



# BRIDGE INSPECTION HANDBOOK

A guide to the proper safety inspection and evaluation of  
vehicular bridges on USFWS facilities

U.S. Fish and Wildlife Service  
Division of Engineering





# **USFWS Bridge Inspection Handbook**



## Table of Contents

1	INTRODUCTION.....	1
1.1	BACKGROUND.....	1
1.2	SCOPE OF HANDBOOK.....	1
2	INSPECTION REQUIREMENTS.....	2
2.1	USFWS RESPONSIBILITIES.....	2
2.2	BRIDGE INSPECTION TEAM.....	2
2.3	TYPES OF INSPECTIONS.....	3
2.3.1	Initial Inspection.....	3
2.3.2	Routine Inspection.....	4
2.3.3	In-Depth Inspection.....	4
2.3.4	Damage Inspection.....	4
2.3.5	Fracture Critical Member Inspection.....	5
2.3.6	Underwater Inspection.....	5
2.3.7	Interim Inspection.....	6
2.3.8	Special Inspection.....	6
2.4	FREQUENCY OF INSPECTION.....	6
2.4.1	Initial Inspections.....	7
2.4.2	Routine Inspections.....	7
2.4.3	Fracture Critical Member Inspections.....	7
2.4.4	Underwater Inspections.....	7
2.4.5	Interim Inspections.....	7
2.4.6	In-Depth, Damage, and Special Inspections.....	7
3	INSPECTION PROCEDURES.....	8
3.1	PREPARATION FOR INSPECTION.....	8
3.2	BRIDGE ACCESS.....	8
3.3	FIELD DOCUMENTATION TECHNIQUES.....	8
3.3.1	Field Notes.....	8
3.3.2	Urgent Item Forms.....	9
3.3.3	Images.....	9
3.4	Fracture Critical Members.....	10
3.4.1	General Requirements.....	10
3.4.2	Pre-Inspection / Documentation.....	10
3.4.3	Inspection Documentation.....	10

3.4.4 Inspection Procedures: ..... 11

3.5 In-Depth Dive Inspections ..... 11

3.6 STATION PRE-INSPECTION COORDINATION ..... 12

3.7 STATION POST-INSPECTION DEBRIEFING ..... 13

3.8 POST-TRIP DEBRIEFING ..... 13

4 LOAD RATING ..... 15

4.1 DATA COLLECTION ..... 15

4.2 TYPES OF LOAD RATING ..... 16

4.2.1 Inventory Rating ..... 16

4.2.2 Operating Rating ..... 16

4.3 STANDARD DESIGN VEHICLES ..... 16

4.4 ANALYSIS METHOD ..... 18

4.5 INITIAL LOAD RATING ..... 18

4.6 REVIEW AND UPDATE OF LOAD RATINGS ..... 18

4.7 LOAD RATING CALCULATIONS AND RESULTS ..... 18

4.8 BRIDGE POSTING ..... 18

4.9 NBI CODING OF LOAD RATING RESULTS ..... 19

5 INSPECTION REPORTS ..... 21

5.1 INTRODUCTION ..... 21

5.2 TYPES ..... 21

5.2.1 Full Reports ..... 22

5.2.2 Check Report ..... 22

5.2.3 Documentation Report ..... 22

5.2.4 Underwater and Damage Reports ..... 23

5.3 CONTENT ..... 23

5.3.1 Summary of Findings ..... 23

5.3.2 Fracture Critical Members (FCM) Findings ..... 23

5.3.3 Recommendations ..... 24

5.3.4 Load Rating and Posting ..... 26

5.3.5 Condition Ratings ..... 26

5.3.6 Sketches ..... 27

5.3.7 Images ..... 31

5.3.8 Structure Inventory and Appraisal Data ..... 32

5.3.9 Additional NBI and FWS Items ..... 32

5.4 WRITING GUIDELINES ..... 36

## Bridge Inspection Handbook

5.4.1	Be Clear .....	36
5.4.2	Be Concise .....	36
5.4.3	Be Correct .....	37
Appendices.....		A-1
I.	Sample Reports .....	A-3
A.	Full Report.....	A-3
B.	Check Report.....	A-39
II.	Urgent Item Form .....	A-45
III.	Bridge Closure Guidance.....	A-49
IV.	Glossary Of Common Engineering And Construction Terms .....	A-53
V.	National Bridge Inspection Standards.....	A-87
VI.	Federal Highway Administration Memoranda.....	A-95





# 1 INTRODUCTION

## 1.1 BACKGROUND

On August 29<sup>th</sup>, 1990, then U.S. Fish and Wildlife Service (Service) Deputy Director Richard N. Smith initiated the Service “Bridge Safety Inspection Program.” The stated intent of the initiative was “...to ensure the safety and structural integrity of the Service’s bridges.”

Since its inception, the Service Bridge Safety Program (Program) has been an integral part of Service asset management-related activities. The Program is governed by Service Manual Chapter 362 FW 3, which provides policy regarding structures we must inspect, inspection frequency, inspection program personnel, and other Bridge Safety Program requirements. Program management and technical oversight is the responsibility of the Division of Engineering - Headquarters office (DEN).

## 1.2 SCOPE OF HANDBOOK

This document, the *USFWS Bridge Inspection Handbook*, provides supplemental guidance about specific bridge inspection activities that have evolved over the duration of the Program. The purpose of this handbook is to:

- Ensure the proper safety inspection and evaluation of bridges on Service facilities,
- Standardize reporting procedures, and
- Provide guidance for complying with the requirements of 362 FW 3 and the National Bridge Inspection Standards (NBIS).

Both pedestrian and vehicular bridges are found on Service installations. This handbook addresses the requirements for the inventory, inspection, rating, and reporting for vehicular bridges only.

## 2 INSPECTION REQUIREMENTS

The Service conducts bridge inspections to determine the physical and functional condition of a bridge, to form a basis for evaluation and load rating, to provide a continuous record of the structure, and to establish priorities for repair or replacement. The success of the inspection is dependent on proper planning, having the right equipment, and the experience and qualifications of the inspection team.

All bridge inspections are to be conducted in accordance with NBIS and Service requirements. Service bridge inspection requirements are in 362 FW 3, Vehicular Bridge Inspection.

We must plan and conduct bridge inspections as necessary to properly evaluate the condition of the structure and to protect people traveling over or under the structure. The inspection plan should:

- Identify unique structural characteristics and special problems or hazards
- Apply current technology and practice
- Ensure the intensity and frequency of the inspection is consistent with the type of structure and details
- Assign inspection personnel in accordance with their qualifications

### 2.1 USFWS RESPONSIBILITIES

The Service must ensure the safety of vehicular bridges on Service-managed lands. In 1990, we initiated the Bridge Safety Inspection Program (as it was then known) to address this responsibility. Service Manual chapter 362 FW 3 provides policy, guidelines, and procedures for implementing the Bridge Safety Program, as it is now known. The responsibilities we describe in the 362 FW 3 ensure that we inventory, inspect, load rate, and report to the Federal Highway Administration (FHWA) National Bridge Inventory (NBI) for our bridges.

As the organizational unit responsible for Program Management, the Headquarters Division of Engineering (DEN) has responsibility for maintaining the Service bridge inventory, for bridge inspection, and for annual NBI reporting. The Service Bridge Safety Program Manager (PM) oversees the day-to-day activities of the Bridge Safety Program.

Regionally, the Regional Engineer appoints a Regional Bridge Coordinator who assists the Program Manager with coordination of inspections within the Region, reviews findings and recommendations included in bridge inspection reports, and distributes bridge inspection reports to field stations and others within the Region.

### 2.2 BRIDGE INSPECTION TEAM

Each bridge inspection team must be comprised of at least two bridge inspectors. The bridge inspection team must be under the full-time, on-site supervision of a team leader. Some inspections will require more than two team members for safety reasons or to include needed expertise.

A bridge inspection team leader must have, at a minimum, the following qualifications:

- Registration as a Professional Engineer;
- 5 years of bridge inspection experience;
- Certification of completion of an FHWA-approved comprehensive bridge inspection training course.

The Service Bridge Safety PM may waive the Professional Engineering registration requirement on a case-by-case basis if the following conditions are met:

- The proposed team leader meets the NBIS requirements of 23 CFR 650.309 (b). , and

- It is in the best interest of the Service to waive the requirement.

Team leaders must complete an FHWA-approved bridge inspection refresher course every 5 years.

If a team leader will be engaged in a fracture critical member inspection, he/she must have successfully completed an FHWA-approved fracture critical member inspection course.

Underwater inspection personnel must:

- Have successfully completed an FHWA-approved underwater bridge inspection course, or
- Provide suitable documentation that they have received training throughout their career that covers the topics covered in an FHWA-approved underwater bridge inspection course.

Commercial diver certification is not in itself sufficient to meet underwater bridge inspection training requirements.

All inspectors conducting non-destructive tests must be trained in the specific technology employed and must have appropriate certification, as required, in accordance with the American Society for Nondestructive Testing (ASNT).

We strongly suggest that other members of the inspection team complete an FHWA-approved comprehensive bridge inspection training course.

## 2.3 TYPES OF INSPECTIONS

The type of inspection team personnel perform may vary over the useful life of a bridge to reflect the level of effort needed to document its condition. The following sections describe these types of inspections:

- Initial inspection
- Routine inspection
- In-depth inspection
- Damage inspection
- Fracture critical member inspection
- Underwater inspection
- Interim inspection
- Special inspection

### 2.3.1 Initial Inspection

An initial inspection is the first inspection of a bridge as it becomes part of the Service's bridge inventory. The initial inspection is a fully documented investigation performed by qualified personnel. It must also include an analytical determination of the load carrying capacity (load rating).

The purpose of an initial inspection is twofold. We use it to gather the FHWA NBI Structure Inventory and Appraisal (SI&A) data and any other data that the Service Bridge Safety PM requires. We also use it to determine the baseline structural conditions and identify any existing deficiencies or potential deficiencies. As part of the planning for an initial inspection, inspectors should review all available information about the bridge, including as-built plans. This review, in conjunction with the inspection, should identify any fracture critical elements that may warrant special attention. Refer to Section 2.3.5 for more information on fracture critical member inspection.

As a part of the initial inspection, inspectors must complete a structural analysis to determine the safe load carrying capacity (load rating). If there is not enough existing information available in the bridge history file to determine the load rating, the inspectors must collect more detailed information in the

field. Refer to Section 2.3.3, In-Depth Inspection, for more information. During the initial inspection for bridges over a waterway, inspectors must take soundings of the channel bottom around each of the substructure units, across the channel along the upstream and downstream fascia, and along lines parallel to the upstream and downstream fascia at specified distances from the bridge.

### 2.3.2 Routine Inspection

The Service regularly schedules routine inspections consisting of observations and/or measurements needed to determine the physical and functional condition of the bridge and to identify changes from the previous inspection. The results of a routine inspection should fully document the condition of the bridge and must include text, images, and drawings.

Routine inspections consist of an arm's length visual inspection of all portions of the structure with the use of simple tools, measuring devices, and recording methods. Inspectors must use climbing techniques, ladders, and access equipment to reach all portions of the bridge structure. As part of a routine inspection, inspectors must estimate and document losses of bridge member cross sections due to deterioration and damage.

The routine inspection will include rating all components and component elements in accordance with the 1988 FHWA *Recording and Coding Guide for the Nations Bridges* (Coding Guide), and reporting the results of the inspection in accordance with the Service's reporting requirements, as described in Chapter 5.

During the routine inspection, the inspection team must verify all data, correct inconsistencies, and update the Structure Inventory and Appraisal (SI&A) data.

Routine inspections of bridges over water must include a visual inspection for indications of scour and an examination of the condition of the channel embankments. During the routine inspection for bridges over a waterway, inspectors should take soundings of the channel bottom around each of the substructure units and across the channel along the upstream and downstream fascias of the bridge.

### 2.3.3 In-Depth Inspection

An in-depth inspection is a close-up, hands-on inspection of one or more bridge members above or below water to identify and assess any deficiencies not readily detectable using routine inspection procedures. Inspectors may need special equipment, such as under-bridge inspection equipment, staging, and workboats to obtain access. Non-destructive field tests and/or material tests may be required to fully ascertain the existence or extent of deficiencies. We may need to conduct in-depth inspections to gather detailed information about the remaining cross section of structural members for load rating (see Chapter 4)

The level of effort necessary to collect the needed information is determined to some extent by the availability of design and as-built drawings. For well-documented structures, we may limit the field inspection to a routine inspection, plus verification of key dimensions, visual estimation of remaining thickness, and limited measurements. When there are limited or no construction drawings available, it will be necessary to get detailed measurements of structural members and the general configuration of the structure.

### 2.3.4 Damage Inspection

A damage inspection is an unanticipated inspection that is undertaken to assess the structural damage caused by environmental or human actions. Typically, Regional personnel initiate these inspections to determine if emergency load restrictions or closure of the bridge to traffic is necessary, and to

## Bridge Inspection Handbook

determine what repairs are necessary. The effort needed for this type of inspection may vary significantly depending on the extent of damage. Inspectors must evaluate the affected members, determine the extent of section loss, measure misaligned members, and check for any loss of foundation support. The inspection team must be capable of making on-site assessments to determine if emergency load restrictions are necessary.

### 2.3.5 Fracture Critical Member Inspection

The Service regularly schedules fracture critical member (FCM) inspections to examine the fracture critical members or member components of a bridge. Bridges require a fracture critical member inspection if they have steel tension members or steel tension components along a non-redundant load path, whose failure would likely result in partial or full collapse of the bridge. Inspectors should have identified the FCMs during the initial inspection of the bridge. Below are some typical examples of FCMs:

- One or two girder systems, including single boxes with welds
- Suspension systems with two eyebar components
- Steel pier caps and cross girders
- Suspended spans with two girders
- Welded tied arches
- Pin and hanger connections on two or three girder systems
- Steel trusses or gusset-plate connection systems

### 2.3.6 Underwater Inspection

Underwater inspection is the examination and assessment of bridge elements located below the waterline.

#### 2.3.6.1 Routine Wading Inspection

If the water is shallow enough (below approximately 3 feet), the inspector can cautiously wade through the water to do the inspection. While wading, the inspector should be able to touch or access all portions of the bridge elements below water.

#### 2.3.6.2 In-Depth Diving Inspection

If the water is too deep, the current too swift, or other conditions are present such that the inspector cannot safely conduct the inspection or achieve certainty as to the underwater conditions, an underwater diving inspection is required.

Underwater diving inspections must be accomplished in accordance with the requirements for Level I, II, and III inspections, as described in the current editions of the AASHTO Manual for Bridge Evaluation and FHWA-NHI-10-027 Underwater Bridge Inspection manual. Generally, these are the underwater inspection levels:

- Level I inspection of 100% of underwater elements: This level is essentially a “swim-by” overview, which does not involve cleaning any structural elements. It should confirm as-built plans and detect obvious defects.
- Level II inspection of 10% of underwater elements: This level of effort is directed toward detecting and identifying damaged/deteriorated areas which may be hidden. It requires cleaning the structural elements in 1-foot-high bands at the mudline, waterline, and half way between.
- Level III inspection of 5% of underwater elements: This level of effort often requires the use of non-destructive testing techniques, but may also require use of partially destructive techniques, such as sample coring, material sampling, or in-situ surface hardness testing.

If the percentage of element inspection does not allow the inspector to be certain about the structural condition of the underwater elements, then he/she should increase the level of inspection and use whatever techniques necessary to achieve certainty.

### 2.3.6.3 Soundings

At a minimum, the inspector should take soundings (elevation measurements) of the channel bottom around each of the substructure units, across the channel along the upstream and downstream fascias of the structure, and along additional lines parallel to the upstream and downstream fascias of the bridge as specified in the scope of work or as deemed necessary.

### 2.3.7 Interim Inspection

The Service uses interim inspections to monitor a particular known or suspected deficiency, such as foundation settlement, scour (undermining), or member conditions that may have an impact on the structural integrity of the bridge.

The team leader for an interim inspection, with input from the Regional Engineer, Regional Coordinator, and Service Bridge Safety PM, must:

- Have a clear understanding of the known or suspected deficiency
- Incorporate the appropriate guidelines and procedures from this handbook regarding what to observe or measure
- Develop an appropriate reporting method based on mitigation urgency

Interim inspections are usually not comprehensive enough to meet NBIS requirements for biennial inspections. Conditions and events warranting interim inspection include:

- Summary condition rating of 3.0 or less
- Load Rating of less than 3 tons
- Excessive deformation of any load bearing element
- Cracks in the tension zone of a Fracture Critical Member
- Scour that threatens the stability of a substructure unit
- Any other condition or event that the Service Bridge Safety PM deems sufficient, such as:
  - Natural disasters in the vicinity of the bridge including wildfire, flooding, or earthquake
  - Damage caused by humans, animals, or any other outside agency

### 2.3.8 Special Inspection

The Service Bridge Safety PM may schedule special inspections, which he/she typically uses to verify and document the closure or removal of a bridge. The Service Bridge Safety PM will specify the condition to be documented and the appropriate reporting method in the bridge inspection task order Statement of Work (SOW).

