to be quite normal as measured against the environmental factors, operating practices, or both that are considered typical by the agency.
4—Severe	Environmental factors, operating practices, or both contribute to the rapid decline in the condition of the element. Protective systems are not in place or are ineffective.

Examples of factors that could increase the severity of the environment rating for various types of elements may include any of the following. The inspector would record the predominant environmental factor affecting an element.

Elements	Example Environmental Factors
Timber Elements	High moisture content
	Pest infestation
	Ice flow impacts
Steel Elements	Distance from salt air
	Water wet/dry cycles
	Exposure to corrosive soils and liquids
Concrete Elements	Freeze–thaw cycles
	Tire chain wear
	Deck salting
Petroleum-Based	High temperature
Joints and Bearings	Extreme temperature ranges
Operating Practices	High traffic, truck volume, or both

APPENDIX A: AGENCY-DEFINED ELEMENTS (ADES)

This Manual was developed with the understanding that agencies may have elements in their inventory that are not included in the defined element set. An unlimited number of agency elements can be defined as necessary, providing that they conform to this Manual.

Agency elements fall into three main categories:

- Subsets of defined National Bridge Elements,
- Subsets of defined Bridge Management Elements, and
- Elements that are entirely independent of the defined elements.

A1—AGENCY-DEFINED SUBSETS OF THE NATIONAL BRIDGE ELEMENTS

The National Bridge Elements (NBEs) represent the primary structural components of bridges and are of national concern for safety. The NBE elements are intended to form an element basis for bridge condition assessment in the National Bridge Inventory (NBI). Due to the higher purpose for these NBEs, the flexibility for an agency to customize them is limited. An agency is permitted to create NBE sub-elements providing that the sub-elements can be aggregated back together for NBI submission. In all cases, the element condition states are fixed at four states and the specific condition state and defect criteria must remain consistent between the NBE and all agency-developed NBE sub-elements. For example, many agencies have developed elements to capture the quantity and condition of their "beam ends." This agency-developed element isolates the area around joints or hinges to capture the rapid deterioration that may occur in this area. Since the beam element itself is an NBE, this agency-developed sub-element would need to inherit all of the language characteristics of the encompassing NBE. In this example, the agency will simply subdivide the element quantity between two items that both share the same language. Combining the NBE beam element and the agency-developed "beam ends" together is simple addition and would permit consistent reporting of the quantity and condition distribution of this item to the NBI.

A2—AGENCY-DEFINED SUBSETS OF THE BRIDGE MANAGEMENT ELEMENTS

Agency-developed elements that are not a subset of an NBE have considerably more flexibility in customization. The Bridge Management Elements (BMEs) represent many components of bridges that require preservation but are not primary structural members. These elements include joints, wearing surfaces, protective coatings, and deck protection systems. These elements as a class are defined to provide a sound basis for bridge management. In order to identify these additional agency elements, the number range of 800 and above has been reserved and is not used in this Manual.

This Manual has defined a set of basic BMEs with the expectation that agencies may opt for considerably more detail in certain areas. For example, an agency may wish to individually define the wearing surfaces typically used in their bridge inventory into their own wearing surface elements in order to track performance and recognize cost differences for actions. In this example, these detailed wearing surface elements would be sub-elements of the general BME for wearing surfaces. For this wearing surface example, an agency would still be required to define only four condition states following the Good, Fair, Poor, and Severe convention. However, the BME would not need to be aggregated for national reporting unless the particular element information is required for submission to the FHWA for inclusion in the NBI.

When developing a sub-element of one of the defined 500-series BMEs, the agency needs to consider the potential impacts on the deterioration modeling in their bridge management systems (BMSs). The BMEs for protective coatings, wearing surfaces, and protection systems may need to be set up to influence the deterioration rates of certain elements. The relationship between these protective BMEs and other elements (NBEs or BMEs) must be considered if the agency wishes to have the deterioration modeling influenced by the protective element. For example, the steel protective coating element (Element 515) defines condition state language that covers conventional paint systems, weathering steel, and galvanized protective coatings. An agency may wish to break these three classes of protective coatings into their own BME to capture performance or cost differences among them. All of these protective coatings will influence the rate of deterioration of the base element that they are designed to protect. Condition forecast models in BMSs, such as the AASHTOWare Bridge Management™ software program, will slow or eliminate deterioration of the base element as long as the protective element is in good condition. This relationship between protective system and base element will constrain the degree of customization that an agency can exercise on the condition state element definitions of sub-elements to the 500-series BMEs.

A3—INDEPENDENT AGENCY-DEFINED ELEMENTS

Agencies may identify a business need to develop a completely independent custom element that is not a subset or derivative of an NBE or BME. Such custom elements provide the most flexibility; these elements are not intended to be reported at a national level, nor are they expected to be rolled up into any element with defined condition state language in this Manual. These elements are available for agencies utilizing BMSs to track elements unique to their inventory, such as movable bridge components, or to capture specific performance aspects of bridges. Independent agency-defined elements may or may not have defined feasible actions or defined deterioration, and need not follow any condition state or defect language included in this Manual. These are free-form elements that are only limited by the number of required condition states (four).

Examples of independent agency-developed elements could include approach guardrails, slope paving, seismic retrofit components, or tunnels, just to name a few. Independent agency elements could also be created to track maintenance items that an agency wishes to capture during the inspection process. Items such as the condition of drains, structure lighting, appurtenances, or bridge identification plaques could be developed into elements that are not associated with deterioration but potentially have feasible actions.

Independent agency-developed elements can also be created to capture the components and condition of ancillary structures that an agency may wish to inspect. These elements can exist side by side with the bridge elements and can optionally be defined with deterioration models or feasible actions as an agency desires. Custom element definitions provide a ready-made framework for capturing items such as tunnels, walls, median barriers, high-mast lighting, and overhead sign structures within an agency's BMS.

A3.1—Example Element Definition: Concrete Tunnel Ancillary Structure

The example on the following page shows an Agency-defined concrete tunnel element. The definition is presented in a format consistent with element definitions in Section 3 and uses the standard defect names, identifiers, and state language appropriate to reinforced concrete elements. While this example follows the conventions for concrete elements defined earlier, there is no requirement that an agency utilize any or all of these defects or defect state language. An agency may define entirely new defects and state language as necessary.

A3.1.1—Element 600—Concrete Tunnel (Example)

Description: All concrete tunnels.

Classification: ADE **Units of Measurement**: ft

Quantity Calculation: Sum of the lengths of the bores in decimal feet.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The remaining capacity of the tunnel been reduced due to the condition. The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel; OR a structural review has been completed and the defects impact strength or serviceability of the element or tunnel.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Crack (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Distortion (1900)	None.	None.	Tolerable without reducing load capacity.	
Load Capacity (5000)	No reduction.	No reduction.	No reduction.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in CS 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in CS 3 under the appropriate material defect entry.	The element or tunnel has impact damage. The specific damage caused by the impact has been captured in CS 4 under the appropriate material defect entry.

Element Commentary

None.

APPENDIX B: INSPECTION EXAMPLES

The examples provided show the evaluation and coding of bridge inspection data for timber, concrete, and steel bridges of varying complexity. The examples include the use of National Bridge Elements (NBEs) and Bridge Management Elements (BMEs) and the recording of defects. While it is an agency's choice of how to record defect codes, these examples were developed to demonstrate the use of the defect codes.

B1—TIMBER BRIDGE

The subject of this example is a four-span timber bridge crossing a small creek. The sketches in Figure B-1 show the bridge elements with relevant dimensions and note the locations of the defects described in Article B1.2.