## 2.4 FREQUENCY OF INSPECTION

In general, Service bridges are inspected at regular, 24-month intervals in accordance with the NBIS. Certain bridges may require inspection at less than 24-month intervals, while we can inspect others at greater than 24-month intervals. The Service Bridge Safety PM, based on the NBIS, Service policy, the recommendation of the inspection team leader, Regional input, and these guidelines, will determine the level and frequency of inspection for each bridge in the Service's inventory.

## Bridge Inspection Handbook

### 2.4.1 Initial Inspections

We conduct initial inspections once when we add a bridge to the Service inventory, typically during the next biennial inspection cycle encompassing the bridge's geographic area.

### 2.4.2 Routine Inspections

Routine inspections are required for all bridges on the Federal Highway Administration's National Bridge Inventory (NBI) at 24-month intervals. We inspect non-NBI bridges (typically bridges under 20 feet long or bridges not open to the public), at 24-month intervals unless they meet all of the following criteria:

- Structural condition ratings are seven or higher,
- Scour condition ratings are seven or higher,
- The bridge does not have fracture critical members, and
- The bridge's estimated remaining life is greater than 10 years.

If a non-NBI bridge meets these criteria, then we may inspect it at 48-month intervals.

### 2.4.3 Fracture Critical Member Inspections

All FCM elements of a bridge require fracture critical member inspection during initial and routine inspections.

### 2.4.4 Underwater Inspections

All submerged elements of a bridge require underwater inspection during initial and routine inspections. The team leader and Service Bridge Safety PM should assess the need for in-depth diving inspection for any portion of a bridge exposed to water deeper than 3 feet. The assessment should consider such factors as:

- Structure type
- Foundation type
- Footing location relative to channel bottom
- Known or suspected problems
- Waterway characteristics
- Superstructure and substructure redundancy

Any portion of a bridge submerged more than 6 feet during periods of normal low water must undergo an in-depth diving inspection at least every 5 years.

### 2.4.5 Interim Inspections

The Service Bridge Safety PM determines when to schedule interim inspections. Typically, we schedule interim inspections to take place midway between the regularly scheduled routine inspections and will continue until the deficiency requiring monitoring has been eliminated.

### 2.4.6 In-Depth, Damage, and Special Inspections

The Regional Engineer, Regional Coordinator, and Service Bridge Safety PM determine how often to conduct in-depth, damage, and special inspections.

## 3 INSPECTION PROCEDURES

### 3.1 PREPARATION FOR INSPECTION

Prior to beginning the inspection, the inspection team should obtain the original design drawings, as-built drawings, repair drawings, maintenance history, and previous inspection reports for the bridge. The Service Bridge Safety PM, Regional Engineering Office, or facility Point of Contact (POC) can assist in locating or supplying the original design drawings, records, previous inspection reports, etc.

The inspection team should review available records prior to going into the field. Inspection planning activities should include a determination of the necessary inspection equipment, required forms, and any special access requirements such as rigging, snooper or bucket trucks, underwater inspection equipment, and/or personnel. A copy of the previous inspection report, if available, should be used as a reference during the current inspection.

FCM inspection requires additional preparation. The most important activities are:

- Identify possible FCMs.
- Note the particular members in the structure that may require special field attention, such as built-up tension members composed of few individual pieces.
- Pre-plan necessary access to the members, including special equipment needs such as ladders, bucket truck, or climbing gear.
- Identify and make available any necessary special tools and equipment that may be required in addition to the normal inspection gear.

### 3.2 BRIDGE ACCESS

Many Service bridges are located in remote locations or in other areas that are not accessible to the general public. It is not unusual to encounter locked gates or other access controls due to wildlife migration and breeding, or because of natural hazards such as wildfire and flooding. Other bridge sites may be home to unexploded ordnance or wildlife that may not be amenable to human interaction. Some locations can only be accessed by boat, All Terrain Vehicle (ATV), or other means of conveyance. It's important to closely coordinate with the facility POC to make arrangements for special access, lodging, keys, escort (armed or otherwise), or site-specific training in the months, weeks, and days preceding field inspection.

### 3.3 FIELD DOCUMENTATION TECHNIQUES

Inspectors must document existing conditions found during the inspection with detailed field notes and digital color images. You must prepare inspection notes and sketches in enough detail to accurately locate deficiencies, describe the limits of the deficiencies in enough detail to estimate the quantities for proposed repairs and restoration work, and evaluate the effect of the deficiencies on the load carrying capacity of the structure. Images should support and supplement the field notes.

#### 3.3.1 Field Notes

Thoroughly examine all physical features of a bridge that affect its structural integrity during the inspection. The inspection team must accurately determine and record the location, severity, and extent of all damaged and deteriorated sections. Direct measurements of the surface area, depth, and location of defects are preferred to visual estimates of percentage loss.

Inspectors make field measurements to provide baseline data on the existing structure components and to track changes, such as crack width and length. Deficiencies such as cracks, spalls, and delamination



can change over time, so it's important to acquire the initial measurements in a manner that can be replicated during future inspections.

Measurements may be required on structures for which no plans are available or to verify data shown on plans. Your measurements should be precise enough to serve the purpose for which they are intended.

When plans are available for a structure that is to be load rated, you typically take dimensions, member types, and member sizes from the plans. However, many plans are not as-built plans and may not reflect all changes made to a bridge during construction or subsequent repairs. Check and compare the plans during the field inspection to ensure that they truly represent the structure before you use them in structural calculations. Give special attention to changes in dead load, such as alterations in deck geometry, additional overlays, and/or new utilities. Increased dead load may affect the load rating for the structure.

Make and record enough measurements to track changes in joint opening, crack size, or bearing position. You may also have to take measurements to monitor suspected or observed substructure tilting or movement. In these cases, it is necessary to permanently mark on the structure and record in the field notes the measurements to serve as a datum for future readings. Include a log of the readings in the inspection report and update it with the new readings after each inspection cycle.

### 3.3.2 Urgent Item Forms

Inspectors must bring critical findings to the attention of station personnel as soon as practicable using an Urgent Item form. A critical finding is an existing bridge or bridge-related condition that presents an imminent safety hazard to Service staff or to the general public. A completed Urgent Item form should contain the following:

- The location of the hazard
  - Region
  - Station
  - Bridge name and number
- A description of the hazard
- Feasible action or actions that will address the hazard
- The date that the hazard was *first* brought to the attention of station personnel (may be the current reporting date)
- The name and affiliation of the team leader reporting the hazard
- The name and title of the station representative to whom the critical finding is reported
- The date that the report is acknowledged by the station

Urgent Item forms must be prepared by the team leader and provided to a station representative within 24 hours of identification of the critical finding.

Stations should resolve all items identified on the Urgent Item form as soon as possible, but in no case should a critical finding remain unresolved after 12 months.

A blank Urgent Item form is included in Appendix II.

### 3.3.3 Images

Take images with a minimum resolution of 240 dpi to document typical and significant structure conditions. Your images should be well composed, without extraneous vehicles, people, or debris. Images should be properly lighted using a flash if necessary. When composing images of details or

localized deficiencies, place a scale or inspection tool (e.g., hammer, pencil, etc.) on the area you are recording in order to provide a frame of reference for the subject. Add digital annotations, such as arrows, when you prepare the report to draw attention to the deficiency or detail.

As a minimum, record the following images in the field:

- An elevation view of each side of the bridge
- A view of each approach roadway, looking toward the bridge
- A view of each approach roadway, looking away from the bridge
- A view looking upstream and a view looking downstream from the bridge
- Typical view of any deficiency rated “5” or less
- Typical view of superstructure
- Typical view of substructure units

## 3.4 Fracture Critical Members


### 3.4.1 General Requirements

Inspection of fracture critical members requires hands-on inspection, i.e. close up within arm’s length to properly identify, measure, and determine the extent of deficiencies. When required by the condition of the member or where required by procedures established for the bridge, visual inspection must be supplemented by applicable non-destructive testing (NDT).

Inspections of fracture critical members are done at the same time as the routine inspection, and will be inspected on a frequency not to exceed 24 months. If a significant defect is found in a fracture critical member, inspection frequency will generally be 12 months or less until the defect can be repaired.

### 3.4.2 Pre-Inspection / Documentation

Bridges with fracture critical members are identified by the structure folder and any special inspection procedures must be in the folder. The outside of the folder must be labeled “Fracture Critical.”

Fracture critical members are called out on the sketches with the symbol:  Beneath the symbol is the member description (e.g. Bottom Chord, Floor Beams, etc.)

### 3.4.3 Inspection Documentation

Inspection types may be initial or routine. Formats for report types may be full or check.

NBI Item 92A will be coded as “Y \_\_” where the second and third characters contain the inspection frequency in months (not to exceed 24).

NBI Item 93A must be coded with the last date a fracture critical inspection was done.

The “Additional Comments” field of the “Additional Information and Comments” section of the full report or the “Comments” section of the check report must contain a summary statement of the findings of the inspection of fracture critical members.

Recommendations for repair work or other action, such as load restriction or bridge closure due to significant inspection findings, must be included in the “Recommended Work” section of the report and marked as urgent.

### 3.4.4 Inspection Procedures:

FCM inspections are done no further than arm's length away. This may entail walking along the lower chord of trusses or conducting close inspections by other means. The inspection of FCMs may require an under bridge access vehicle, a ladder, a bucket truck, or a boat to get close enough to the members and connections to clean and measure corrosion and/or cracks. The inspector needs to follow safety protocol by using fall arrest or other applicable safety equipment. The inspector may need to remove dirt and debris to sufficiently observe and measure the remaining section on the lower chord, gusset plates, and ends of floor beams. Tension areas of FCMs will be the main focal points. The inspector needs to observe the coped sections of floor beams and their connections to the truss.

Inspectors must follow any special inspection procedures outlined in the bridge folders. For most bridges special inspection procedures are not needed, for example the detection of fatigue cracks in most steel girders is adequately addressed in the FHWA manual for the Safety Inspection of In-Service Bridges and the FHWA Bridge Inspector's Reference Manual.

If fatigue cracks are suspected, the bridge inspector must clean the area, remove any applied coating, if necessary, and perform grinding and/or dye penetrant testing as necessary to determine if there is cracking and the extent. If these methods are inadequate or impractical for the particular situation, the Service Bridge Safety PM must be consulted and additional personnel must be employed to complete the fracture critical inspection using ultrasonic or other applicable NDT methods. The locations, date, and type of test must be documented in the inspection report.

Significant defects, such as fatigue cracking, tearing, impact damage, significant corrosion, etc. will be brought to the attention of the station POC and Service Bridge Safety PM. The defects and repair or other action, such as load restriction or bridge closure, will be relayed to the station POC before leaving the station using the Urgent Bridge Work Recommendation Items form. The Service Bridge Safety PM or consultant's Senior Bridge Inspection Engineer must reduce the inspection frequency to 12 months or less until the defect can be repaired. The structure may be load restricted or closed until the deficiency is repaired. The Service Bridge Safety PM will determine the course of action.

### 3.5 In-Depth Dive Inspections

Each bridge with elements requiring in-depth dive inspection must have written bridge-specific inspection procedures which address items unique to the bridge. The written inspection procedures must address those items that the dive team leader should know to insure a successful inspection. In-depth dive inspections must be performed according to these written inspection procedures. Proper development of good inspection procedures and concerted attention to following those procedures will mitigate most risks. The prior inspection report is a valuable resource for reviewing previous inspection findings, but it does not serve the same purpose as the bridge-specific in-depth dive inspection procedures.

In addition to following the bridge-specific in-depth dive inspection procedures, planning and preparation for in-depth dive inspections must incorporate:

- Identified underwater elements
- Physical scour countermeasures
- Access
- Inspection equipment
- Structural details
- Hydraulic features and characteristics

- Risk factors (as detailed below)
- Inspection methods and frequencies
- Required qualifications of inspecting personnel
- Scheduling considerations (lake draw down, canal dry time, etc.)

Specific risk factors include waterway features that may promote scour and undermining of substructure elements, such as:

- Rapid stream flows
- Significant debris accumulation
- Constricted waterway openings
- Soft or unstable streambeds
- Meandering channels

Water conditions that may affect the inspection such as black water or rapid stream flows should also be identified and accounted for in the inspection methods. Water environment and structural systems or materials that may combine for accelerated deterioration of the bridge elements should be identified, such as highly corrosive water, unprotected steel members, timber piling in the presence of marine borers, etc. By identifying these conditions or risk factors, the underwater inspectors can appropriately prepare for and perform a thorough inspection.

### 3.6 STATION PRE-INSPECTION COORDINATION

Prior to arrival at a station, the inspection team must notify the station POC of the team's pending arrival. In the best circumstances, this should occur twice:

- Once prior to the start of the inspection trip to confirm the tentative inspection *date*, and
- Once anywhere from 3 to 24 hours before the anticipated arrival *time* at the station.

After arrival at the station but prior to starting the actual field work, the inspection team must conduct an in-brief meeting with station personnel. The purpose of this meeting is to:

- Review the scope of work
- Ensure all available information is collected
- Ensure facility personnel are aware of the scope and schedule
- Exchange emergency contact numbers
- Determine any special requirements, such as:
  - Work hour restrictions
  - Locked gates
  - Special access (boat, ATV, horse)
  - Special vehicles (required for load rating)

The agenda should include:

- Introductions
- Scope of work
- Maps of facilities
- Bridge plans
- Average Daily Traffic (ADT) counts
- Property record numbers

- Special bridge concerns/scheduling issues

During the meeting, the inspection team leader must ensure all interested parties understand the nature of the work and determine if they have any special requirements.

### 3.7 STATION POST-INSPECTION DEBRIEFING

At the end of the field inspection, the inspection team must hold a debriefing in conjunction with the on-site station representative. The purpose of the debriefing is to notify station personnel of conditions found during the inspection, any operational restrictions, and any possible repair recommendations. The inspection team leader must summarize the inspection findings for each bridge inspected.

Items to present include:

- General condition of each bridge
- Critical findings
- Other findings
- General recommendations for repairs or maintenance

Although the information presented is typically general in nature, it should be thorough and well-presented.

### 3.8 POST-TRIP DEBRIEFING

At the end of the field inspection trip, the inspection team must conduct a post-trip debriefing with the Service Bridge Safety PM and Regional Bridge Coordinator. This debriefing should include:

- Lead inspector(s) and stations visited
- Unscheduled inspections that were completed
  - Type of inspection completed
  - Reason for inspection
- Scheduled inspections that were not completed
- Critical findings
- Urgent Item forms
  - Acknowledged
  - Outstanding
    - Not yet provided
    - Not yet acknowledged
- Information still needed
  - Bridge numbers
  - Drawings
  - Other
- Follow-on inspection needs
  - Underwater dive inspections
  - Interim inspections
  - Other
- SOW changes and reason for change:
  - Check report to full report
  - Full report to check report
  - Other report- or inspection-type changes
- Station post-inspection debriefing status
- Public relations issues

- Station POC changes
- Brief review of *noteworthy* items at stations visited

## 4 LOAD RATING

Load rating provides a basis for determining the safe load capacity of a bridge based on a structural analysis and helps us to determine whether or not posting is required. The safe load carrying capacity of a bridge must be based on the existing conditions you observe during field inspection. A load rating is required:

- When a bridge is added to our inventory,
- When a bridge is modified, or
- When a bridge is damaged.

Bridge load rating calculations start with information available in the bridge file, including recent inspection findings and as-built or original design drawings. The bridge rating analysis must take into account any loss of cross-sectional area found during inspection.

Service load ratings must adhere to the American Association of State Highway and Transportation Officials (AASHTO) guidelines in effect at the time the rating calculations are prepared.

The Service records bridge load ratings in tons (U.S. Customary Units).

### 4.1 DATA COLLECTION

In order to complete the load rating of a bridge, inspectors must obtain several pieces of information. Following is a list of sources and types of information to collect:

- As-built or original design drawings
  - Bridge geometry
  - Roadway geometry
  - Dead loads
  - Superimposed dead loads
  - Primary load carrying member details
  - Material properties
  - Design live load
  - Design methodology
- Bridge inspection reports
  - Current condition of bridge elements
  - Size, location, and extent of defects
  - Images
  - SI&A data
- Structural calculations

In general, the information you obtain for rating analysis includes span lengths of major structural members; depths, widths, and thicknesses of main structural members and member components; locations and sizes of diaphragms, cross frames, and bracing members; identification of fatigue details; slab thicknesses; and wearing surface thicknesses. In some instances, additional measurements will be necessary to analyze the structure. Normally you don't need details of bearings and connections.

If the inspection report indicates damage, distress, or the presence of fatigue-prone details, it may be necessary to get measurements of those details. If the rating results indicate an unsafe condition, the unsafe condition is a critical finding subject to the requirements in Section 3.3.2 of this handbook.

## 4.2 TYPES OF LOAD RATING

Load ratings are calculated for two levels of performance using AASHTO standard design vehicles. The most common class of AASHTO design vehicle is prefixed "HS." Section 4.3 provides more information about AASHTO standard design vehicles.

### 4.2.1 Inventory Rating

Inventory rating is a measure of a bridge's serviceability. It represents the load that a bridge can safely carry on a day-to-day basis without adversely impacting the bridge's useful life. Simply defined, the inventory rating represents the largest sustained live load that a structure can safely carry for an indefinite period.

### 4.2.2 Operating Rating

Operating rating is a measure of a bridge's strength. It represents the absolute maximum permissible live load that a bridge can safely carry on a limited basis. Unlimited use of vehicles that subject the bridge to operating levels may shorten the useful life of the bridge.

## 4.3 STANDARD DESIGN VEHICLES

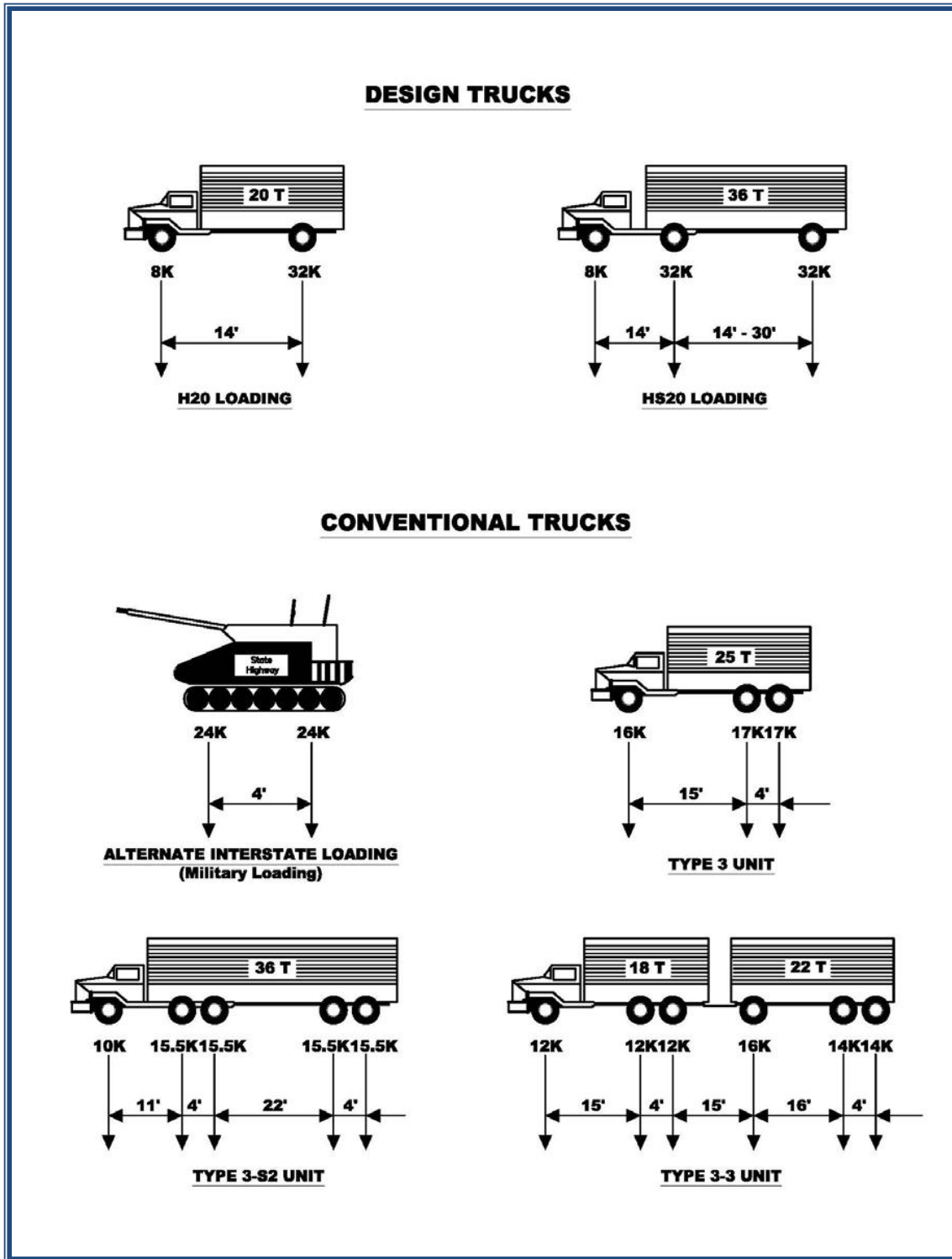
AASHTO has developed standard design vehicle live loads for use in bridge design and rating. These standard vehicles do not represent actual vehicles; rather, they were developed to allow a relatively simple method of analysis based on an approximation of actual highway live loads. We use the AASHTO HS truck as the standard design vehicle to load rate bridges. Other standard design vehicles are used to determine posting loads.

The Service's policy is that bridges be load rated for the following standard design vehicles:

- HS20
- Type 3 Unit
- Type 3-3 Unit
- Type 3-S2 Unit

The HS20 vehicle is a purely "design" vehicle comprised of a highway tractor and semi-trailer. Types 3, 3-S2, and 3-3 vehicles are based on actual vehicles that conform to the load regulations of most State agencies. Figure 4.3-1 shows these and other standard design vehicles





#### 4.4 ANALYSIS METHOD

All bridge structures must be analyzed per current AASHTO and FHWA load rating guidelines.

If a structure was designed using the load factor method for HS20 or greater HS loading and other specific conditions are met (see FHWA *Assigned Load Ratings* memorandum dated September 29, 2006 in Appendix VI), inventory and operating ratings may be assigned based on the design loading unless changes to the structure occur that would reduce the inventory rating below the design load level. The HS design load rating factors for these bridges can be taken as:

- Inventory        1.00
- Operating        1.67

Appendix VI of this handbook includes additional FHWA load rating guidelines and policy memoranda that must be followed when analyzing Service bridges.

#### 4.5 INITIAL LOAD RATING

You determine the initial load rating based on the actual condition of the bridge during the initial inspection. If the original design information is insufficient to determine the rating, you will have to calculate the load rating. Consider the extent of deterioration of the structural components of the bridge in the computation of dead loads and live load and their effect on the capacity of the members.

#### 4.6 REVIEW AND UPDATE OF LOAD RATINGS

The team must review the load rating calculations of bridges inspected during regular inspection cycles. If the inspection results indicate a change that may affect the existing rating of the bridge, the team must notify the Service Bridge Safety PM and update the rating calculations within 90 days of discovering the change.

#### 4.7 LOAD RATING CALCULATIONS AND RESULTS

You must present the load rating calculations in a clear and easily understood format. State clearly all of your assumptions, definitions, and nomenclature. Describe any formulas you use in the analysis and reference where you got them. All calculations must be checked and initialed by the engineer who developed them and the engineer who checked them. Computer output must include a cover page explaining the analysis performed, and must be initialed by the engineer who developed the input and the engineer who checked the input and results. The inspection team leader for the bridge being rated, as well as the person in charge of the bridge ratings, must also review the rating. This may be the same individual, except in special cases where the inspection team leader is not a registered engineer. All bridge ratings must be approved by a registered professional engineer qualified to perform bridge analysis.

Include a summary of the results of the calculations (inventory and operating ratings) listed by vehicle type in the calculations and in the inspection report.

When you have completed the load rating calculations, add a copy to the bridge history file.

#### 4.8 BRIDGE POSTING

It is the Service's responsibility to enforce posting. The Service posts bridges to warn users of the load capacity of the bridge, to avoid safety hazards, and to adhere to Federal law. We typically post a bridge when the load rating indicates that the bridge cannot safely carry AASHTO standard design vehicles.

The inspection team leader must notify the Service within 24 hours of determining that a bridge requires posting. He or she must present the reasons for the posting recommendation, the suggested load limit, and the type and location of recommended signage.

Posting recommendations should be acted on by the station responsible for maintaining the bridge as soon as practical after receiving the posting recommendation. If a bridge cannot be posted in a timely manner, the station should take other action to insure that no oversized vehicles use the bridge, including erecting barricades or detouring traffic. A station should never allow a bridge to remain open to unrestricted traffic 90 days after posting has been recommended for the bridge.

Posting signage must conform to the latest edition of the FHWA's *Manual of Uniform Traffic Control Devices* (MUTCD). The MUTCD outlines the requirements for type and placement of signage for posting bridges. Figure 4.9-1 illustrates the types of signs found in the MUTCD that we commonly use for our bridges.

### 4.9 NBI CODING OF LOAD RATING RESULTS

The inspection team leader must ensure that new and updated load rating values are accurately and correctly recorded for NBI items 63, 64, 65, and 66. The inspection team leader should code these items using English units, following the guidelines provided in the current *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* and the FHWA policy and guidance memoranda included in Appendix VI.

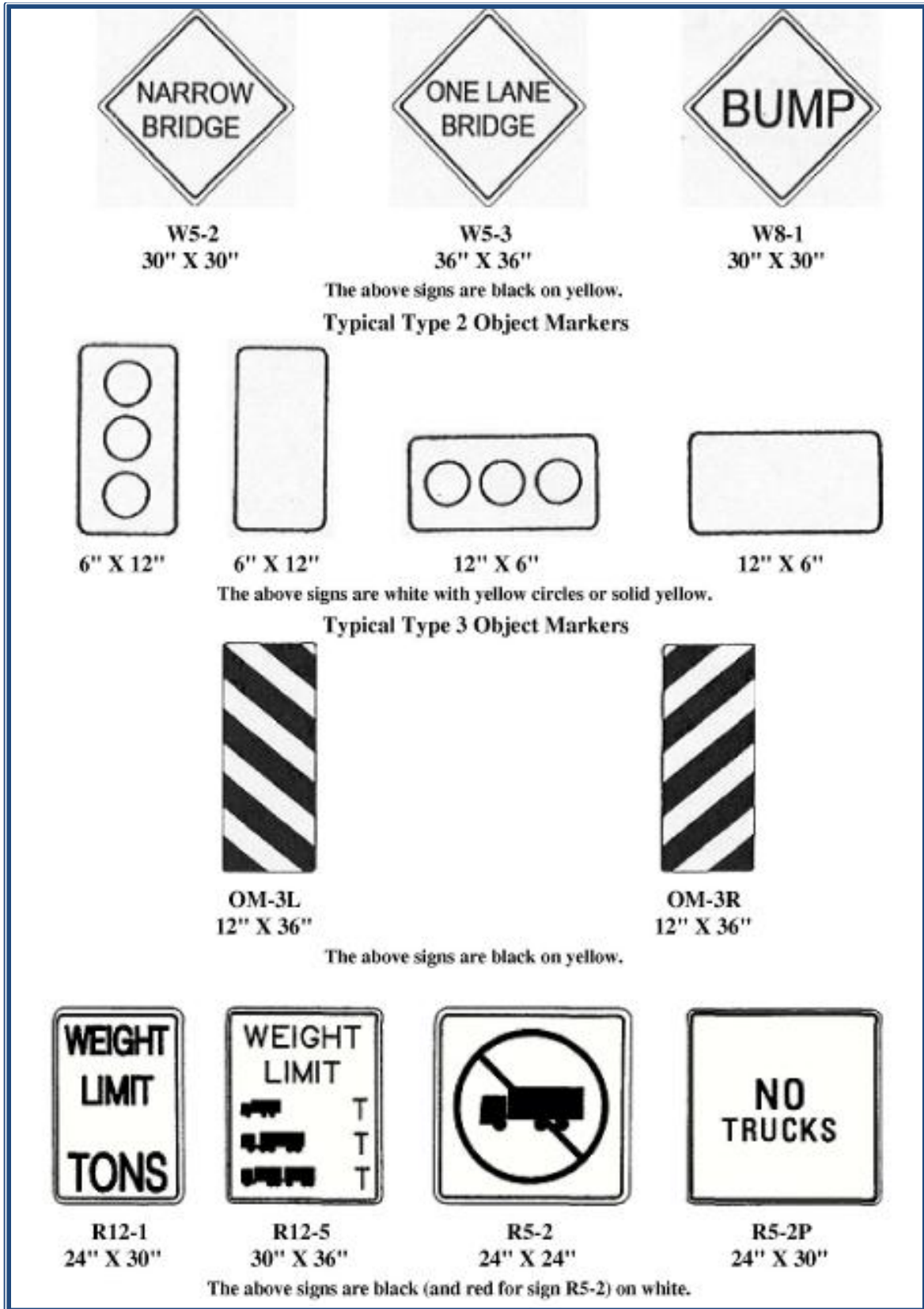


Figure 4.9-1 Typical Bridge Signs

## 5 INSPECTION REPORTS

### 5.1 INTRODUCTION

The primary objective of the inspection report is to provide Regional Service personnel an assessment of the existing condition of the bridge and all of its components. The report provides detailed information necessary to determine the maintenance and repair needs of the bridge, as well as that necessary to substantiate maintenance and repair funding requests. A separate report is required for each inspected structure.

In general, the report includes:

- Description of all major damage and deterioration.
- Description of the condition of non-structural components and component elements.
- Evaluation of existing physical condition of all structural and non-structural components and component elements.
- Recommendations for necessary repairs or maintenance measures.
- Load rating summary and posting recommendations.
- Signage recommendations.
- Budgetary estimates for the recommended maintenance or repair items.
- Recommendations for types and frequencies of future inspections.

### 5.2 TYPES

The following report types are typically prepared for Service bridges:

- Full
- Check
- Documentation
- Underwater
- Damage

INSPECTION	REPORT TYPES				
	FULL	CHECK	DOCUMENTATION	UNDERWATER	DAMAGE
INITIAL	✓				
ROUTINE	✓	✓			
IN-DEPTH	✓				
DAMAGE					✓
FRACTURE CRITICAL	✓	✓			
UNDERWATER	✓	✓		✓	
INTERIM	✓	✓			
SPECIAL			✓		

Table 5.2-1 Inspections and Report Types

The bridge inspection task order SOW will list the report type required for each bridge inspected. Table 5.2-1 lists the most common report types we use for each inspection type. Appendix I contains sample full and check reports.

### 5.2.1 Full Reports

A full report is a detailed, comprehensive record of inspection findings including all of the sections listed below:

- Cover Page
- Table of Contents
- Location Map
- Bridge Identification, Use, and Summary of Findings
- Recommended Work and Estimated Costs
- Replacement Cost
- Sign Recommendations and Load Ratings
- Additional Information and Comments
  - Description of Bridge
  - Comparison to Previous Inspection
  - Next Inspection Recommendations
  - Additional Comments
- Condition Ratings
- Sketches
- Photos
- Typical Signs (*final reports only*)
- Rating Vehicles (*final reports only*)
- Inventory and Appraisal Data Sheet (*draft reports only*)
- Additional National Bridge Inventory and FWS Items (*draft reports only*)

### 5.2.2 Check Report

A check report is a brief, one page narrative summary prepared for bridges that had no signs of progressive deterioration and were in satisfactory or better condition during the previous inspection. Check reports are only prepared when inspection findings verify that no significant adverse change has occurred in the condition of the bridge since the previous inspection. Check reports are never prepared for the same bridge during consecutive inspections. Check reports contain the following items:

- Bridge Identification
- Summary of Findings
- Comments
- Next Inspection Recommendations
- Recommended Work and Estimated Costs from Previous Inspection (with costs updated to the inspection year)
- Sign Recommendations and Load Ratings (from most recent full report)
- SI&A Datasheet (draft reports only)

### 5.2.3 Documentation Report

A documentation report is generally prepared as a result of a special inspection. We typically use documentation reports to verify the removal or proper closure of a bridge prior to removing it from the

active Service bridge inventory or placing it in a non-inspection status. Documentation reports typically consist of the following report elements:

- Cover Page
- Additional Information and Comments
  - Description of Bridge
  - Comparison to Previous Inspection
  - Next Inspection
  - Additional Comments
- Photos of approach showing barricade or removal

### 5.2.4 Underwater and Damage Reports

Because we rarely develop underwater and damage reports, the requirements for these reports are specified on a case-by-case basis.