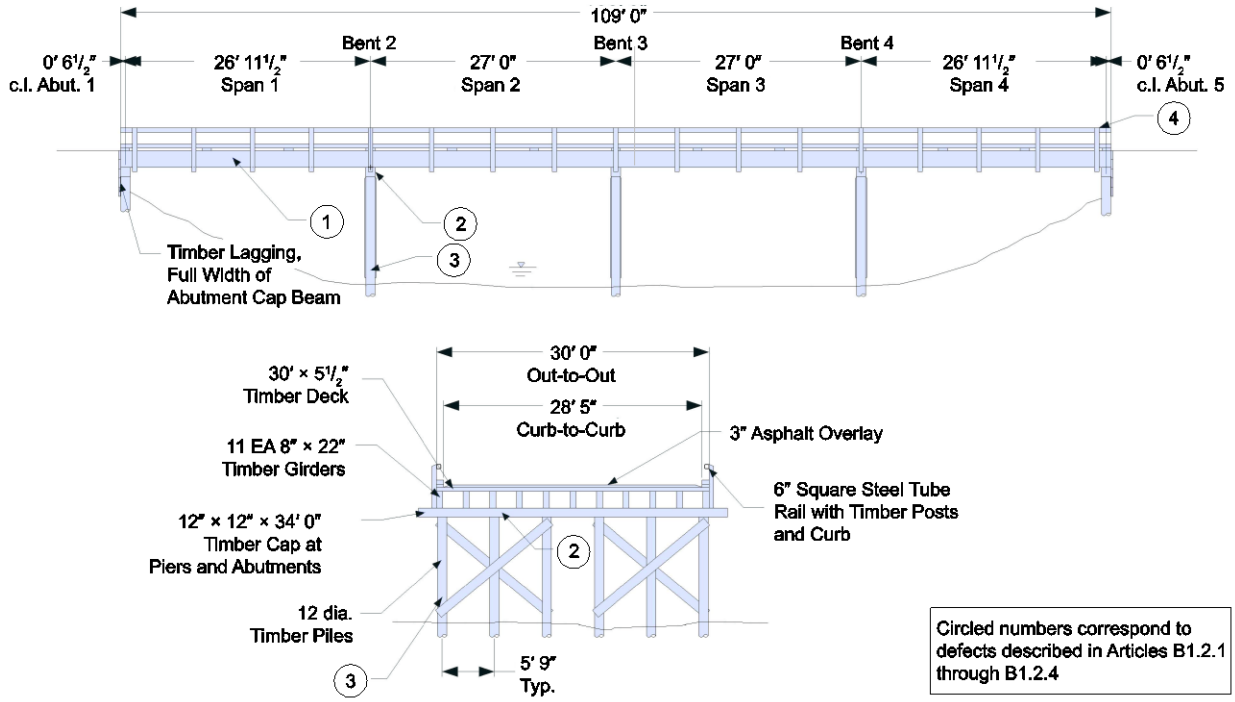


Figure B1-1—Elevation and Typical Section of Bridge for Timber Bridge Example

B1.1—Element Quantities

B1.1.1—Deck

The timber deck has an asphalt wearing surface that runs curb to curb:

Timber Deck (Element 31) Quantity: 30 ft × 109 ft = 3,270 ft^2
Wearing Surface (Element 510) Quantity: 28.42 ft × 109 ft = 3,097.78 ft^2 (round up to 3,098 ft^2)

The metal bridge railing has timber posts and curb. The square steel tube rail elements are galvanized:

Metal Bridge Railing (Element 330) Quantity: 109 ft × (2 railing lines) = 218 ft
Steel Protective Coating (Element 515) Quantity: 0.50 ft × (4 sides) × 109 ft × (2 railing lines) = 436 ft^2

B1.1.2—Superstructure

All four spans are composed of timber beams:

Timber Open Girder/Beam (Element 111) Quantity: 109 ft × (11 beams) = 1,199 ft

B1.1.3—Substructure

As separate elements distribute vertical loads to the piles and retain the approach embankment, the vertical load-carrying elements will be considered similar to a bent and the timber abutment will consist of only the lagging retaining the approach embankment behind the abutment piles and cap beam:

Timber Abutment (Element 216) Quantity: 34 ft × (2 abutments) = 68 ft

The timber piles at the abutments and bents can be visually inspected to mud line:

Timber Pile (Element 228) Quantity: (6 piles per substructure unit) × (3 bents + 2 abutments) = 30 piles

Vertical load is transferred to the piles at the abutments and bents by the timber bent caps:

Timber Pier Cap (Element 235) Quantity: (34 ft per substructure unit) × (3 bents + 2 abutments) = 170 ft

B1.2—Element Condition States

Aside from the defects described in Articles B1.2.1 through B1.2.4, all remaining element quantities are in good condition and are assigned to Condition State One. The following defects correspond to those labeled in Figure B1-1.

B1.2.1—Defect #1, Timber Open Girder/Beam (Element 111)

A 2-in. deep check (Defect #1150) extends the length of the right side exterior beam in Span 1, shown in Figure B1.2.1-1. As it penetrates 25 percent (2 in. of the 8-in. member thickness), the length of this beam (27 ft) is placed in Condition State 2. No other defects are present in the element.

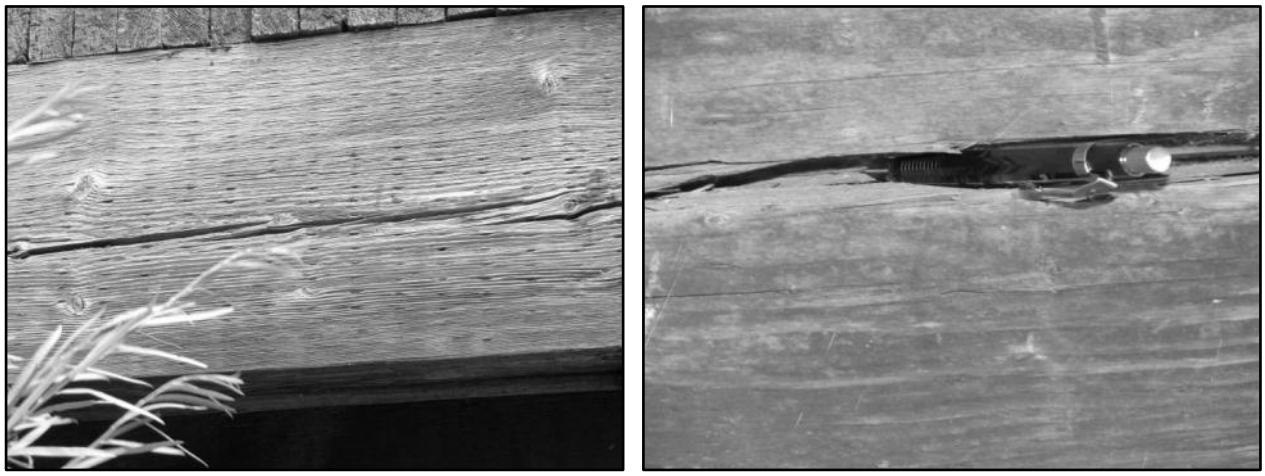


Figure B1.2.1-1—2-in. Deep Check in Exterior Beam

B1.2.2—Defect #2, Timber Pier Cap (Element 235)

A 1-in. deep check (Defect #1150) extends the length of the bent cap at Bent 2 as shown in Figure B1.2.2-1. As it penetrates 8 percent (1 in. of the 12-in. width of the member), the length of this beam (34 ft) is placed in Condition State 2. No other defects are present in the element.

Figure B1.2.2-1—1-in. Deep Check in Bent Cap at Bent 2

B1.2.3—Defect #3, Timber Pile (Element 228)

A 7-in. deep check (Defect #1150) 3 ft long is present in the left exterior pile of Bent 2 as seen in Figure B1.2.3-1. As it penetrates 58 percent (7 in. of the 12-in. member thickness), this condition meets the criteria for either Condition State 3 or Condition State 4. Per agency guidance, the severity of the check does not warrant structural review; this pile is placed in Condition State 3. Five other piles exhibit $1^1/_2$-in. to 2-in. deep checks (not shown) and are placed in Condition State 2.