## 5.3 CONTENT

### 5.3.1 Summary of Findings

This section presents the overall findings of the inspection of the bridge and its components. The narrative should provide sufficient detail to ensure the reader understands the type of defect/deterioration, its typical or specific location, and the general condition of the component. The general condition assessment is based on the observed conditions and should indicate the condition of the entire component and its ability to perform its intended function. The 10 terms you must use to describe the general condition are:

- Excellent – Typically only used for very recent construction.
- Very Good – No problems noted.
- Good – Some minor problems noted.
- Satisfactory – Structural elements show some minor deterioration.
- Fair – All primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.
- Poor - Advanced section loss, deterioration, spalling, or scour.
- Serious – Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible.
- Critical – Advanced deterioration of primary structural elements. Unless closely monitored, it may be necessary to close the bridge until corrective action is taken.
- Imminent Failure – Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic, but corrective action may allow light service.
- Failed – Out of service and beyond corrective action.

### 5.3.2 Fracture Critical Members (FCM) Findings

You must include a description of the FCM inspection findings in the body of the report. For full reports, list your findings under “Additional Comments” on the “Additional Information and Comments” section of the report. For check reports, list your findings under the “Comments” section of the report. For other report types, list the findings as required in the bridge inspection task order SOW.

### 5.3.3 Recommendations

Recommendations should address structural repairs as well as maintenance and safety items. They must be clearly presented and include:

- Recommendation for next inspection type and interval.
- Sign recommendations
- Specific actions to take to repair or maintain the bridge or any of its components.
- Bridge replacement recommendation, when applicable.

#### 5.3.3.1 Cost Estimate

You must provide a construction cost estimate that details the quantities, materials, and labor costs for each repair, maintenance, and bridge replacement item that you recommend.

Construction cost estimates must be prepared for the specific location of the bridge in order to reflect the cost of labor and materials in the specific geographical area. This is especially important in remote areas, where the cost of mobilization and/or transportation of materials can be significantly higher. Construction cost estimates should be based on cost data such as R.S. Means, local State DOT costs, or similar data sources.

For repair and maintenance items with an estimated material plus labor cost up to \$100,000, engineering (planning, design, construction management) costs, if needed, can be estimated as 0.18 (18%) times the material plus labor cost. A construction contingency, if needed, can be estimated as 0.15 (15%) times the material plus labor cost.

For repair and maintenance items greater than \$100,000 and for bridge replacement, use the percentages shown in Table 5.3-1.

Item	\$0-100,000	\$101,000-500,000	\$501,000-1,000,000	\$1,001,000-5,000,000	\$5,001,000-10,000,000+
Construction Contingency	15%	15%	10%	10%	9%
Planning/Design	21%	21%	18%	15%	14%
Construction Management	9%	9%	9%	9%	7%
Value Engineering	0%	0%	0%	2%	1%
G.A.S.	0%	5%	5%	5%	5%

Table 5.3-1 Indirect Costs and Construction Contingencies

As you prepare your estimate, keep the following in mind:

- Use the indicated markups only when applicable.
- The above percentages are guidelines based on average project complexity. You should adjust your estimate up or down as appropriate based on the anticipated complexity of the recommended item.
- G.A.S. is to be applied to any item over \$100,000 in total project cost (materials + labor + engineering + construction contingency).



### 5.3.3.2 Priority Assessment Codes

The inspector must assign each recommended work item a Priority Assessment Code (PAC). The PAC represents a subjective, suggested priority associated with the recommended work item. It combines the elements of perceived hazard severity and potential negative outcome possibility. The inspector uses the PAC solely to help him/her assign a relative priority for the recommended work item, and is not to be construed or interpreted as a prediction of future negative consequences.

Derive the PAC using the following:

1. Hazard Severity. The hazard severity is an assessment, based on the inspector's experience, of the worst potential consequence, as determined by degree of injury or damage, that is possible as a result of an identified deficiency. Assign hazard severity categories according to the following criteria:
  - I. Catastrophic: May cause death or result in permanent loss-of-use of the structure; replacement of structure would be required.
  - II. Critical: May cause severe bodily injury or temporary loss-of-use of all or a portion of the structure.
  - III. Marginal: May cause vehicle damage, minor bodily injury, or result in damage that would reduce the capacity or useful life of the structure.
  - IV. Negligible: Probably will not affect personnel safety or structural integrity; lack of corrective action could result in localized damage to bridge.
2. Likelihood of Outcome. The likelihood of outcome represents the inspector's subjective estimation of the possibility of a hazard resulting in a negative outcome—based on the inspector's judgment and a qualitative assessment of such factors as location, use, and traffic volume—assigned using the following criteria as a guide:
  - A. Likely to occur either immediately, within a short period of time, or prior to the next regularly scheduled inspection.
  - B. Likely to occur eventually.
  - C. Possibly could occur eventually.
  - D. Unlikely to occur in the foreseeable future.

The PAC is an expression of priority that combines the elements discussed above. Using the matrix shown in Figure 5.3-1, the PAC is expressed as an integer that can be used to help assign repair priorities, using 1 as the highest priority and 7 as the lowest priority.

HAZARD SEVERITY	OUTCOME LIKELIHOOD			
	A	B	C	D
I	1	2	3	4
II	2	3	4	5
III	3	4	5	6
IV	4	5	6	7

Figure 5.3-1 PAC Determination Matrix

### 5.3.4 Load Rating and Posting

The report must include a table showing the results of inventory and operating rating results, in tons, for each element analyzed. In addition, you should include a discussion of how the bridge was analyzed. This discussion should include the assumptions made as well as the material properties used for each element.

If, based on the results of the load rating, the bridge needs to be posted, the report must describe the recommended posting. Bridge posting recommendations should be based on the minimum operating rating capacity of the bridge.

### 5.3.5 Condition Ratings

We use condition ratings to describe the existing, in-place bridge as compared to the as-built condition. Inspectors must evaluate the material-related physical condition of the deck, superstructure, and substructure components, as well as the elements that make up these bridge components. Inspectors must also evaluate the condition of channels, channel protection, and culverts. Your evaluation should provide an overall characterization of the general condition of the entire component or element being rated. Conversely, they should not attempt to describe localized or nominally occurring instances of deterioration or disrepair. Correct assignment of a condition code must, therefore, consider both the severity of the deterioration or disrepair and the extent to which it exists throughout the component or element being rated.

We use the codes and instructions in the *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation’s Bridges* (FHWA, December 1988) for evaluating and coding nearly all NBI-related bridge inventory and appraisal data. The inspection team must develop each element rating in accordance with the guidance provided in that document.

The condition rating section of the report also includes the inspector’s remarks describing – at a minimum – his or her observations of the physical condition of each element rated less than 6 (Satisfactory). These remarks describe the defects that justify the less-than-satisfactory rating. The remarks also identify:

- Repair or rehabilitation work along with completion dates
- Fracture Critical Members (FCM)
- Any observation that the inspector deems noteworthy

### 5.3.6 Sketches

Sketches are very important in conveying the physical arrangement of the bridge. They should be detailed enough to give the reader a graphical representation of the major elements of the bridge structure and bridge-related items. If available, use original design drawings to develop the figures in the report. If these are not available, you'll need to gather enough information in the field to develop the figures to the level of detail needed. The sketch section of the report must contain the following:

- A plan view
- A cross section
- A profile view

Additional items that may be required, depending on the complexity of the bridge, include:

- Framing plan
- Details of superstructure elements

The sketches must be prepared using engineering industry standards and conventions.

#### 5.3.6.1 Plan View

The plan view should illustrate the bridge in enough detail to allow the reader to understand the configuration of the bridge in relation to the roadway approaching and crossing the bridge, the feature or features crossed, and all appurtenant safety elements. The plan view should be oriented with South to North or West to East shown left to right and include the following elements:

- Title ("Plan")
- A North arrow
- Structure and approaches/sidewalks/etc. (as applicable)
- Wingwalls, headwalls
- Edges of channel
- Indication of water or traffic flow under bridge
- Dimensions
  - Out-to-out of the deck
  - Curb-to-curb clear distance
  - Overall NBIS bridge length
- Labels and call-outs
  - Roadway name
  - Edge of channel
  - Guardrails, bridge rails, and/or barriers
  - Wingwalls
- Appropriate notes, legend, and abbreviations

Refer to Figure 5.3-2 for a sample plan view sketch.

#### 5.3.6.2 Section

The section illustrates the typical cross-sectional configuration of the superstructure. It usually includes:

- Title ("Section")
- Orientation
- Primary superstructure elements
- Barriers/guardrails

- Dimensions
  - Out-to-out of bridge deck
  - Clear distance curb-to-curb
  - Deck thickness
  - Pavement/topping thickness (if applicable)
  - Curb reveals
- Beam types, sizes, spacing, and materials
- Barriers and bridge rail

Refer to Figure 5.3-3 for a sample section sketch.

### **5.3.6.3 Profile**

The profile should be oriented with South to North or West to East shown from left to right and include the following elements, appropriately labeled:

- Title (“Profile”)
- Structure and approaches
- Wingwalls, headwalls
- Piles and footings
- Channel profile
- Barriers/guardrails
- Ground line with appropriate earth hatching below
- Waterline
- Spans
- Abutment and pier caps
- Columns/piles (diameter/width)

Refer to Figure 5.3-4 for a sample profile sketch.

### **5.3.6.4 Fracture Critical Members**

The FCMs, if any, must be identified on the inspection report sketches. Figure 5.3-5 shows typical FCM call-outs on a sketch.