Figure B1.2.3-1—7-in. Deep Check in Right Exterior Pile of Bent 2

B1.2.4—Defect #4, Metal Bridge Railing (Element 330)

Two posts at Abutment 4 exhibit severe decay (Defect #1140) affecting 80 percent of the post section as seen in Figure B1.2.4-1. Based on the severity and extent of the decay, this defect warrants structural review and the horizontal length of rail represented by the posts (2 ft) is placed in Condition State 4.

Figure B1.2.4-1—Decay in Timber Rail Posts

B1.3—Element Quantity and Condition State Summary

The element quantities and defects described above are summarized as follows:

Element Number	Element Description	Unit of Measure	Total Quantity	Condition State 1	Condition State 2	Condition State 3	Condition State 4	Defect #*
31	Timber Deck	ft^2	3,270	3,270	0	0	0	
510	Wearing Surfaces	ft^2	3,098	3,098	0	0	0	
330	Metal Bridge Railing	ft	218	216	0	0	2	4
1140	*Decay/Section Loss*	*ft*	*2*	*0*	*0*	*0*	*2*	*4*
515	Steel Protective Coating	ft^2	436	436	0	0	0	
111	Timber Open Girder/Beam	ft	1,199	1,172	27	0	0	1
1150	*Check/Shake*	*ft*	*27*	*0*	*27*	*0*	*0*	*1*
228	Timber Pile	each	30	24	5	1	0	3
1150	*Check/Shake*	*each*	*6*	*0*	*5*	*1*	*0*	*3*
216	Timber Abutment	ft	68	68	0	0	0	
235	Timber Pier Cap	ft	170	136	34	0	0	2
1150	*Check/Shake*	*ft*	*34*	*0*	*34*	*0*	*0*	*2*

Notes:

* See Figure B1-1 for defect locations.
Violet background: National Bridge Element
Blue background: Bridge Management Element
Italic type: Defect

B2—PRESTRESSED CONCRETE GIRDER BRIDGE

The subject of this example is a four-span prestressed concrete girder bridge crossing a divided highway. The sketches in Figure B2-1 show the bridge elements with relevant dimensions and note the locations of the defects described in Article B2.2.

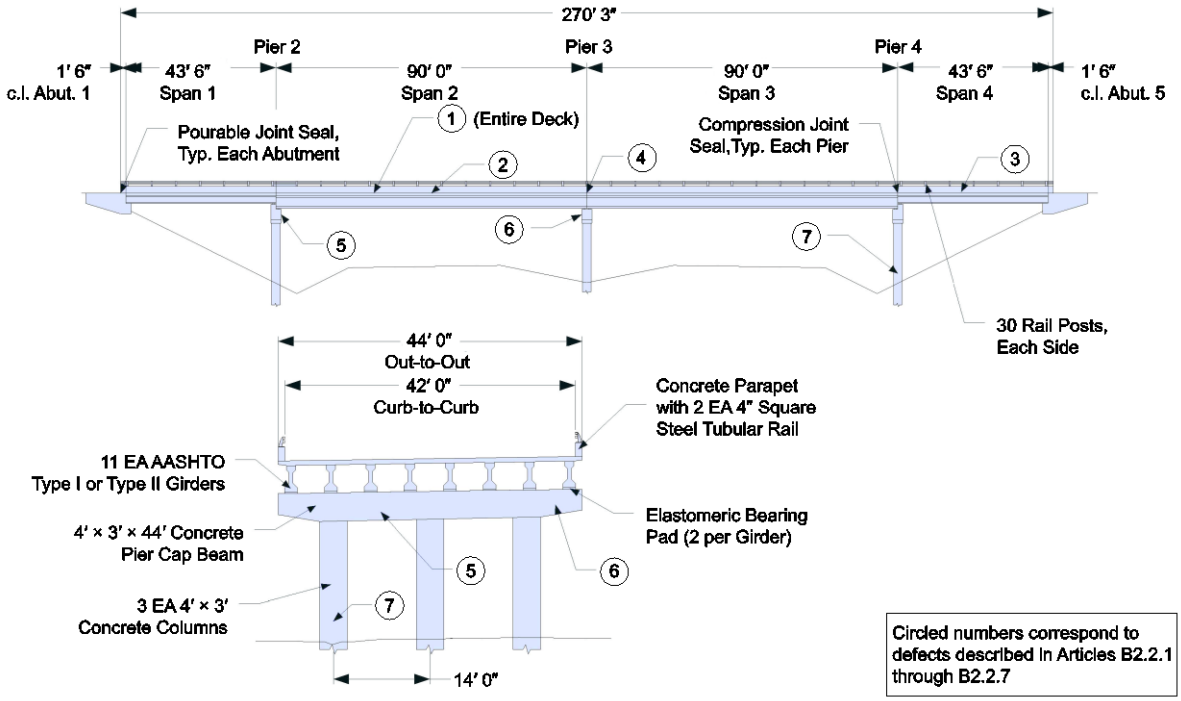


Figure B2-1—Elevation and Typical Section of Bridge for Prestressed Concrete Girder Bridge Example

B2.1—Element Quantities

B2.1.1—Deck

The reinforced concrete deck has uncoated reinforcing steel and no protective overlay.

Reinforced Concrete Deck (Element 12) Quantity: 270 ft × 44 ft = 11,880 ft^2

As the redirective elements of the bridge railing consist of a combination of concrete and metal components, both the metal and reinforced concrete railing elements will be considered. The metal railing members are galvanized; estimate the surface area of each metal post as 5 ft^2:

Metal Bridge Railing (Element 330) Quantity: 270 ft × (2 railing lines) = 540 ft
Steel Protective Coating (Element 515) Quantity: [0.33 ft × (4 sides)] × (2 rails) × 270 ft + 5 ft^2 per post × 30 posts × (2 railing lines) = 1,725.60 ft^2 (rounded up to 1,726 ft^2)
Reinforced Concrete Bridge Railing (Element 331) Quantity: 270 ft × (2 railing lines) = 540 ft

There is a deck joint at every substructure unit, extending out-to-out of the bridge deck, with pourable joint seals at the abutments and compression joint seals at the piers. There is no skew:

Pourable Joint Seal (Element 301) Quantity: 44 ft × (2 joints) = 88 ft
Compression Joint Seal (Element 302) Quantity: 44 ft × (3 joints) = 132 ft

B2.1.2—Superstructure

Since the prestressed concrete girders extend past the bearings and are embedded in the end and pier diaphragms, the length of the bridge minus the backwall thickness (1 ft at each end) provides a good estimate of the total length of each girder line:

Prestressed Concrete Open Girder (Element 109) Quantity: [270 ft—(2 × 1 ft)] × (8 girders) = 2,144 ft

Elastomeric bearings transfer load from the girders to the substructure:

Elastomeric Bearing (Element 310) Quantity: (2 bearings per girder) × (8 girders per span) × (4 spans) = 64 bearings

B2.1.3—Substructure

The reinforced concrete abutment distributes vertical load to the piles (not visible for inspection) and retains the approach embankment.

Reinforced Concrete Abutment (Element 215) Quantity: (44 ft per abutment) × (2 abutments) = 88 ft

Each reinforced concrete pier consists of a pier cap (Element 234) and three columns (Element 205):

Reinforced Concrete Column (Element 205) Quantity: (3 columns per pier) × (3 piers) = 9 columns
Reinforced Concrete Pier Cap (Element 234) Quantity: (44 ft per pier) × (3 piers) = 132 ft

B2.2—Element Condition States

Aside from the defects described in Articles B2.2.1 through B2.2.7, all remaining element quantities are in good condition and assigned to Condition State One. The following defects correspond to those labeled in Figure B2-1.