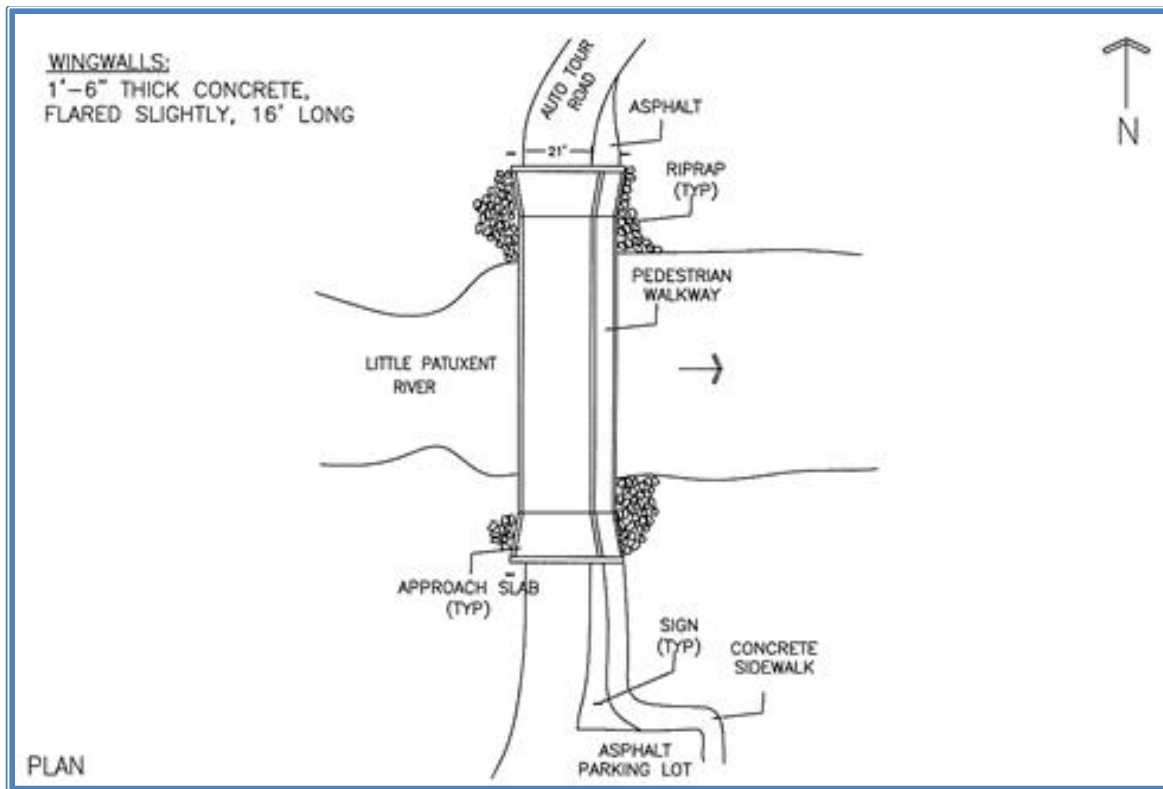


Figure 5.3-2 Sample Plan Sketch

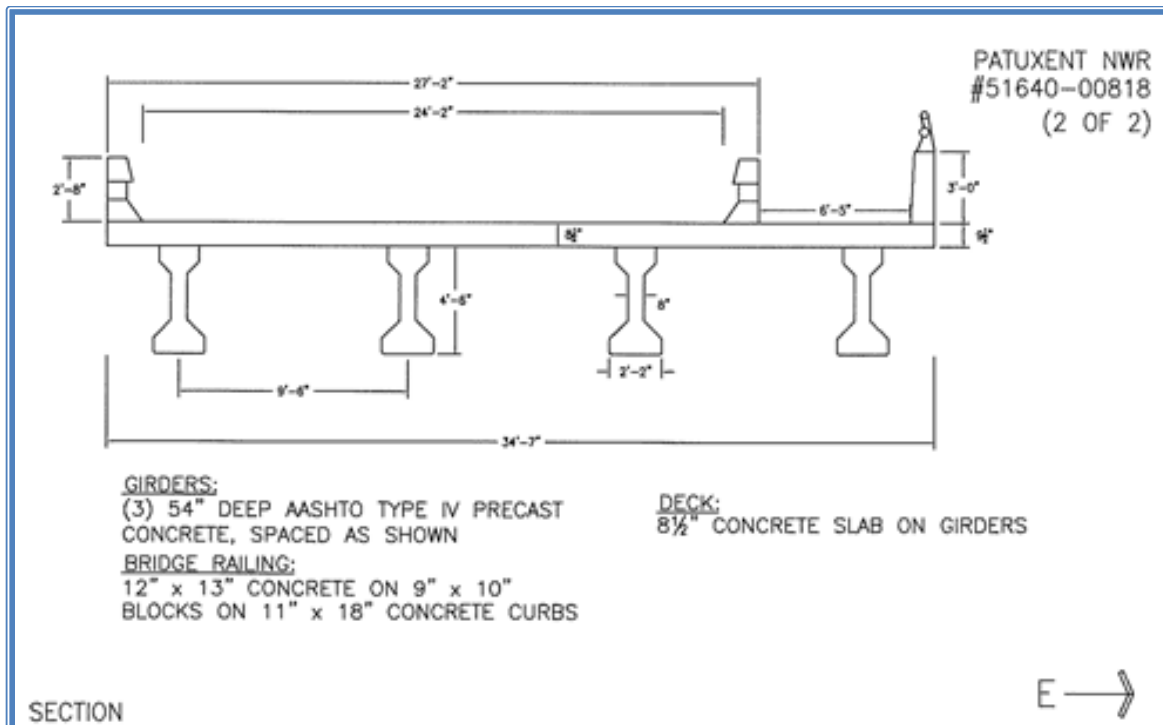


Figure 5.3-3 Sample Section Sketch

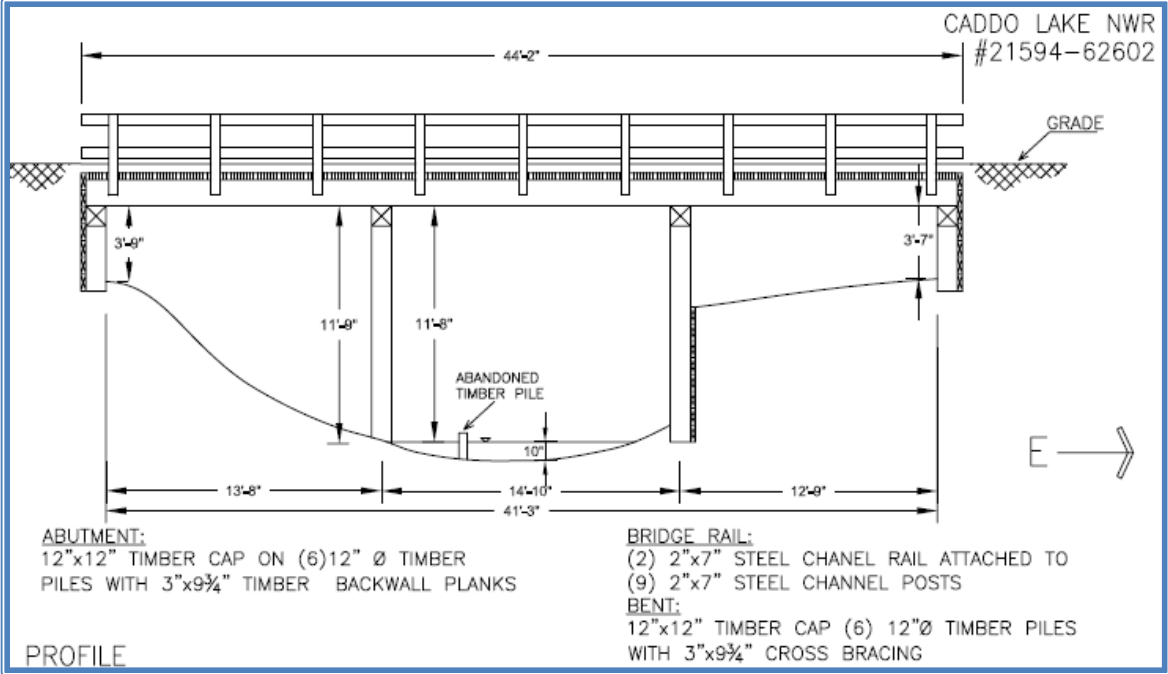


Figure 5.3-4 Sample Profile Sketch

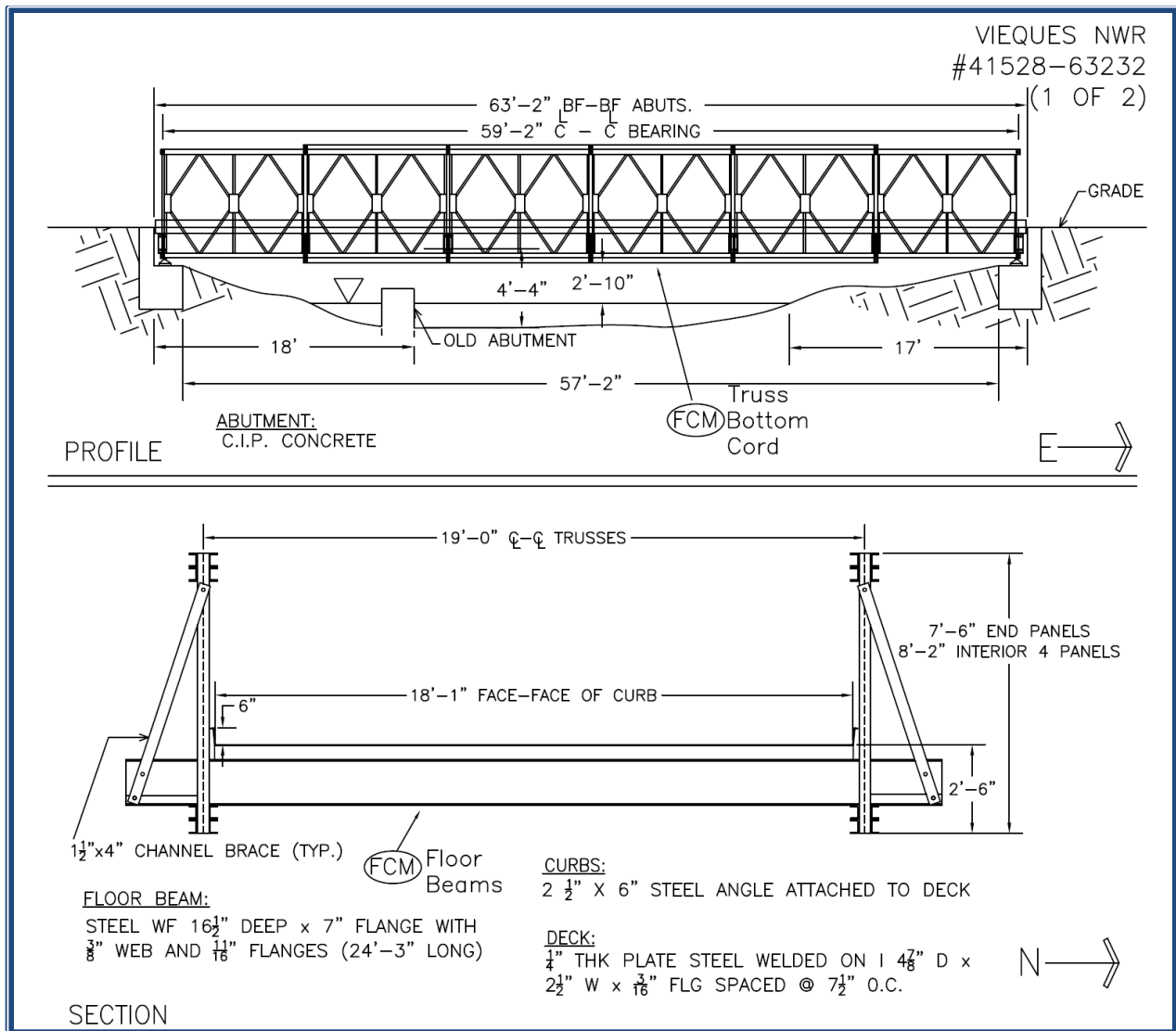


Figure 5.3-5 Typical FCM Call-outs

### 5.3.7 Images

Good images are an excellent way to document the condition of a bridge. They help to verify the identity of the bridge, provide clear evidence of the defects and deterioration that were found during the inspection, and can support funding requests.

Images must be of high quality, in focus, and of sufficient contrast. Each image must have a caption that reinforces the findings described in the narrative. The captions should describe where the image was taken and what it depicts.

Images should be simple and uncluttered. Include a measuring scale or some other reference object when digital imaging damage and defects to provide a frame of reference for the size and extent of deterioration. Superimpose arrows or reference lines to emphasize specific characteristics that may not be readily apparent.

To completely document the inspection findings, the images should include, at a minimum, the following bridge elements:

- View of the bridge as seen from the approaching roadway
- Upstream and downstream elevations
- Typical views of the approach roadways
- Typical views of the feature crossed
- Bridge signage and object markers
- Typical view of the underside of the superstructure

In addition to the above elements, include any examples of notable defects described in the “Bridge Summary” and “Condition Rating” remarks.

### 5.3.8 Structure Inventory and Appraisal Data

The inspection team must update the Service’s bridge inventory data after every bridge inspection. Code SI&A data in accordance with the 1988 edition of the FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation’s Bridges*. Our SI&A data is included in the FHWA National Bridge Inventory (NBI), which is used to track and report on the health of the Nation’s public bridges.

Too often there are errors or information that is omitted when coding the SI&A data. The inspection team must exercise extreme care when inputting or updating the data to ensure that it conforms *exactly* to the noted guidelines. This will ensure a smooth transmission of Service data to FHWA.

### 5.3.9 Additional NBI and FWS Items

NBI and FWS items are either defined in the 1988 *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation’s Bridges* or described below. Items not described are self-explanatory.

#### 5.3.9.1 NBI Items 63 and 65 Method Used to Determine Operating and Inventory Rating

These NBI items should be coded using the current edition of the *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation’s Bridges* and any subsequent FHWA guidance included in Appendix VI.

#### 5.3.9.2 NBI Item 106 Year Reconstructed

Reconstruction is defined as a significant amount of work done to increase the load carrying capacity of a component or an element of a bridge that is not capable of carrying current design loads.

Reconstruction also includes work that substantially changes the physical geometry of a bridge to correct a previous functional deficiency, such as widening the roadway or raising the superstructure in order to significantly increase the waterway opening below.

Reconstruction varies with the size and type of bridge under consideration. A complete deck replacement for a concrete bridge may constitute reconstruction, while a complete deck replacement for a timber bridge normally would not, unless the new deck increased the load carrying capacity or eliminated a structural deficiency of the bridge.

#### 5.3.9.3 FWS Item 204 Bridge Number

The FWS Bridge Number is a unique 10-digit number assigned by the Service Bridge Safety PM. The first 5 digits are typically an organizational code, and the second 5 digits are typically derived from Real Property Inventory (RPI) records. (Note: the second 5 digits reflect RPI coding in use at the time the value is/was assigned).



5.3.9.4 FWS Item 205 FWS Bridge Class

Refer to Table 5.3-2.

Class	Description
A	Bridges that have minimum openings of more than 20 feet and are open to public travel as defined under Title 23 United States Code.
B	Bridges that have minimum openings of 20 feet or more and are not open to public travel, and bridges with openings between 10 feet and 20 feet that require frequent inspections because of condition or hazard (that is, not meeting the requirements for Class C bridges). Multiple pipes with openings less than 20 feet between extreme ends are excluded from this and the following classifications.
C	<p>Bridges with openings between 10 feet and 20 feet where an increased interval of inspection is justified on the basis of the following criteria determined in accordance with the NBIS:</p> <ul style="list-style-type: none"> <li>• Structural condition ratings are seven or higher (good condition with only minor problems).</li> <li>• Scour condition ratings are seven or higher (any previous scour problems have been corrected; bridge is no longer scour critical).</li> <li>• The bridge does not have fracture critical members requiring special attention.</li> </ul> <p>The estimated remaining life is more than 10 years; that is, the structure shows no appreciable signs of deterioration.</p>
D	Bridges out of service because of condition, road closure, etc.
E	Bridges that are maintained and inspected under another jurisdiction: i.e., State, county, or other agency.
N	Bridge-like structures that have been brought to the Service Bridge Safety PM’s attention by station or Regional personnel that were subsequently determined to be non-inventory structures.
X	Bridges that were included on the inventory at one time, but have been removed due to physical removal or replacement. Bridges in this category should have the prefix “(OLD)” added to their name and the bridge records should be “Archived.”

Table 5.3-2 FWS Bridge Class

**5.3.9.5 FWS Item 206 FWS Functional Level**

Refer to Table 5.3-3

Level	Description
1	Serves the main circulatory tour or thoroughfare for visitors or critical administrative functions.
2	Provides optional side trips to areas of scenic beauty, picnic areas, etc. for visitors or serves secondary administrative functions.
3	Provides convenience for visitors or service personnel, but is not critical to the function of the Service. Reasonable alternate access exists.
4	Provides only truck or 4-wheel drive access and no public use. Serves lower priority administrative or management functions.

Table 5.3-3 FWS Functional Level

**5.3.9.6 FWS Item 219 Estimated Remaining Life**

You should code this item under the assumption that no reconstruction work is planned for the bridge. Table 5.3-4 provides additional guidance.

Remaining Life (years)	Description
> 10	Structure shows no appreciable signs of deterioration.
5-10	Structure is beginning to deteriorate. This structure is not in particular risk at the present, but inspectors anticipate that unless corrective action is taken, it will need to be reconstructed within the foreseeable future.
2-5	Structure has deteriorated to the point where we should begin to program funds for a replacement.
0-2	Structure has deteriorated to the point that it could be closed at any time, but is still able to function at the time of the inspection. This is generally considered to be a "critical" structure.
0	Structure should be closed immediately.

Table 5.3-4 Estimating Remaining Useful Life

**5.3.9.7 FWS Item 220 FWS Structural Capacity Code**

Refer to Table 5.3-5

Code	Description
A	Closed or in danger of collapse.
B	Deficient, may require repair or major rehabilitation, but can remain in service at reduced loads.
C	Sound, may require preventive maintenance or minor rehabilitation.
D	Good or better, only minor problems noted or no problems.

Table 5.3-5 FWS Structural Capacity Code

**5.3.9.8 FWS Item 221 FWS Safety Features Code**

Refer to Table 5.3-6

Code	Description
A	Functionally obsolete or dangerous.
B	Deficient, but can remain in use with vehicle and/or speed restrictions.
C	Safe with existing traffic.

Table 5.3-6 FWS Safety Features Code

**5.3.9.9 FWS Item 227 Bridge Summary Condition**

The Summary Condition is a weighted average consisting of:

- The bridge condition,
- An adjustment for the bridge width,
- An adjustment for meeting the needs of the station (station input),
- An adjustment for safety concerns, and
- A bottom line inspector's subjective correction, which is usually a neutral entry of 0.5 to get the weighted average centered on the following scale:
  - Excellent = 9.9 to 9.0
  - Very Good = 8.9 to 8.0
  - Good = 7.9 to 7.0
  - Satisfactory = 6.9 to 6.0
  - Fair = 5.9 to 5.0
  - Poor = 4.9 to 4.0
  - Critical = below 3.0

Calculate the Summary Condition using the applicable formula below:

- Culverts:  $(\text{Item 218} + 5 \times \text{Item 62} + \text{Item 61} + 2 \times \text{Item 67} + \text{Item 236}) / 10 + \text{Item 237} + \text{Item 238} + \text{Item 239}$
- All Other:  $(\text{Item 218} + \text{Item 58} + 2 \times \text{Item 59} + 2 \times \text{Item 60} + \text{Item 61} + 2 \times \text{Item 67} + \text{Item 236}) / 10 + \text{Item 237} + \text{Item 238} + \text{Item 239}$

Where:

Item 58	=	Deck Condition Rating
Item 59	=	Superstructure Condition Rating
Item 60	=	Substructure Condition Rating
Item 61	=	Channel Condition Rating
Item 62	=	Culvert Condition Rating
Item 67	=	Structural Evaluation
Item 218	=	Approach Evaluation
Item 236	=	Deck Width Rating
Item 237	=	Meets Needs Adjustment
Item 238	=	Safety Concerns Adjustment
Item 239	=	Summary Condition Adjustment (usually 0.5)

## 5.4 WRITING GUIDELINES

The Service selects and retains architectural and engineering firms (A/Es) based on their expertise and their professionalism. A completed inspection report should convey this image and instill in the reader confidence in the A/E's work. Clear and concise language, full sentences, and correct grammar go a long way toward projecting a favorable image.

### 5.4.1 Be Clear

Use consistent terms throughout the report, in both text and figures.

While the use of engineering vernacular is necessary, keep in mind that non-technical people who probably do not have an engineering dictionary handy may read the inspection report. As a general rule regarding technical terminology: If you cannot find it in the *Glossary of Common Engineering and Construction Terms* in this handbook, do not use it.

Provide context when necessary to avoid ambiguity:

- The rocker bearings on the east abutment are rotated toward the backwall.
- The wingwall is tilted toward the north.

When listing a number of items in a sentence, use commas to separate the items, including before the word 'and:'

- The timber was secured by a bolt, nail, and lag bolt.
- The timber was secured by a bolt, hook and eye, and lag bolt.

### 5.4.2 Be Concise

Avoid long complicated sentences.

Use relatively short paragraphs to divide various thoughts and subjects.

Do not use qualifying clauses that overwhelm and confuse the subject of the sentence:

*For example, instead of saying:*

- It was observed that the timber is rotten, or
- It appears that the timber is rotten

*state facts directly:*

- The timber is rotten.

### 5.4.3 Be Correct

Be consistent and correct with subject-verb tense.

Do not misuse or misspell words. Have a dictionary handy and refer to it often.

Do use abbreviations for units of measure; however, do not use abbreviations when referring to a unit within the text:

- The pier is 100 ft long.
- The length of the pier was measured in feet.

(Note that there is a space between the number and the abbreviation.)

Do not use a period when abbreviating units of measure, except when abbreviating inches (in.) where it might be confused with the preposition 'in.'

Spell out integers of less than ten, unless units of measure or units of time are given. Always write integers of ten or greater in numeral form:

- A support beam is needed every 8 ft
- A total of eight beams will be needed
- A total of 10 beams are affected
- The reconstruction was completed 4 years ago

Avoid starting a sentence with an integer in numeral form.

Hyphenate numbers that you use as compound adjectives before a noun:

- The 15-year-old structure
- The 300-ft pier

Do not hyphenate numbers used elsewhere in a sentence:

- This structure is 15 years old
- The pile is 30 ft long

When referring to a group of numbered items, such as column lines, bents, or figures, avoid using the abbreviation 'no.' whenever practical:

- Bent 12 is preferable to Bent no. 12

**APPENDICES**



**I. SAMPLE REPORTS**

**A. Full Report**





# BRIDGE INSPECTION AND APPRAISAL REPORT

**BELOW DEVILS KITCHEN DAM**

**Bridge Number: 33610-00444**

**CRAB ORCHARD NATIONAL WILDLIFE REFUGE**

**Region 3**

**U.S. Fish & Wildlife Service**

**Type of Inspection: Routine**

**Date of Inspection: 05/25/2013**

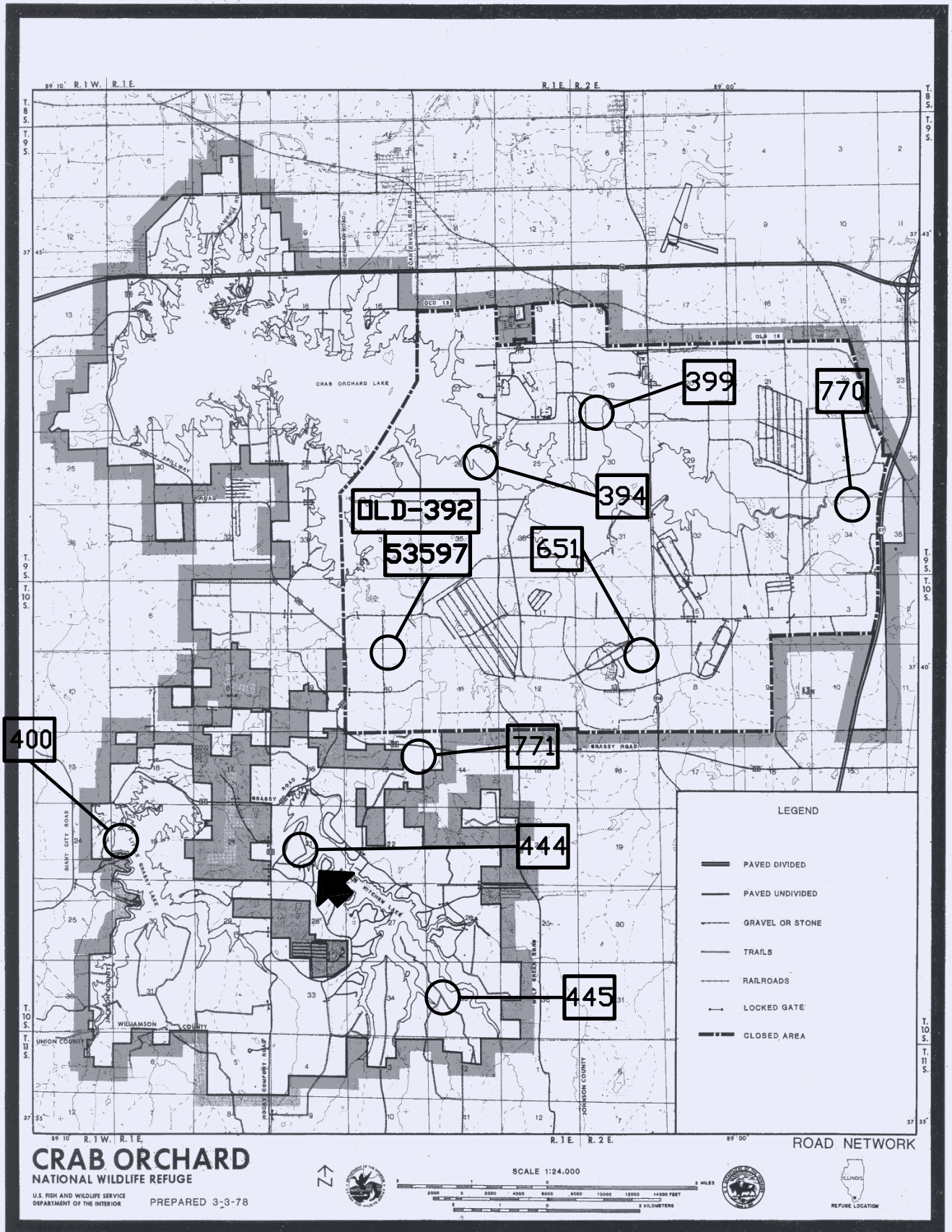
**Date of Report: 06/21/2013**

**Prepared by:** Geocal, Inc., and  
Short Elliott Hendrickson, Inc.  
Denver, CO

**Submitted by:** U.S. Fish & Wildlife Service  
Division of Engineering  
Dam, Bridge & Seismic Safety Branch  
Arlington, VA

## TABLE OF CONTENTS

SECTION	<u>PAGE</u>
MAPS	2
BRIDGE IDENTIFICATION, USE, SUMMARY OF FINDINGS	3
RECOMMENDED WORK AND ESTIMATED COSTS	4
SIGN RECOMMENDATIONS AND LOAD RATINGS	8
ADDITIONAL INFORMATION AND COMMENTS	9
CONDITION RATINGS	10
SKETCHES	17
PHOTOGRAPHS	19
INVENTORY AND APPRAISAL DATA SHEET	29
ADDITIONAL NBI AND FWS ITEMS	33



## Bridge Identification, Use, Summary of Findings

### Bridge Identification and Location

Station:	CRAB ORCHARD NWR	Region:	3
Bridge Name:	BELOW DEVILS KITCHEN DAM	State:	Illinois
Bridge Location:	SEC 16, T10S, R1E	County:	Williamson
Road on Bridge:	NO. DEVILS KITCHEN	Bridge Number:	33610-00444
Feature Crossed:	GRASSY CREEK	Asset Number:	10013545

### Bridge Features

Main Structure Type:	402 - Steel	Width (Curb-Curb):	0023.9	Ft.
Deck Type:	1 - Concrete cast-in-place	Width (Out-Out):	0028.8	Ft.
Deck Surface:	1 - Concrete	No. of Main Spans:	003	
Year Built:	1959	Max Span Length:	000090	Ft.
Year Rebuilt:	0000	Total Length:	0000310	Ft.

Type Construction/Materials: Steel stringers with concrete deck on concrete column bents and abutments.

### Bridge Use

In-Use (Y/N):	Yes	Average Daily Traffic (ADT):	000200
Public Use (Y/N):	Yes	Year of ADT:	13

Type Use: The bridge provides FWS and public access in the west portion of the refuge.

### Summary of Findings

The summary condition of the bridge is SATISFACTORY.

Drainage from the roadway south (uphill) of the bridge flows onto the bridge and through the open expansion joints down to the bent caps, causing deterioration of the girder and stringer bearing areas. The deck drains are plugged with debris allowing drainage to continue along the bridge to the expansion joints. Drainage flowing off of the north end of the bridge is causing erosion at the ends of the north wingwalls; erosion of the shoulders has been partially repaired with asphalt at the northeast corner. Sections of the southwest approach rail are lapped in the wrong direction. There is slight settlement of the roadway embankment at both ends creating a bump onto the bridge which causes impact of vehicle loads on the bridge. Feathered patches at both ends are abrupt and short causing impacts onto bridge also.

Lead Inspector:	Jason Triplett, P.E.	Date of Inspection:	05/25/2013
Inspector Organization:	Short Elliott Hendrickson, Inc.	Date of Report:	06/21/2013

## Recommended Work and Estimated Costs

Estimated Remaining Life (Years): ..... > 10

(At current load limits without major repairs or rehabilitation.)

# of Recommendation Items: 9

Item	Recommendation (See Footnote 1)	Priority Assessment	Maint/Repair/ Rehab	Replacement														
1	<p>Install signs in accordance with 'Sign Recommendations' in the next section of this report. Install object markers at southeast and southwest. Material: \$100, Labor: 4 Hours at \$30/hour = \$120, Adjustment for Location: \$25</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">a. Construction Estimate: \$245</td> <td style="width: 30%;">f. Subtotal: \$245</td> <td style="width: 30%;"></td> </tr> <tr> <td>b. Construction Contingency: \$0</td> <td>g. G.A.S.: \$0</td> <td rowspan="5" style="text-align: center; vertical-align: middle;"><input type="checkbox"/> Urgent Item</td> </tr> <tr> <td>c. Planning/Design/Const. Mgmt.: \$0 (See footnote 2)</td> <td>h. Project Total for Year of Estimate 2013 : \$245</td> </tr> <tr> <td>d. Planning/Design: \$0 (See footnote 3)</td> <td>i. Escalation for Current Year 2013 : \$245</td> </tr> <tr> <td>e. Const. Mgmt.: \$0 (See footnote 3)</td> <td>j. Escalation for Future Year 2015 : \$270</td> </tr> <tr> <td></td> <td></td> </tr> </table>	a. Construction Estimate: \$245	f. Subtotal: \$245		b. Construction Contingency: \$0	g. G.A.S.: \$0	<input type="checkbox"/> Urgent Item	c. Planning/Design/Const. Mgmt.: \$0 (See footnote 2)	h. Project Total for Year of Estimate 2013 : \$245	d. Planning/Design: \$0 (See footnote 3)	i. Escalation for Current Year 2013 : \$245	e. Const. Mgmt.: \$0 (See footnote 3)	j. Escalation for Future Year 2015 : \$270			3	\$245	\$0
a. Construction Estimate: \$245	f. Subtotal: \$245																	
b. Construction Contingency: \$0	g. G.A.S.: \$0	<input type="checkbox"/> Urgent Item																
c. Planning/Design/Const. Mgmt.: \$0 (See footnote 2)	h. Project Total for Year of Estimate 2013 : \$245																	
d. Planning/Design: \$0 (See footnote 3)	i. Escalation for Current Year 2013 : \$245																	
e. Const. Mgmt.: \$0 (See footnote 3)	j. Escalation for Future Year 2015 : \$270																	
2	<p>Replace damaged approach rail at southeast and upgrade to meet current AASHTO/USFWS guidelines. Material, Equipment and Labor: \$50 per foot x 300 feet = \$15,000, Adjustment for Location: \$1,000.</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">a. Construction Estimate: \$16,000</td> <td style="width: 30%;">f. Subtotal: \$16,000</td> <td style="width: 30%;"></td> </tr> <tr> <td>b. Construction Contingency: \$0</td> <td>g. G.A.S.: \$0</td> <td rowspan="5" style="text-align: center; vertical-align: middle;"><input type="checkbox"/> Urgent Item</td> </tr> <tr> <td>c. Planning/Design/Const. Mgmt.: \$0 (See footnote 2)</td> <td>h. Project Total for Year of Estimate 2009 : \$16,000</td> </tr> <tr> <td>d. Planning/Design: \$0 (See footnote 3)</td> <td>i. Escalation for Current Year 2013 : \$19,448</td> </tr> <tr> <td>e. Const. Mgmt.: \$0 (See footnote 3)</td> <td>j. Escalation for Future Year 2015 : \$21,442</td> </tr> <tr> <td></td> <td></td> </tr> </table>	a. Construction Estimate: \$16,000	f. Subtotal: \$16,000		b. Construction Contingency: \$0	g. G.A.S.: \$0	<input type="checkbox"/> Urgent Item	c. Planning/Design/Const. Mgmt.: \$0 (See footnote 2)	h. Project Total for Year of Estimate 2009 : \$16,000	d. Planning/Design: \$0 (See footnote 3)	i. Escalation for Current Year 2013 : \$19,448	e. Const. Mgmt.: \$0 (See footnote 3)	j. Escalation for Future Year 2015 : \$21,442			3	\$19,448	\$0
a. Construction Estimate: \$16,000	f. Subtotal: \$16,000																	
b. Construction Contingency: \$0	g. G.A.S.: \$0	<input type="checkbox"/> Urgent Item																
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d. Planning/Design: \$0 (See footnote 3)	i. Escalation for Current Year 2013 : \$19,448																	
e. Const. Mgmt.: \$0 (See footnote 3)	j. Escalation for Future Year 2015 : \$21,442																	

Item	Recommendation (See Footnote 1)	Priority Assessment	Maint/Repair/ Rehab	Replacement																
3	Clean the deck expansion joint over the north bent and seal with a compressible seal. Epoxy inject four deck construction cold joints. Material & Labor: \$4,000 + \$9,300 = \$13,300, Adjustment for Location: \$900	4  <input type="checkbox"/> Urgent Item	\$17,260	\$0																
	<table border="0"> <tr> <td>a. Construction Estimate:</td> <td>\$14,200</td> <td>f. Subtotal:</td> <td>\$14,200</td> </tr> <tr> <td>b. Construction Contingency:</td> <td>\$0</td> <td>g. G.A.S.:</td> <td>\$0</td> </tr> <tr> <td>c. Planning/Design/Const. Mgmt.: (See footnote 2)</td> <td>\$0</td> <td>h. Project Total for Year of Estimate 2009 :</td> <td>\$14,200</td> </tr> <tr> <td>d. Planning/Design: (See footnote 3)</td> <td>\$0</td> <td>i. Escalation for Current Year 2013 :</td> <td>\$17,260</td> </tr> <tr> <td>e. Const. Mgmt.: (See footnote 3)</td> <td>\$0</td> <td>j. Escalation for Future Year 2015 :</td> <td>\$19,029</td> </tr> </table>				a. Construction Estimate:	\$14,200	f. Subtotal:	\$14,200	b. Construction Contingency:	\$0	g. G.A.S.:	\$0	c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2009 :	\$14,200	d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$17,260
a. Construction Estimate:	\$14,200	f. Subtotal:	\$14,200																	
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c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2009 :	\$14,200																	
d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$17,260																	
e. Const. Mgmt.: (See footnote 3)	\$0	j. Escalation for Future Year 2015 :	\$19,029																	
4	Lap rail splices in direction of traffic at southwest approach rail. Labor: 16 Hours at \$40/hour = \$640, Adjustment for Location: \$50.	4  <input type="checkbox"/> Urgent Item	\$690	\$0																
	<table border="0"> <tr> <td>a. Construction Estimate:</td> <td>\$690</td> <td>f. Subtotal:</td> <td>\$690</td> </tr> <tr> <td>b. Construction Contingency:</td> <td>\$0</td> <td>g. G.A.S.:</td> <td>\$0</td> </tr> <tr> <td>c. Planning/Design/Const. Mgmt.: (See footnote 2)</td> <td>\$0</td> <td>h. Project Total for Year of Estimate 2013 :</td> <td>\$690</td> </tr> <tr> <td>d. Planning/Design: (See footnote 3)</td> <td>\$0</td> <td>i. Escalation for Current Year 2013 :</td> <td>\$690</td> </tr> <tr> <td>e. Const. Mgmt.: (See footnote 3)</td> <td>\$0</td> <td>j. Escalation for Future Year 2015 :</td> <td>\$761</td> </tr> </table>				a. Construction Estimate:	\$690	f. Subtotal:	\$690	b. Construction Contingency:	\$0	g. G.A.S.:	\$0	c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2013 :	\$690	d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$690
a. Construction Estimate:	\$690	f. Subtotal:	\$690																	
b. Construction Contingency:	\$0	g. G.A.S.:	\$0																	
c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2013 :	\$690																	
d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$690																	
e. Const. Mgmt.: (See footnote 3)	\$0	j. Escalation for Future Year 2015 :	\$761																	
5	Install galvanized interlocking sheet pile wingwall at 75 degree angle from backface of abutment, 15' long at northeast and northwest corners of the bridge to better retain embankment. Material & Labor: \$13,400, Adjustment for Location: \$600	5  <input type="checkbox"/> Urgent Item	\$17,017	\$0																
	<table border="0"> <tr> <td>a. Construction Estimate:</td> <td>\$14,000</td> <td>f. Subtotal:</td> <td>\$14,000</td> </tr> <tr> <td>b. Construction Contingency:</td> <td>\$0</td> <td>g. G.A.S.:</td> <td>\$0</td> </tr> <tr> <td>c. Planning/Design/Const. Mgmt.: (See footnote 2)</td> <td>\$0</td> <td>h. Project Total for Year of Estimate 2009 :</td> <td>\$14,000</td> </tr> <tr> <td>d. Planning/Design: (See footnote 3)</td> <td>\$0</td> <td>i. Escalation for Current Year 2013 :</td> <td>\$17,017</td> </tr> <tr> <td>e. Const. Mgmt.: (See footnote 3)</td> <td>\$0</td> <td>j. Escalation for Future Year 2015 :</td> <td>\$18,761</td> </tr> </table>				a. Construction Estimate:	\$14,000	f. Subtotal:	\$14,000	b. Construction Contingency:	\$0	g. G.A.S.:	\$0	c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2009 :	\$14,000	d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$17,017
a. Construction Estimate:	\$14,000	f. Subtotal:	\$14,000																	
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e. Const. Mgmt.: (See footnote 3)	\$0	j. Escalation for Future Year 2015 :	\$18,761																	