B2.2.1—Defect #1, Reinforced Concrete Deck (Element 12)

Transverse, hairline cracks throughout at variable spacing greater than 3 ft throughout the top surface of the deck. Based on the cracks' widths (less than 0.012 in.) and density (greater than 3 ft), these areas meet the criteria for Condition State 1.

B2.2.2—Defect #2, Reinforced Concrete Deck (Element 12)

1-in. to 2-in. deep spalls with exposed rebar (with no section loss) and areas of distressed patches in both lanes near midspan of Span 2, shown in Figure B2.2.2-1. The total area of spalls is 12 ft^2; the total area of distressed patches is 100 ft^2. With no section loss, the exposed rebar (Defect #1090) meets the criteria for Condition State 2. As the spalls (Defect #1080) are more than 1 in. deep, all of these areas (112 ft^2 total) meet the criteria for Condition State 3, which controls.

Figure B2.2.2-1—Spalls and Distressed Patches in Span 2 Deck

B2.2.3—Defect #3, Reinforced Concrete Deck (Element 12)

1-in. to 2-in. deep spalls with exposed rebar (with no section loss) and areas of distressed patches in both lanes near midspan of Span 4, shown in Figure B2.2.3-1. The total area of spalls is 40 ft^2; the total area of distressed patches is 60 ft^2. With no section loss, the exposed rebar (Defect #1090) meets the criteria for Condition State 2. As the spalls (Defect #1080) are more than 1 in. deep and the patches are not sound, all of these areas (100 ft^2 total) meet the criteria for Condition State 3.

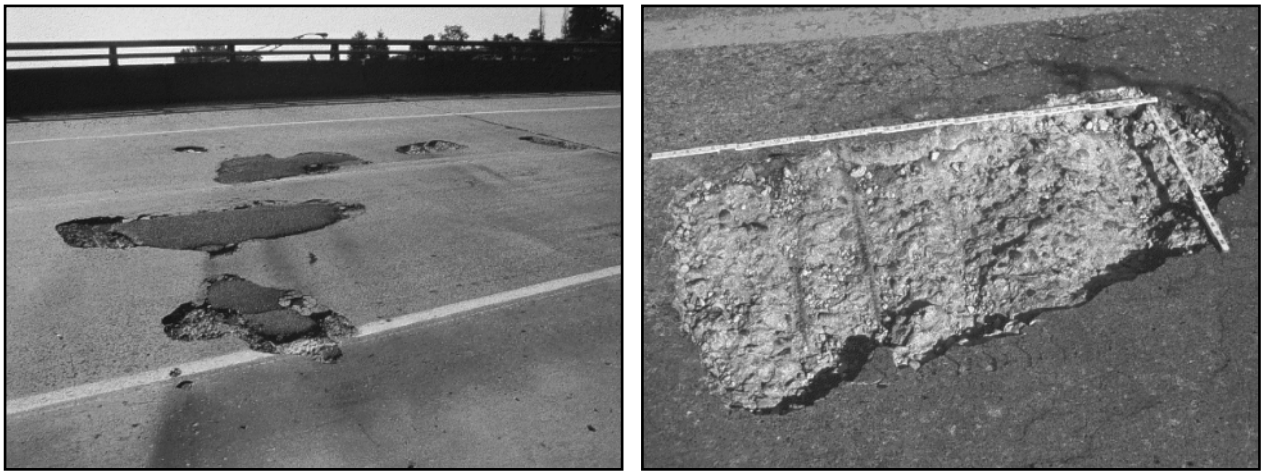


Figure B2.2.3-1—Spalls and Distressed Patches in Span 4 Deck

B2.2.4—Defect #4, Compression Joint Seal (Element 302) and Reinforced Concrete Deck (Element 12)

Deep spalls with unsound concrete the full length (40 ft) of the deck 6 in. adjacent to the joint seal at Pier 3, shown in Figure B2.2.4-1. The gland at this joint is also partially pulled out. For the joint element, the seal damage (Defect #2330) meets the criteria for Condition State 3 but the adjacent deck damage (Defect #2360) meets the criteria for Condition State 4, which controls. Due to their depth, the spalls (Defect #1080) in the concrete deck element in this area (40 ft × 1 ft = 40 ft^2) meet the criteria for Condition State 3.

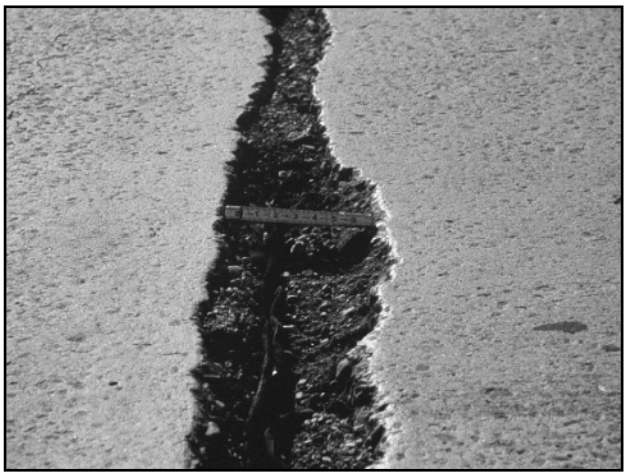


Figure B2.2.4-1—Deep Spalls in the Deck Adjacent to the Joint Seal at Pier 3

B2.2.5—Defect #5, Reinforced Concrete Pier Cap (Element 234)

The underside of the Pier 2 cap has a spalled area 12 ft long and 2 in. deep with exposed rebar and rust staining, shown in Figure B2.2.5-1. The depth of the spall (Defect #1080) meets the criteria to place this length of cap beam in Condition State 3. The section loss measured on the exposed rebar (Defect #1090) does not warrant a structural review of the cap beam and also meets the criteria for Condition State 3. Agency policy in this situation places a higher priority on the exposed rebar, making it the predominant defect.

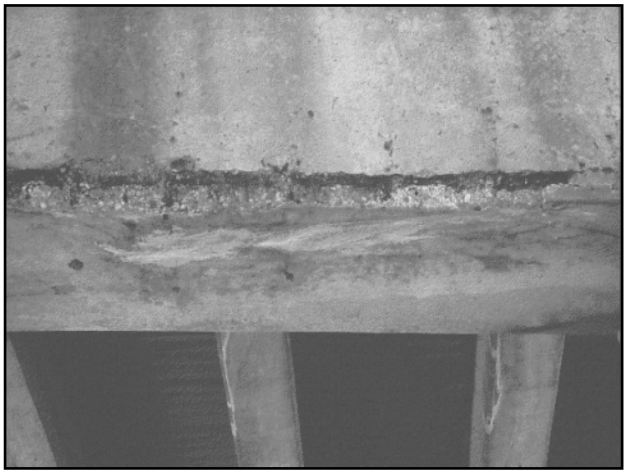


Figure B2.2.5-1—Spall, Underside of Pier 2 Cap

B2.2.6—Defect #6, Reinforced Concrete Pier Cap (Element 234)

Both the right and left cantilevers of the Pier 3 cap exhibit 0.04-in. wide cracks, some with rust staining, shown in Figure B2.2.6-1. This cracking extends for 2 ft on the left side and for 4 ft on the right. The widths of these cracks (Defect #1130) meet the criteria to place this quantity of the cap in Condition State 2; however, the presence of efflorescence (Defect #1120) with rust staining meets the criteria for Condition State 3, which controls.

Figure B2.2.6-1—0.04-in. Width Cracks with Rust Staining in the Cantilevers of the Pier 3 Cap

B2.2.7—Defect #7, Reinforced Concrete Column (Element 205)

The left column of Pier 4 has a $^{3}/_{16}$-in. wide × 11-ft long vertical crack, shown in Figure B2.2.7-1. A previous structural review found that this crack does not affect the strength or serviceability of the element; thus, the width of this crack (Defect #1130) meets the criteria to place this column in Condition State 3.

Figure B2.2.7-1—$^{3}/_{16}$-in. Width Vertical Crack in Left Column of Pier 4

B2.3—ELEMENT QUANTITY AND CONDITION STATE SUMMARY

The element quantities and defects described above are summarized as follows:

Element Number	Element Description	Unit of Measure	Total Quantity	Condition State 1	Condition State 2	Condition State 3	Condition State 4	Defect #*
12	Reinforced Concrete Deck	ft^2	11,880	11,628	0	252	0	1,2,3,4
1080	*Delamination/Spall/ Patched Area*	*ft^2*	*252*	*0*	*0*	*252*	*0*	*2,3,4*
301	Pourable Joint Seal	ft	88	88	0	0	0	
302	Compression Joint Seal	ft	132	92	0	0	40	4
2360	*Adjacent Deck or Header*	*ft*	*40*	*0*	*0*	*0*	*40*	*4*
330	Metal Bridge Railing	ft	540	540	0	0	0	
515	Steel Protective Coating	ft^2	1,726	1,726	0	0	0	
331	Reinforced Concrete Bridge Railing	ft	540	540	0	0	0	
109	Prestressed Concrete Girder/Beam	ft	2,144	2,144	0	0	0	
310	Elastomeric Bearing	each	64	64	0	0	0	
215	Reinforced Concrete Abutment	ft	88	88	0	0	0	
205	Reinforced Concrete Column	each	9	8	0	1	0	7
1130	*Cracking (RC and Other)*	*each*	*1*	*0*	*0*	*1*	*0*	*7*
234	Reinforced Concrete Pier Cap	ft	132	114	0	18	0	5,6
1090	*Exposed Rebar*	*ft*	*12*	*0*	*0*	*12*	*0*	*5*
1120	*Efflorescence/Rust Staining*	*ft*	*6*	*0*	*0*	*6*	*0*	*6*

Notes:

* See Figure B2-1 for defect locations
Violet background: National Bridge Element
Blue background: Bridge Management Element
Italic type: Defect

B3—STEEL TRUSS BRIDGE

The subject of this example is a two-span steel truss bridge crossing a river. The sketches in Figure B3-1 show the bridge elements with relevant dimensions and note the locations of the defects described in Article B3.2.

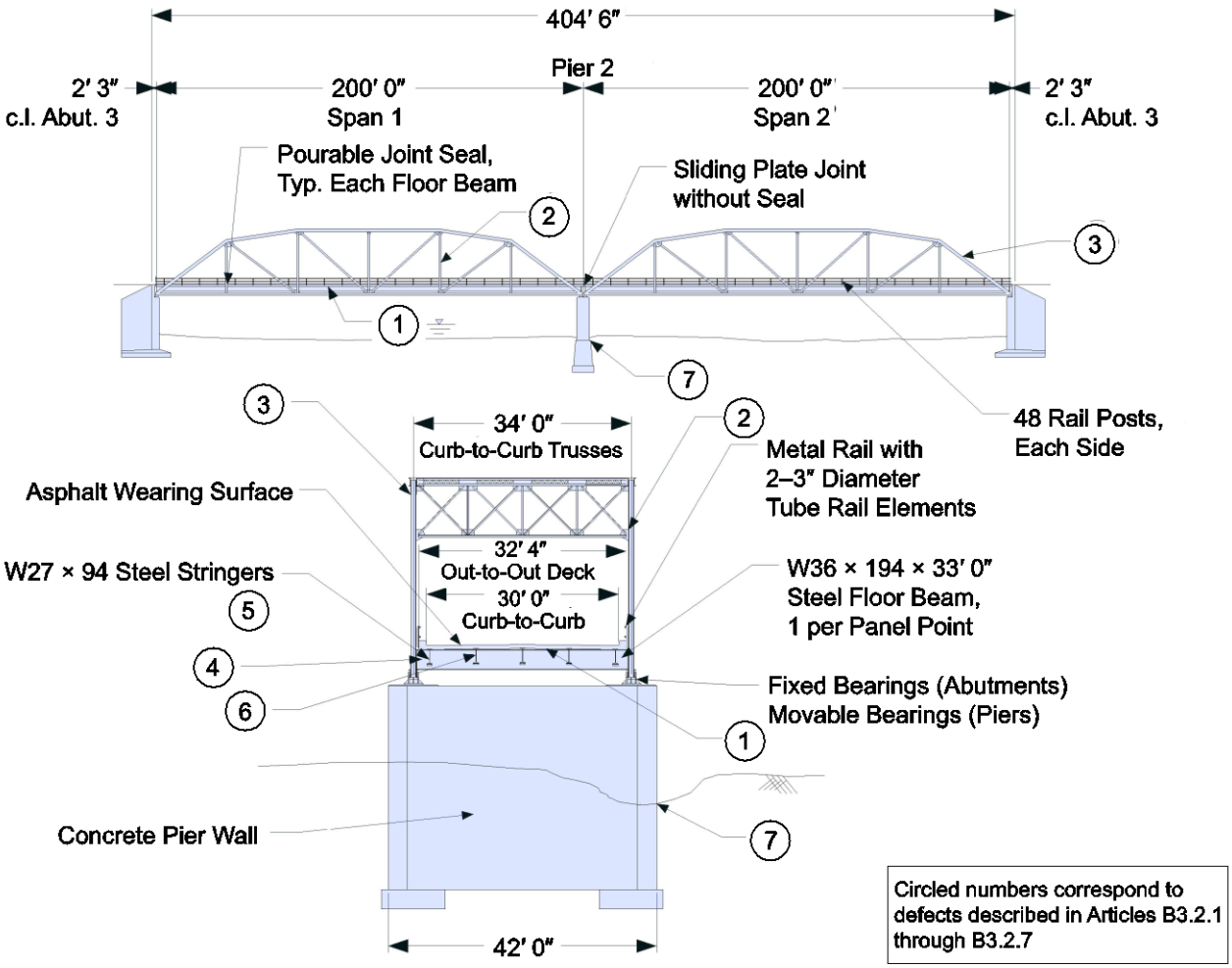


Figure B3-1—Elevation and Typical Section of Bridge for Steel Truss Bridge Example

B3.1—Element Quantities

B3.1.1—Deck

The reinforced concrete deck has uncoated reinforcing steel and an asphalt wearing surface overlay.