Item	Recommendation (See Footnote 1)	Priority Assessment	Maint/Repair/ Rehab	Replacement																
6	Regrade shoulders at the south approach to direct roadway drainage off of bridge before it can run across deck. Grader & Operator: 6 Hours at \$150/hour = \$900, Labor: 8 Hours at \$40/hour = \$320, Adjustment for Location: \$50	5  <input type="checkbox"/> Urgent Item	\$1,270	\$0																
	<table border="0"> <tr> <td>a. Construction Estimate:</td> <td>\$1,270</td> <td>f. Subtotal:</td> <td>\$1,270</td> </tr> <tr> <td>b. Construction Contingency:</td> <td>\$0</td> <td>g. G.A.S.:</td> <td>\$0</td> </tr> <tr> <td>c. Planning/Design/Const. Mgmt.: (See footnote 2)</td> <td>\$0</td> <td>h. Project Total for Year of Estimate 2013 :</td> <td>\$1,270</td> </tr> <tr> <td>d. Planning/Design: (See footnote 3)</td> <td>\$0</td> <td>i. Escalation for Current Year 2013 :</td> <td>\$1,270</td> </tr> <tr> <td>e. Const. Mgmt.: (See footnote 3)</td> <td>\$0</td> <td>j. Escalation for Future Year 2015 :</td> <td>\$1,400</td> </tr> </table>				a. Construction Estimate:	\$1,270	f. Subtotal:	\$1,270	b. Construction Contingency:	\$0	g. G.A.S.:	\$0	c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2013 :	\$1,270	d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$1,270
a. Construction Estimate:	\$1,270	f. Subtotal:	\$1,270																	
b. Construction Contingency:	\$0	g. G.A.S.:	\$0																	
c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2013 :	\$1,270																	
d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$1,270																	
e. Const. Mgmt.: (See footnote 3)	\$0	j. Escalation for Future Year 2015 :	\$1,400																	
7	Install elastomeric gland or other trough device to catch water that flows through finger joint to keep it off the bent cap. Material & Labor: \$9,350, Adjustment for Location: \$450	5  <input type="checkbox"/> Urgent Item	\$13,133	\$0																
	<table border="0"> <tr> <td>a. Construction Estimate:</td> <td>\$9,800</td> <td>f. Subtotal:</td> <td>\$9,800</td> </tr> <tr> <td>b. Construction Contingency:</td> <td>\$0</td> <td>g. G.A.S.:</td> <td>\$0</td> </tr> <tr> <td>c. Planning/Design/Const. Mgmt.: (See footnote 2)</td> <td>\$0</td> <td>h. Project Total for Year of Estimate 2007 :</td> <td>\$9,800</td> </tr> <tr> <td>d. Planning/Design: (See footnote 3)</td> <td>\$0</td> <td>i. Escalation for Current Year 2013 :</td> <td>\$13,133</td> </tr> <tr> <td>e. Const. Mgmt.: (See footnote 3)</td> <td>\$0</td> <td>j. Escalation for Future Year 2015 :</td> <td>\$14,479</td> </tr> </table>				a. Construction Estimate:	\$9,800	f. Subtotal:	\$9,800	b. Construction Contingency:	\$0	g. G.A.S.:	\$0	c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2007 :	\$9,800	d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$13,133
a. Construction Estimate:	\$9,800	f. Subtotal:	\$9,800																	
b. Construction Contingency:	\$0	g. G.A.S.:	\$0																	
c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2007 :	\$9,800																	
d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$13,133																	
e. Const. Mgmt.: (See footnote 3)	\$0	j. Escalation for Future Year 2015 :	\$14,479																	
8	Clean deck drains periodically so that runoff does not flow off north end of bridge. Labor: 8 Hours at \$40/hour = \$320, Adjustment for Location: \$25.	6  <input type="checkbox"/> Urgent Item	\$365	\$0																
	<table border="0"> <tr> <td>a. Construction Estimate:</td> <td>\$365</td> <td>f. Subtotal:</td> <td>\$365</td> </tr> <tr> <td>b. Construction Contingency:</td> <td>\$0</td> <td>g. G.A.S.:</td> <td>\$0</td> </tr> <tr> <td>c. Planning/Design/Const. Mgmt.: (See footnote 2)</td> <td>\$0</td> <td>h. Project Total for Year of Estimate 2013 :</td> <td>\$365</td> </tr> <tr> <td>d. Planning/Design: (See footnote 3)</td> <td>\$0</td> <td>i. Escalation for Current Year 2013 :</td> <td>\$365</td> </tr> <tr> <td>e. Const. Mgmt.: (See footnote 3)</td> <td>\$0</td> <td>j. Escalation for Future Year 2015 :</td> <td>\$402</td> </tr> </table>				a. Construction Estimate:	\$365	f. Subtotal:	\$365	b. Construction Contingency:	\$0	g. G.A.S.:	\$0	c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2013 :	\$365	d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$365
a. Construction Estimate:	\$365	f. Subtotal:	\$365																	
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d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$365																	
e. Const. Mgmt.: (See footnote 3)	\$0	j. Escalation for Future Year 2015 :	\$402																	



Item	Recommendation (See Footnote 1)	Priority Assessment	Maint/Repair/ Rehab	Replacement																
9	Seal crack at abutments and feather asphalt for 20' at both abutments to eliminate bump at ends of bridge. Material and Labor: \$2,400, Adjustment for Location: \$100.	6  <input type="checkbox"/> Urgent Item	\$2,500	\$0																
	<table border="0"> <tr> <td>a. Construction Estimate:</td> <td>\$2,500</td> <td>f. Subtotal:</td> <td>\$2,500</td> </tr> <tr> <td>b. Construction Contingency:</td> <td>\$0</td> <td>g. G.A.S.:</td> <td>\$0</td> </tr> <tr> <td>c. Planning/Design/Const. Mgmt.: (See footnote 2)</td> <td>\$0</td> <td>h. Project Total for Year of Estimate 2013 :</td> <td>\$2,500</td> </tr> <tr> <td>d. Planning/Design: (See footnote 3)</td> <td>\$0</td> <td>i. Escalation for Current Year 2013 :</td> <td>\$2,500</td> </tr> <tr> <td>e. Const. Mgmt.: (See footnote 3)</td> <td>\$0</td> <td>j. Escalation for Future Year 2015 :</td> <td>\$2,756</td> </tr> </table>				a. Construction Estimate:	\$2,500	f. Subtotal:	\$2,500	b. Construction Contingency:	\$0	g. G.A.S.:	\$0	c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2013 :	\$2,500	d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$2,500
a. Construction Estimate:	\$2,500	f. Subtotal:	\$2,500																	
b. Construction Contingency:	\$0	g. G.A.S.:	\$0																	
c. Planning/Design/Const. Mgmt.: (See footnote 2)	\$0	h. Project Total for Year of Estimate 2013 :	\$2,500																	
d. Planning/Design: (See footnote 3)	\$0	i. Escalation for Current Year 2013 :	\$2,500																	
e. Const. Mgmt.: (See footnote 3)	\$0	j. Escalation for Future Year 2015 :	\$2,756																	
<b>Totals</b>			<b>\$71,928</b>	<b>\$0</b>																

Footnotes:

1/Recommended work are items noted by the inspection team on the date of inspection. Urgent items are those which pose a current threat to the strength or stability of the bridge, or involve a significant safety concern. Items are listed in their order of importance. Item 1 considered most important. Adjustments for location include geographical region and remoteness of the bridge adjustment. For multi-use structures such as water control structures or dam spillways, repair or reconstruction estimates, if applicable, are for the bridge component only.

2/Item c., when needed, is used for items up to \$100,000 in construction value, except replacements, and includes a mark-up of approximately 18% assuming MMS program accomplishment. If the item is accomplished by other than MMS, the mark-up should be adjusted accordingly.

3/Items d. and e., when needed, are used for replacements, and work items over \$100,000 in construction value, and use a sliding scale based on the construction estimate. If the item is accomplished by MMS, the mark-up should be adjusted accordingly.

4/Priority assessment value is a representation of the relative priority of a recommendation, with a value of 1 representing the highest priority and 7 representing the lowest priority.

Work Recommendation Remarks

## Sign Recommendations and Load Ratings

### Sign Recommendations

Sign Recommendations

No load posting required. Install object markers at all corners of the bridge.

Sign Status

Object markers at northeast and northwest corners of bridge only.

Sign Recommendation Remarks

### Load Ratings (Tons)

Bridge Element	Deck		Stringer (Interior End Span)		Stringer (Interior Main Span)					
	INV	OPER	INV	OPER	INV	OPER	INV	OPER	INV	OPER
AASHTO TRUCK TYPE										
TYPE HS 20-44	32.4	44.6	23.7	44.6		39.1				
TYPE 3 (25T)										
TYPE 3S2 (36T)										
TYPE 3-3 (40T)										

INV = Inventory Rating      OPER = Operating Rating

Load posting sign recommendations are based on operating ratings. See note regarding posting recommendations below.

Load Rating Remarks

DECK: 7" thick concrete with no asphalt or fill. Stresses Used: Concrete Compressive Stress = 3,000 psi, Reinforcing Steel Yield Stress = 40,000 psi. STRINGER (INTERIOR END SPAN): W 24x94, spacing = 7'-4", spanning 35'-3". Stresses Used: Structural Steel Yield Stress = 33,000 psi. STRINGER (INTERIOR MAIN SPAN): W 33x152, spacing 7'-4", spanning 72'-3", 89'-9" and 72'-2" continuous. Stresses Used: Structural Steel Yield Stress = 33,000 psi.

RATING PREPARED BY: Wayne Patras, 12/27/94

RATING VERIFIED BY: Jason Triplett, 6/9/13

The load rating from 1994 is still considered valid. No significant changes in the condition of the bridge which would affect the rating were observed during the 2013 inspection. The load capacity and weight limit posting recommendations remain as shown above.

### Important Note Regarding Posting Recommendations

Project leaders (and others) should be aware that the posting recommendations are for the absolute maximum load levels to which a structure may safely be subjected for limited passages of the loads. Should the need arise to subject the bridge to sustained loading at or near this level, the Project Leader should contact the Regional Engineer for guidance regarding an appropriate safe load capacity.

## Additional Information and Comments

### Description of Bridge

The bridge was constructed in 1959 and consists of five spans of steel wide flange stringers with a concrete deck that is assumed to have no composite action with the stringers. The end spans are simply supported and the center three spans are continuous. The spans are supported on open column concrete bents and concrete abutments.

### Comparison to Previous Inspection

There are no significant changes in the condition of the bridge since the previous inspection. Object markers in accordance with MUTCD have been placed at the northeast and northwest corners. The joint filler at the construction joint between the north span and the north end of the continuous spans has almost completely fallen out. Flexure cracks up to 1/32 inch wide were noted on the underside of the south bent cap.

### Next Inspection

The next inspection for this bridge is recommended as a routine inspection with a check report in two years.

### Additional Comments

## CONDITION RATINGS

Condition Rating Codes for Items 218, and 58 through 62:

Note - Items left blank are not applicable for this bridge.

N - N/A.

9 - Excellent Condition.

8 - Very Good Condition - no problems noted.

7 - Good Condition - some minor problems.

6 - Satisfactory Condition - structural elements show some minor deterioration.

5 - Fair Condition - all primary structural elements but may have minor section loss, cracking, spalling, or scour.

4 - Poor Condition - advanced section loss, deterioration, spalling, or scour.

3 - Serious Condition - loss of section, deterioration, spalling, or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.

2 - Critical Condition - advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the structure until corrective action can be taken.

1 - Imminent Failure Condition - major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Structure is closed to traffic but corrective action may return structure to light service.

0 - Failed Condition - out of service; beyond corrective action.

### Approaches (218)

ITEM	RATING	REMARKS
Overall Rating (218)	6	Satisfactory.
218.1 Approach Slab		
218.2 Relief Joints		
218.3 Approach Guardrail	5 Fair	Galvanized 'W' beam rail on 6" diameter treated timber posts spaced at 12'-6" centers, additional rail added between 2001 and 2003 inspections. Posts rotting, rail lapped incorrectly and leaning out at southwest. End protection damaged at southeast.
218.4 Surfacing	6 Satisfactory	Asphalt - Transverse minor hairline cracks at abutments, feather patched and rough at both ends covered with oiled gravel patch.
218.5 Embankment	7 Good	Erosion around ends of wingwalls at north end encroaching into roadway. Partial asphalt patch placed at northeast between 2001 and 2003 inspections. 1' of backwall exposed at northeast corner.
218.6 Signs	7 Good	Object markers, black and yellow, at northeast and northwest are in accordance with MUTCD.
218.7 Vegetation	7 Good	Grassy.

## Deck (58)

ITEM	RATING	REMARKS
Overall Rating (58)	6	Satisfactory condition (minor deterioration).
58.1 Deck Structure	6 Satisfactory	Concrete - Aggregate exposed where slightly abraded on top. No delamination. 2" wide x 8"x1" spall with exposed reinforcement at south construction joint in east bay. Minor transverse cracks in bottom of deck with light efflorescence, full width. Haunches are spalling at corners.
58.2 Expansion Joints	5 Fair	Finger joint between south span and south end of continuous spans - About 3/4" opening in fingers. Leaking onto bent cap. Construction joints in slab near splice locations - Leaking. Construction joint between north span and north end of continuous spans - Open and leaking, joint filler material mostly fallen out.
58.3 Wearing Surface		
58.4 Rideability	7 Good	
58.5 Curbs	7 Good	Concrete - Minor hairline cracks.
58.6 Parapets/railings	6 Satisfactory	Concrete rail and posts, integral with curb - Few spalls in posts and underside of rail with exposed rebar.
58.7 Drains/drainage	5 Fair	Drains in front of curbs - All are plugged with debris and leaves.
58.8 Cleanliness	6 Satisfactory	
58.9 Utilities		
58.10 Lighting		

## Superstructure (59)

ITEM	RATING	REMARKS
Overall Rating (59)	7	Good condition (some minor problems).
59.1 Bearing Devices	6    Satisfactory	Steel rocker and round sole plate bearing devices (to allow rotation) on concrete caps at abutments and bents - Rockers leaning 10 to 15 degrees (in expansion) at south pier.  Steel wide flange beams with diaphragms at midspan and each end in end spans and at 1/4 points in continuous spans, tapered cover plates at center bents where beams are continuous. Top flanges of diaphragms have pack rust and deck is being lifted approximately 1/8" at abutments.  Well painted.  Riveted and bolted connections.  Light rust at ends of stringers at north and south bents, also at splice locations. Light to moderate rust with pack rust along top flanges at contact with slab, and at bottom flange of stringers in 2nd span from south.
59.2 Girders		
59.2A Diaphragms		
59.2B Bracing		
59.3 Floor Beams		
59.4 Stringers	7    Good	
59.5 Trusses		
59.5A Portals		
59.5B Bracing		
59.6 Paint	7    Good	
59.7 Splices & Conn's	7    Good	
59.8 Rivets or Bolts	7    Good	
59.9 Welds		
59.10 Corrosion (rust)	7    Good	
59.11 Timber Decay		
59.12 Deflection Under Load	7    Good	
59.13 Vibration Under Load	7    Good	
59.14 Collision Damage		

## Substructure (60)

ITEM	RATING	REMARKS
Overall Rating (60)	6	Satisfactory condition (minor deterioration).
<b>ABUTMENTS</b>		
60.1 Wings	7 Good	Concrete, extension of backwall.
60.2 Backwalls/Bulkheads	6 Satisfactory	& .4 Concrete - Minor hairline map cracks with light efflorescence (possible ASR) on front face, especially at south abutment.
60.3 Bearing Seats	7 Good	& .10 Steel bearing devices bear on concrete caps. Light rust at all bearings.
60.4 Breastwalls/Columns	7 Good	
60.5 Weep Holes		
60.6 Footings/Sills		
60.7 Piles/Bracing		
60.8 Erosion/Scour	7 Good	Erosion troughs up to 12" deep have formed at south berm.
60.9 Settlement		
<b>BENTS/PIERS</b>		
60.10 Bearing Seats	6 Satisfactory	
60.11 Caps	6 Satisfactory	Concrete, stepped and widened 9" at north and south bents - Dirty under open finger joint, potential for deterioration due to freeze/thaw, cracks up to 3/8" at both ends of 1st and west end of 2nd bent from south delaminating and minor small cracking (up to 3/8" at soffit of south bent cap) some with efflorescence. Flexure cracks up to 1/32" wide on underside of south bent cap.
60.12 Columns/Walls	6 Satisfactory	Concrete, braced with horizontal struts at middle two bents - Minor vertical hairline cracks at intersection with south cap.
60.13 Piles/Bracing		
60.14 Footings/Sills		
60.15 Erosion/Scour	8 Very good	
60.16 Settlement		

## Channel (61)

ITEM	RATING	REMARKS
Overall Rating (61)	7	Bank protection needs minor repairs.
61.1 Scour/Erosion	7    Good	No signs of scour. Flow 15' deep under bridge in past, 4'-0" deep plunge pool 20' downstream from bridge beyond riprap, far from bents; does not threaten bridge foundation.
61.2 Channel Protection	7    Good	Cobble-sized stone riprap on banks.
61.3 Spur Dikes, Jetties		
61.4 Waterway Obstructions		
61.5 Adequacy of Opening Sufficient	8    Very good	
61.6 Normal Velocity Low	8    Very good	
61.7 Average Opening	8    Very good	
61.8 Stream Bed Material	7    Good	Sandy, gravel and cobbles.