Reinforced Concrete Deck (Element 12) Quantity: 404.50 ft × 32.33 ft = 13,077.49 ft^2 (round up to 13,078 ft^2)
Wearing Surface (Element 510) Quantity: 404.50 ft × 30 ft = 12,135 ft^2

The metal railing has a concrete curb and metal posts. The metal railing members are painted; estimate the surface area of each metal post as 5 ft^2:

Metal Bridge Railing (Element 330) Quantity: 404.50 ft × (2 railing lines) = 809 ft
Steel Protective Coating (Element 515) Quantity: [3.1416 × 0.25 ft] × (2 rails) × 404.50 ft + 5 ft^2 per post × 48 posts × (2 railing lines) = 1,750.78 ft^2 (round up to 1751 ft^2)

There are deck joints with pourable seals at 12 of the 14 floor beams. The sliding plate expansion joint at the pier does not have a seal. All joints extend from out-to-out of the deck. There is no skew:

Pourable Joint Seal (Element 301) Quantity: 32.33 ft × (12 joints) = 388 ft
Assembly Joint without Seal (Element 305) Quantity: 32.33 ft × (1 joint) = 32.33 ft (round up to 33 ft)

B3.1.2—Superstructure

The main superstructure elements are the steel truss, floor beams, and stringers. Each of these elements is painted:

Steel Truss (Element 120) Quantity: 200 ft × (2 trusses per span) × (2 spans) = 800 ft
Steel Protective Coating (Element 515) Quantity: Calculated from "as-built" plans; 18,696 ft^2

Steel Floor Beam (Element 152) Quantity: 33 ft × (7 floor beams per span) × (2 spans) = 462 ft
Steel Protective Coating (Element 515) Quantity: 33 ft × 8.9 ft^2/ft* × (14 floor beams) = 4,112 ft^2

Steel Stringer (Element 113) Quantity: 200 ft × (5 stringers) × (2 spans) = 2,000 ft
Steel Protective Coating (Element 515) Quantity: 200 ft × 6.8 ft^2/ft* x (5 stringers) × (2 spans) = 13,600 ft^2

* Surface area per foot length for W36 × 194 (floor beams) and W27 × 94 (stringers) steel sections are taken from the AISC *Steel Design Guide 19*, "Fire Resistance of Structural Steel Framing," Appendix A, and do not include the surface area of the top face of the top flange.

There is a gusset plate assembly at each truss connection composed of two gusset plates (one on each side). All of the assemblies are painted; estimate the painted surface area of each gusset plate as 16 ft^2:

Steel Gusset Plate (Element 162) Quantity: (12 plate assemblies per span) × (2 trusses) × (2 spans) = 48
Steel Protective Coating (Element 515) Quantity: (48 assemblies) × (2 plates per assembly) × (16 ft^2/plate) = 1,536 ft^2

Each truss is supported on one movable bearing and one fixed bearing. The bearings are painted; estimate the painted surface area of each bearing as 12 ft^2:

Movable Bearing (Element 311) Quantity: (1 bearing per truss) × (2 trusses per span) × (2 spans) = 4 bearings
Steel Protective Coating (Element 515) Quantity: (4 bearings) × (12 ft^2/bearing) = 48 ft^2

Fixed Bearing (Element 313) Quantity: (1 bearing per truss) × (2 trusses per span) × (2 spans) = 4 bearings
Steel Protective Coating (Element 515) Quantity: (4 bearings) × (12 ft^2/bearing) = 48 ft^2

B3.1.3—Substructure

The reinforced concrete abutment distributes vertical load to the spread footing foundation and retains the approach embankment. The abutments are the same width as the pier wall.

Reinforced Concrete Abutment (Element 215) Quantity: 42 ft × (2 abutments) = 84 ft

The trusses are also supported on a reinforced concrete pier wall:

Reinforced Concrete Pier Wall (Element 215) Quantity: 42 ft × (1 pier) = 42 ft

B3.2—Element Condition States

Aside from the defects described in Articles B3.2.1 through B3.2.7, all element quantities are in good condition and assigned to Condition State 1. The following defects correspond to those labeled in Figure B3-1.

B3.2.1—Defect #1, Reinforced Concrete Deck (Element 12)

Moderate efflorescence (Defect #1120) is noted in the two interior deck bays throughout the length of Span 1 (affected area: 15 ft × 200 ft = 3000 ft^2), shown in Figure B3.2.1-1. Based on the extent of the efflorescence build-up and the lack of rust staining, these areas meet the criteria for Condition State 2. Cracks (Defect #1130) measuring 0.015 in. wide spaced at 1 ft are also noted. The width and density of these cracks also meet the criteria for Condition State 2. Agency policy in this situation places a higher priority on the efflorescence, making it the predominant defect.

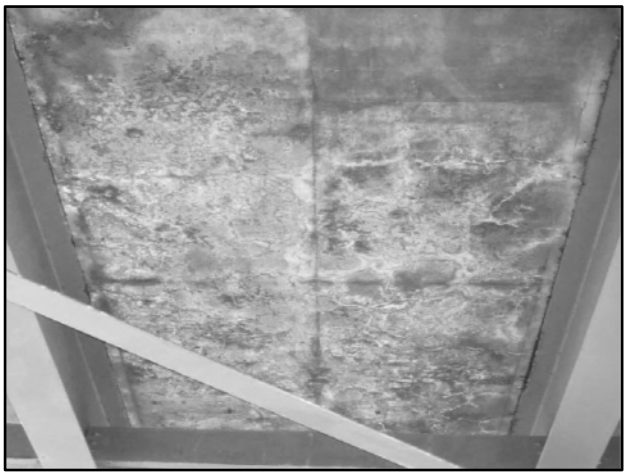


Figure B3.2.1-1—Efflorescence on the Underside of the Deck in Span 1

B3.2.2—Defect #2, Steel Truss (Element 120)

There is new impact damage to the sway bracing at panel point 4 in the Span 1 truss, resulting in a 1-in. distortion (Defect #7000) in the right side L4-U4 vertical member as shown in Figure B3.2.2-1. As the impact of this damage on the strength and serviceability of the truss is unknown, the length of the truss attributed to the vertical, measured parallel to the traveled way (1 ft) is placed in Condition State 4.

Figure B3.2.2-1—Sway Bracing Impact Damage in Span 1

B3.2.3—Defect #3, Steel Truss (Element 120), Steel Gusset Plate (Element 162), and Steel Protective Coating (Element 515)

Freckle rust throughout the length of both spans, both trusses as shown in Figure B3.2.3-1. As no section loss is measured, this corrosion (Defect #1000) results in the entire quantity of the steel truss and gusset plate elements being assigned to Condition State 2. The paint system throughout is chalking (Defect #3410), exhibiting loss of pigment, and meeting the criteria for Condition State 3. The areas of paint where freckle rust is noted (estimated at 5 percent of the painted area, or 18,696 ft^2 × 0.05 = 935 ft^2 of the trusses and 1,536 ft^2 × 0.05 = 77 ft^2 of the gusset plates) have failed (Defect #3440), meeting the criteria for Condition State 4.

Figure B3.2.3-1—Freckle Rust, Typical, Both Trusses, Both Spans

B3.2.4—Defect #4, Steel Floor Beam (Element 152) and Steel Protective Coating (Element 515)

Freckle rust throughout the length of all floor beams; thus, the quantity of the steel floor beam element not showing further corrosion is assigned to Condition State 2. There is corrosion (Defect #1000) with less than 10 percent section loss in the top flange at 20 of the 28 beam ends, shown in Figure B3.2.4-1, which meets the criteria for Condition State 3. Each affected area will be considered to represent 2 ft of floor beam length (20 × 2 ft = 40 ft total). The paint system in these areas (approximately 2 ft^2 per location, 20 × 2 ft^2 = 40 ft^2 total) has failed (Defect #3440) and is assigned to Condition State 4. The paint system throughout the rest of the beams is chalking (Defect #3410), exhibiting loss of pigment and meeting the criteria for Condition State 3. The areas of paint where freckle rust is noted (estimated at 5 percent of the painted area, or 4,112 ft^2 × 0.05 = 206 ft^2) have also failed (Defect #3440), meeting the criteria for Condition State 4.

Figure B3.2.4-1—Corrosion at Floor Beam Ends

B3.2.5—Defect #5, Steel Stringer (Element 113)

Freckle rust present near the floor beam connections; total length affected is 50 ft. As no section loss is evident, the corrosion (Defect #1000) in these areas meets the criteria for Condition State 2. In these areas, the paint is chalking (Defect #3410), exhibiting loss of pigment and meeting the criteria for Condition State 3 (total affected area is 50 ft × 6.8 ft^2/ft = 340 ft^2). The areas of paint where freckle rust is noted (estimated at 5 percent of the affected area, or 340 ft^2 × 0.05 = 17 ft^2) have failed (Defect #3440), meeting the criteria for Condition State 4.

B3.2.6—Defect #6, Steel Stringer (Element 113)

Broken and missing rivets in 8 stringer-to-floor beam connections (Defect #1020), shown in Figure B3.2.6-1. Each affected connection will be considered to represent 1 ft of stringer length, or 8 × 1 ft = 8 ft total. This condition led the Inspector to assign these quantities to Condition State 4 in the field. However, a structural review of the floor system demonstrates that, despite the missing fasteners, the bridge can still carry legal loads and, per agency policy, these quantities are reassigned to Condition State 3.

Figure B3.2.6-1—Missing and Broken Fasteners at Stringer-to-Floor Beam Connections

B3.2.7—Defect #7, Pier Wall (Element 210)

There is a small scour hole (Defect #6000) extending 10 ft in from the upstream end of the pier wall as shown in Figure B3.2.7-1. The measured scour is within the tolerable limits established by the bridge's scour evaluation; thus, the affected length meets the criteria for Condition State 2.

Figure B3.2.7-1—Scour Hole at the Upstream End of the Pier Wall

B3.3—Element Quantity and Condition State Summary

The element quantities and defects described above are summarized as follows:

Element Number	Element Description	Unit of Measure	Total Quantity	Condition State 1	Condition State 2	Condition State 3	Condition State 4	Defect #*
12	Reinforced Concrete Deck	ft^2	13,079	10,079	3,000	0	0	1
1120	*Efflorescence/Rust Staining*	*ft^2*	*3,000*	*0*	*3,000*	*0*	*0*	*1*
510	Wearing Surface	ft^2	12,135	12,135	0	0	0	—
330	Metal Bridge Railing	ft	809	809	0	0	0	—
515	Steel Protective Coating	ft^2	1,751	1,751	0	0	0	—
301	Pourable Joint Seal	ft	388	388	0	0	0	—
305	Assembly Joint without Seal	ft	33	33	0	0	0	—
120	Steel Truss	ft	800	0	799	0	1	2,3
1000	*Corrosion*	*ft*	*800*	*0*	*799*	*0*	*0*	*3*
7000	*Damage*	*ft*	*1*	*0*	*0*	*0*	*1*	*2*
515	Steel Protective Coating	ft^2	18,696	0	0	17,761	935	3
3410	*Chalking*	*ft^2*	*17,761*	*0*	*0*	*17,761*	*0*	*3*
3440	*Effectiveness*	*ft^2*	*935*	*0*	*0*	*0*	*935*	*3*
152	Steel Floor Beam	ft	462	0	442	20	0	4
1000	*Corrosion*	*ft*	*462*	*0*	*442*	*20*	*0*	*4*
515	Steel Protective Coating	ft^2	4,112	0	0	3,866	246	4
3410	*Chalking*	*ft^2*	*3,866*	*0*	*0*	*3,866*	*0*	*4*
3440	*Effectiveness*	*ft^2*	*246*	*0*	*0*	*0*	*246*	*4*
113	Steel Stringer	ft	2,000	1,942	50	8	0	5,6
1000	*Corrosion*	*ft*	*50*	*0*	*50*	*0*	*0*	*5*
1020	*Connections*	*ft*	*8*	*0*	*0*	*8*	*0*	*6*
515	Steel Protective Coating	ft^2	13,600	13,260	0	323	17	5
3410	*Chalking*	*ft^2*	*323*	*0*	*0*	*323*	*0*	*5*
3440	*Effectiveness*	*ft^2*	*17*	*0*	*0*	*0*	*17*	*5*
162	Steel Gusset Plate	each	48	0	48	0	0	3
515	Steel Protective Coating	ft^2	1,536	0	0	1,459	77	3
3410	*Chalking*	*ft^2*	*1,459*	*0*	*0*	*1,459*	*0*	*3*
3440	*Effectiveness*	*ft^2*	*77*	*0*	*0*	*0*	*77*	*3*
311	Movable Bearing	each	4	4	0	0	0	—
515	Steel Protective Coating	ft^2	48	48	0	0	0	—

Element Number	Element Description	Unit of Measure	Total Quantity	Condition State 1	Condition State 2	Condition State 3	Condition State 4	Defect #*
313	Fixed Bearing	each	4	4	0	0	0	—
515	Steel Protective Coating	ft^2	48	48	0	0	0	—
215	Reinforced Concrete Abutment	ft	84	84	0	0	0	—
210	Reinforced Concrete Pier Wall	ft	42	32	10	0	0	7
6000	*Scour*	*ft*	*10*	*0*	*10*	*0*	*0*	*7*

Notes:

* See Figure B3-1 for defect locations
Violet background: National Bridge Element
Blue background: Bridge Management Element
Italic type: Defect

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APPENDIX C: ELEMENT GROUPINGS

The charts on the following pages organize the elements defined in Section 3 into National Bridge Elements (NBEs) and Bridge Management Elements (BMEs). For each element, the name, identifier, and units of measure are shown and elements are grouped by major bridge assembly and material type.

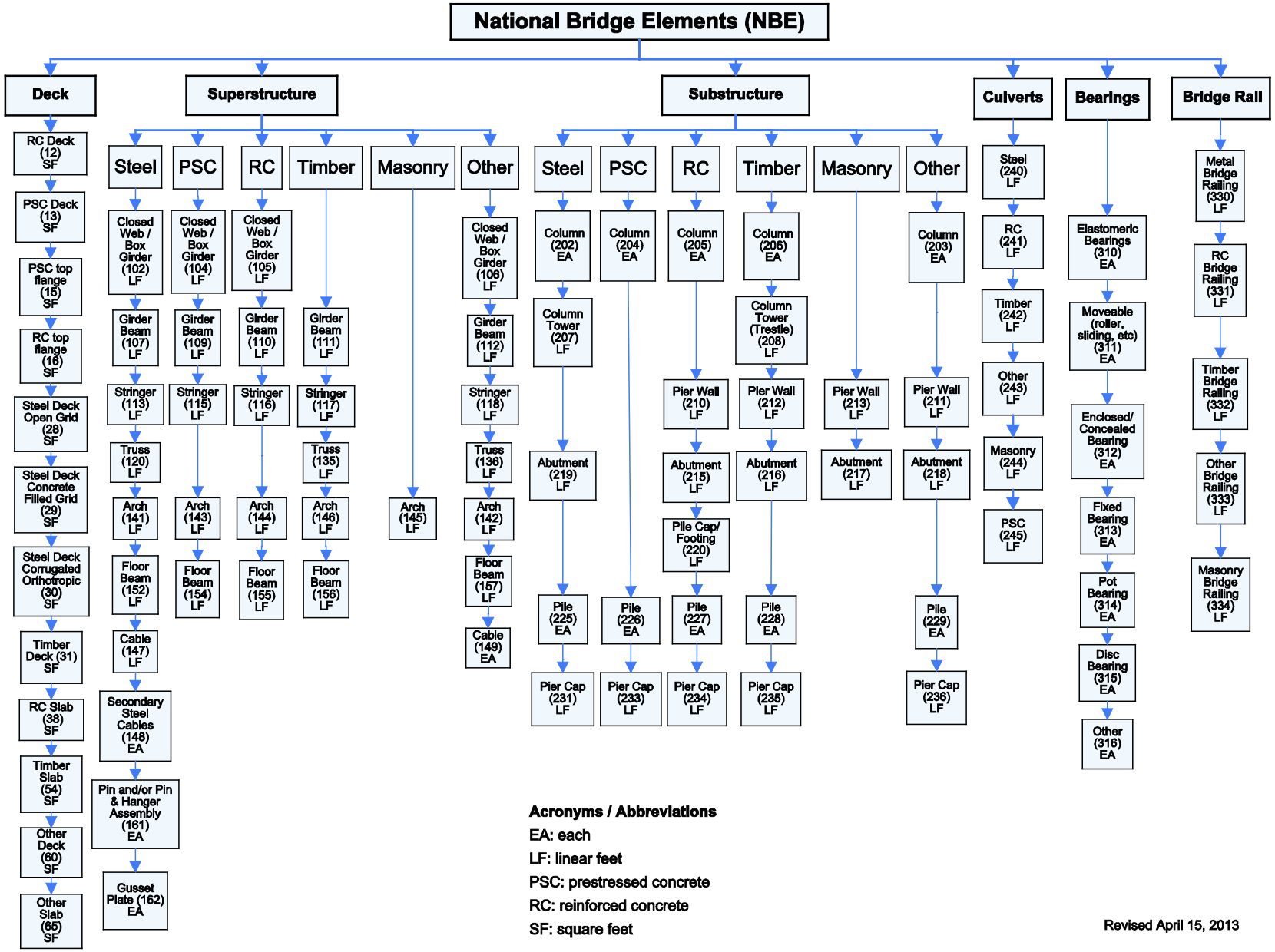

Figure C-1—National Bridge Elements (*courtesy of Federal Highway Administration*)

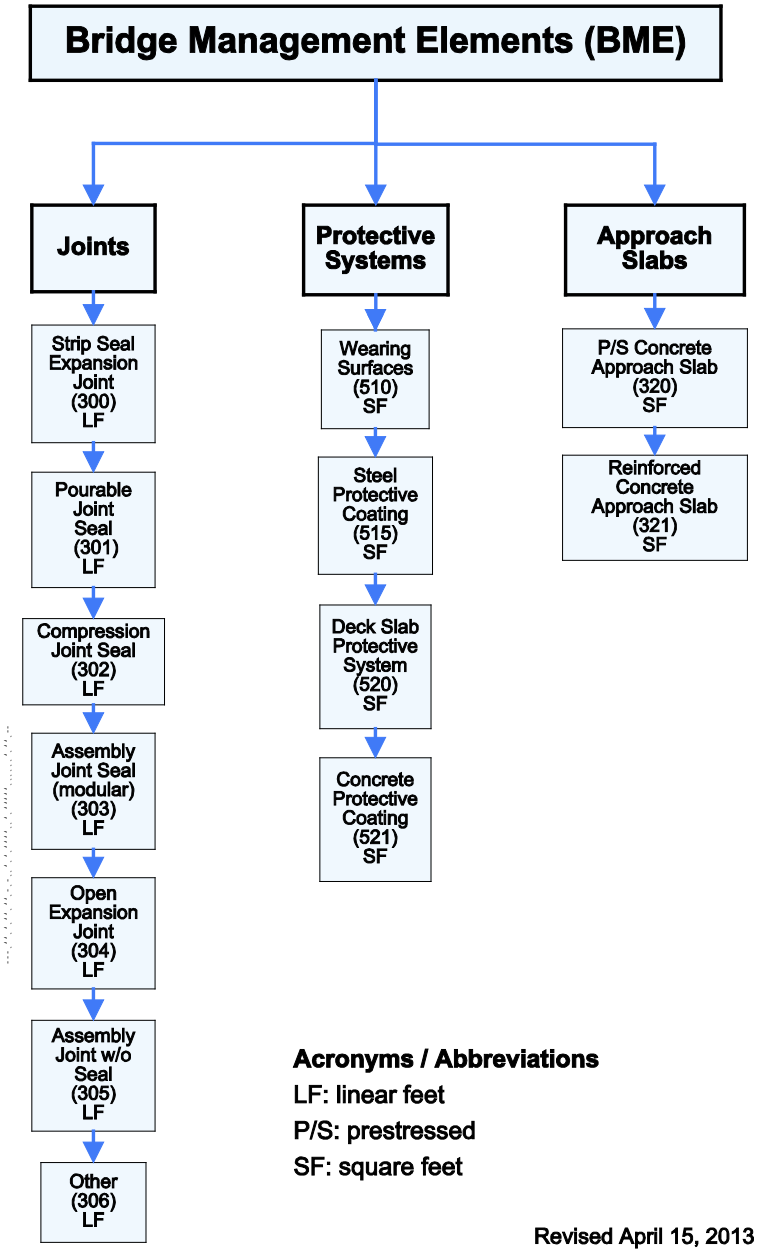

Figure C-2—Bridge Management Elements (*courtesy of Federal Highway Administration*)

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APPENDIX D: MATERIALS AND FEASIBLE ACTIONS BY MATERIAL TYPE

This Appendix describes the element materials defined in this Manual and the feasible actions that may be applied for each condition state. Included are individual materials, such as reinforced and prestressed concrete, steel, timber, masonry, and other materials; and element types that are made of mixed materials or are not material-based, including joints, protective coatings, wearing surfaces, and deck protection systems. For each material or element type, the feasible actions are listed at a high level, with the understanding that agency practices will differ in scope and detail. The primary intent is to provide a roadmap of possible actions scaled by distress or defect severity, with the assumption that needed work for all elements constructed of these materials or in an element family may be addressed by one or more of these common feasible actions. Material identification codes are provided for reference consistent with Section 3.

D1—STEEL (100)

	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Feasible Actions:	Do Nothing Protect	Do Nothing Protect Repair	Do Nothing Protect Repair Rehabilitate Replace	Do Nothing Protect Repair Rehabilitate Replace

D2—PRESTRESSED CONCRETE (300)

	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Feasible Actions:	Do Nothing Protect	Do Nothing Protect Repair	Do Nothing Protect Repair Rehabilitate Replace	Do Nothing Protect Repair Rehabilitate Replace

D3—REINFORCED CONCRETE (400)

	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Feasible Actions:	Do Nothing Protect	Do Nothing Protect Repair	Do Nothing Protect Repair Rehabilitate Replace	Do Nothing Protect Repair Rehabilitate Replace

D4—TIMBER (500)

	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Feasible Actions:	Do Nothing Protect	Do Nothing Protect Repair	Do Nothing Protect Repair Rehabilitate Replace	Do Nothing Protect Repair Rehabilitate Replace

D5—OTHER MATERIALS (600)

	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Feasible Actions:	Do Nothing Protect	Do Nothing Protect Repair	Do Nothing Protect Repair Rehabilitate Replace	Do Nothing Protect Repair Rehabilitate Replace

D6—MASONRY (650)

	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Feasible Actions:	Do Nothing Protect	Do Nothing Protect Repair	Do Nothing Protect Repair Rehabilitate Replace	Do Nothing Protect Repair Rehabilitate Replace

D7—WEARING SURFACES (800)

	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Feasible Actions:	Do Nothing Protect	Do Nothing Protect Repair	Do Nothing Protect Repair Rehabilitate Replace	Do Nothing Protect Repair Rehabilitate Replace

D8—CONCRETE REINFORCING STEEL PROTECTIVE SYSTEMS (820)

	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Feasible Actions:	Do Nothing Protect	Do Nothing Protect Repair	Do Nothing Protect Repair Rehabilitate Replace	Do Nothing Protect Repair Rehabilitate Replace

D9—STEEL PROTECTIVE COATINGS (850)

	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Feasible Actions:	Do Nothing Protect	Do Nothing Protect Repair	Do Nothing Protect Repair Rehabilitate Replace	Do Nothing Protect Repair Rehabilitate Replace

D10—CONCRETE PROTECTIVE COATINGS (880)

	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Feasible Actions:	Do Nothing Protect	Do Nothing Protect Repair	Do Nothing Protect Repair Rehabilitate Replace	Do Nothing Protect Repair Rehabilitate Replace