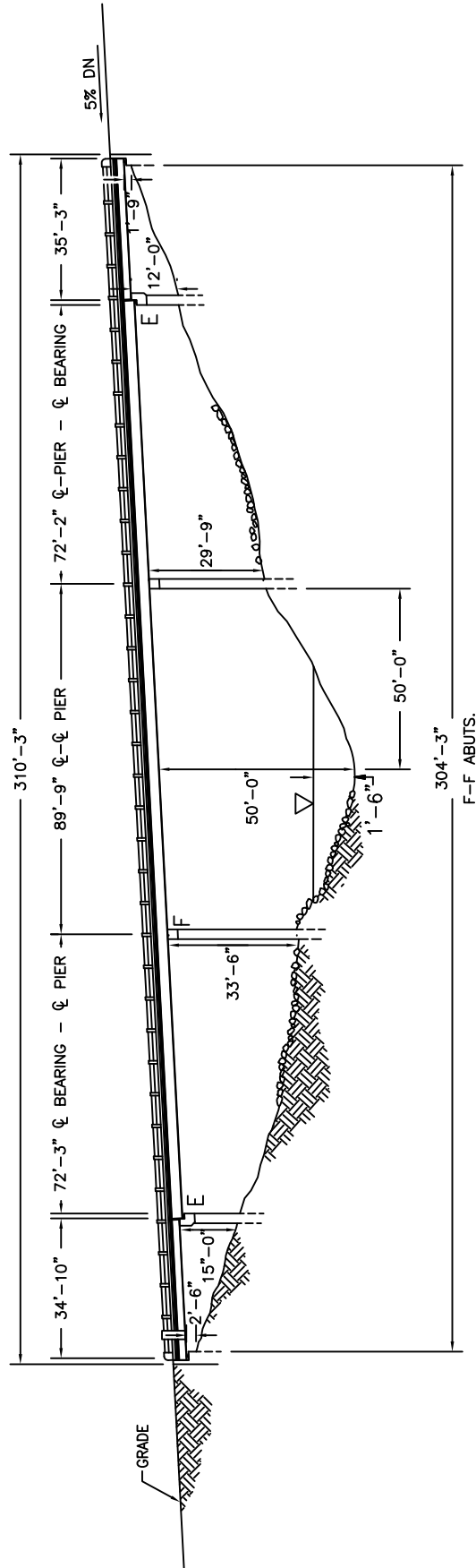


## Culverts (62)

ITEM	RATING	REMARKS
Overall Rating (62)	N	Not applicable.
<p style="text-align: center;">COVER</p> <p>62.1 Embankment</p> <p>62.2 Surfacing</p> <p>62.3 Shoulders</p> <p style="text-align: center;">STRUCTURES</p> <p>62.4 Headwalls</p> <p>62.5 Wings</p> <p>62.6 Barrel</p> <p>62.7 Footings</p> <p style="text-align: center;">HYDRAULICS</p> <p>62.8 Design Opening</p> <p>62.9 Opening Remaining</p> <p>62.10 Debris/Silt</p> <p>62.11 Erosion/Scour</p> <p>62.12 Grade %</p>		

## Railing (36), Scour (113), Load Posting System (41), Accident History

ITEM	RATING	REMARKS
36.A Bridge Railing	0	Concrete rail and posts, integral with curbs, not flush with face of curb.
36.B Guard/Bridge Rail Transitions	0	None.
36.C Approach Railing	0	Galvanized "W" beam rail on 6" diameter posts at 12'-6" centers, not blocked out.
36.D Approach Rail Ends	0	Not flared or anchored.
<p><u>Railing Legend</u></p> <p>0 Does not meet current FWS new rail guidelines</p> <p>1 Meets current FWS guidelines.</p> <p>N Not applicable or a safety feature is not required.</p>		
113. Scour	8      Stable	No signs of significant scour.
41. Load Posting Status	A      Open	Not posted. Load posting is not required.
Accident History		No record available. However, evidence of vehicle hitting both curbs and then impacting approach rail at north end. Noted before 2007.



ABUTMENTS:  
 EXPANSION ROCKER BEARING ON  
 2'-0" SEAT OF 3'-0" CONCRETE WALL

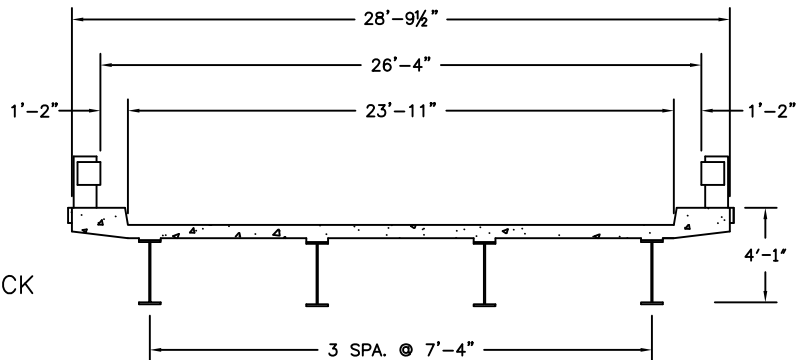
BENTS 2 & 3:  
 3'-3" x 3'-11" CONCRETE CAP WITH  
 1'-6" SEAT, 1'-4" DEEP, ON (2)-  
 2'-6" x 2'-6" CONCRETE COLUMNS WITH  
 SQUARE CONCRETE LATERAL BRACING

F - FIXED  
 E - EXPANSION CAPABLE  
 ABUTMENTS ARE NEUTRAL

BENTS 3 & 4:  
 2'-6" x 2'-7" CONCRETE CAP ON  
 (2)- 2'-6" x 2'-6" CONCRETE COLUMNS WITH  
 SQUARE CONCRETE LATERAL BRACING



PROFILE



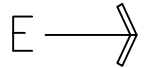
DECK:  
 7" THICK CAST IN PLACE CONCRETE DECK  
 WITH 2'-4" x 9" CONCRETE CURB

STRINGERS (SPAN 1 & 5):  
 (4)- W 24x94 AT 7'-4" SPACING

STRINGERS (SPANS 2 THRU 4):  
 (4)- W 33x152 AT 7'-4" SPACING

BRIDGE RAIL:  
 8" x 12" CONCRETE RAIL ON  
 9" x 12" CONCRETE POSTS  
 AT 8'-2" SPACING

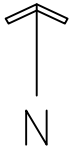
SECTION



WINGWALLS:  
 1'-6" THICK CONCRETE WALL,  
 5'-0" LONG, FLARED 45°

DEVILS KITCHEN DAM

NORTH DEVILS KITCHEN ROAD



(SLOPES AND CHANNEL COVERED  
 BY RIPRAP, BOTH UP AND DOWNSTREAM)

GRASSY CREEK

TREES

APPROACH RAIL:  
 GALVANIZED STEEL W-BEAMS  
 BOLTED TO 6" Ø TREATED TIMBER  
 POSTS, FLARED OUT @ ENDS

APPROACH RAIL (TYP)

22'

PLAN



View down centerline of bridge roadway looking north



Side view looking upstream



Side view looking downstream



Open transverse joint in deck over 1st bent from north



Gravel and debris along edge of deck plugging drain grate (typical of several areas)



Spall with exposed reinforcing on lower portion of inside face of bridge rail post (typical of several)



Crack and spall with reinforcing exposed on top and end of 15th bridge rail post from north on the east side



Damage to north end of east curb due to movement of expansion joint bridging plate





Low approach at north end with incomplete feather patch



Gravel and debris at edge of bridge filling expansion joint opening (typical)



Prior area of sloughing and low shoulder at northeast corner has been filled and covered with pavement (similar at northeast)



Large pothole in wheel path at south approach causing bump onto bridge (similar in other path)



Impact damage to end treatment on southeast approach rail



Southwest approach rail bowed and leaning away from roadway



Damage, possibly from fallen tree, to top of southwest approach rail at the approximate southern 1/3rd-point



Cracks and spalls in haunch below deck at corner of diaphragm and girder at the abutment (common in similar corners of both abutments)



Fine vertical cracks (2-marked with arrows) on inside face of west column at 1st bent from south



Close-up view: Fine vertical cracks (two are marked) on inside face of west column at 1st bent from south



Tensional crack on lower 1/3rd of south face of 1st bent cap from south  
(largest of several between the bent columns)



Typical view of underside of bridge

# Inventory and Appraisal Data Sheet

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## Bridge Identification and Location

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201 Region:.....	Region 3 - Great Lakes-Big Rivers	9 Bridge Location:.....	SEC 16, T10S, R1E
202 Station:.....	CRAB ORCHARD NWR	6 Feature Crossed:.....	GRASSY CREEK
203 Bridge Name:.....	BELOW DEVILS KITCHEN DAM	7 Road on Bridge:.....	NO. DEVILS KITCHEN
204 Bridge Number:.....	33610-00444	11 Milepoint:.....	0000.500
205 FWS Class:.....	A	16 Latitude:.....	37° 38.5'
206 FWS Function:.....	1	17 Longitude:.....	89° 5.9'
207 State:.....	Illinois	22 Owned By:.....	63 - United States Fish & Wildlife Service
208 County:.....	Williamson	21 Maintained By:.....	63 - United States Fish & Wildlife Service

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## Bridge Features

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43 Main Structure Type:.....	402 - Steel	49 Total Length (Ft):.....	0000310
27 Year Built:.....	1959	216 Inventory Length (Ft):.....	000304
106 Year Rebuilt:.....	0000	217 FWS Minimum Length (Y/N):..	Yes
210 Plans Available (Y/N):.....	Yes	112 NBIS Minimum Length (Y/N):..	Y - Yes
28 Lanes On/Under:.....	02/00	50 Curb, Walk Width (Left/Right)(Ft):...	001.2/001.2
42 Type of Service On/Under:.....	1/5 - Highway/Waterway	51 Width (Curb-Curb) (Ft):.....	0023.9
44 Approach Structure Type:.....	302 - Steel	52 Width (Out-Out) (Ft):.....	0028.8
45 No of Main Spans:.....	003	32 Approach Width (Ft):.....	0022.0
46 No. of Approach Spans:.....	002	102 Traffic Direction:.....	2 - 2-way traffic
47 Horizontal Clearance (Ft):.....	023.9	107 Deck Type:.....	1 - Concrete cast-in-place
48 Max Span Length (Ft):.....	000090	108 Deck Surface:.....	100 - Concrete
209 Type Construction/Materials:....	Steel stringers with concrete deck on concrete column bents and abutments.		

## Inventory and Appraisal Data Sheet

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### Bridge Use

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212 In-Use (Y/N):.....	Yes	29 Ave Daily Traffic (ADT):.....	000200
213 Public Use (Y/N):.....	Yes	30 Year of ADT:.....	13
226 Type Use:.....	The bridge provides FWS and public access in the west portion of the refuge.		

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### Condition Ratings and Appraisal Data

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227 Bridge Summary Conditions:....	6.6	219 Estimated Remaining Life (Yrs):..	> 10
218 Approaches:.....	6 - Satisfactory	36 Railing:.....	0000
58 Deck:.....	6 - Satisfactory condition (minor deterioration)	67 Structural Evaluation:.....	4 - Meets minimum tolerable limits
59 Superstructure:.....	7 - Good condition (some minor problems)	68 Deck Geometry:.....	4 - Meets minimum tolerable limits
60 Substructure:.....	6 - Satisfactory condition (minor deterioration)	69 Underclearance:.....	N - Not applicable
61 Channel:.....	7 - Bank protection needs minor repairs	71 Waterway Adequacy:.....	7 - Slight chance of overtopping bridge
62 Culverts:.....	N-Not applicable	72 Approach Alignment:.....	5 - Somewhat better than minimum adequacy
113 Scour:.....	8 - Stable - excellent condition		



## Inventory and Appraisal Data Sheet

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### Load Ratings and Posting

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31 Design Load Category:.....	0 - Unknown	63 Operating Rating Method:.....	2 - Allowable stress (AS)
70 Load Posting Requirement:.....	5 - Equal to or above legal loads	66 Inventory Rating:.....	213
41 Load Posting Status:.....	A - Open	65 Inventory Rating Method:.....	2 - Allowable stress (AS)
64 Operating Rating:.....	237		

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### Recommended Work Estimated Costs

(Estimated costs do not reflect completed work between inspections)

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231 Maint/Repair/Rehab Estimated Costs:....	71928	233 Replacement Estimated Cost:....	0
232 Replacement Recommended (Y/N):.....	No	234 Year Represented by Estimated Costs:.....	2013

(Note: If above cost fields are blank, bridge has not been inspected or data has not yet been entered under the new report system)

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### Inspection Dates

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90 Last Inspection:.....	05/25/2013	92A Fracture Critical Inspect:.....	N - Not required
228 Last Inspection Type:.....	Routine	92B Underwater Inspect:.....	N - Not required
250 Last Report Type:.....	Full	92C Other Special Inspect:.....	N - Not required
91 Inspection Frequency (Mos):.....	24	93A Last Fracture Critical Inspect:...	
229 Next Inspection Year:.....	2015	93B Last Underwater Inspect:.....	
230 Next Inspection Type:.....	Routine	93C Last Other Special Inspect:.....	
251 Next Report Type:.....	Check		

## Inventory and Appraisal Data Sheet

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### Miscellaneous Other Data

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20 Toll Code:.....	3 - On free road	114 Future ADT:.....	000225
37 Historical:.....	5 - Not eligible	115 Year Future ADT:.....	33
100 Defense Hwy Designation:.....	0 - Not a defense highway	214 Inspected by Another Agency (Y/N):.	No
110 Truck Net Designation:.....	0 - Inventory route not on Network	215 Agency:.....	
109 Truck Traffic (%):.....	01	240 Year Added to Inventory:.....	

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### 222 Summary Remarks From Report

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### Inspector Organization

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223 Lead Inspector:.....	Jason Triplett, P.E.	90 Date of Inspection:.....	05/25/2013
224 Inspector Organization:.....	Short Elliott Hendrickson, Inc.	225 Date of Report:.....	06/21/2013
243 Team Member:.....	James Maytum	Report Approved:.....	07/22/2013
244 Team Member Organization:.....	GEOCAL, Inc.		

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### 235 Notes FWS

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## Additional National Bridge Inventory and FWS Items

1 State Code:.....	175	75. Type Improv. Work:.....	
2 State Hwy District:.....	09	76. Improv Length:.....	
3. County Code:.....	199	94. Bridge Cost Est.:.....	
4. City Code:.....	00000	95. Roadway Cost Est.:.....	
5. State Route Number.....	1 6 0 00000 0	96. Project Cost Est.:.....	
8. State Struct Number:....	000033610-00444	97. Year of Estimates:.....	
10. Vertical Clearance:.....	99.99	98. Border Bridge Code:.....	
12. Base Hwy Network:...	0	99. Border Bridge Num.:.....	
13. LRS Inv. Route No.:		101. Par. Str. Desig.:.....	N
19. Detour Length:.....	10	103. Temp Str Desig :.....	
26. Inventory Class :.....	09	104. Inv Rte Hwy Sys :.....	0
33. Median:.....	0	105. St/Lcl, Fed Lands Elig:..	0
34. Skew (Degrees):.....	00	111. Pier/Abut Nav Prot:.....	
35. Deck Flare Code:.....	0	116. Min Nav Vert, Lift:.....	
38. Navig. Control:.....	0	220. FWS Struct. Code:.....	C
39. Nav. Vert. Clear:.....	0000.0	221. FWS Safety Code:.....	B
40. Nav. Horiz. Clear:.....	00000.0	236. Deck Width Rating:.....	8
53. Min Vert Clear Over:..	99 - 99	237. Meets Needs Adj:.....	
54. Min Vert Clr Under:...	N 0 - 0	238. Safety Concerns Adj:....	
55. Min Lat Clr Und Rt:...	N 099.9	239. Summary Cond. Adj:.....	+0.5
56. Min Lat Clr Und Lt:...	00.0	241. Est. RPI Repl Cost:.....	4405
		242. Year RPI Estimate:.....	2013

**B. Check Report**



# "CHECK" BRIDGE INSPECTION REPORT

## A. IDENTIFICATION

1. Station: .....	PATUXENT RR
2. Region: .....	5
3. Bridge Name: .....	BAILEY
4. FWS Bridge: .....	51640-00818
5. Asset Number: .....	10021744
6. Location: .....	BOUNDRY RD S OF GATE C
7. Feature Carried By Bridge (Road On): .....	PATUXENT ROAD
8. Feature Crossed: .....	LITTLE PATUXENT RIVER
9. Date of Inspection: .....	07/30/2011
10. Type Inspection: .....	Routine

## B. PURPOSE

This report is for bridges which were visually inspected ('checked') on the date indicated. Generally these bridges were in satisfactory or better condition during the previous inspection, with no signs of progressive deterioration. The purpose of the current inspection was to ensure that no significant adverse changes have occurred in the condition of the bridge since the previous inspection. No other data regarding the bridge (such as usage data) was verified. A full report would have been prepared if a significant change of condition was found during the inspection. In some cases, the bridge may not be in satisfactory or better condition but a check report was done for other reasons. The Comments section below provides the reason for the check report in these cases.

## C. FINDINGS

The summary condition of the bridge is 'VERY GOOD'. No significant adverse changes were found in the condition of the bridge from the previous inspection conducted on 8/1/09. Due to a washout, the road north of the bridge is closed. Other comments from the previous report remain applicable.

## D. COMMENTS

## E. NEXT INSPECTION RECOMMENDATION

Year:..... 2013

Inspection Type: Routine

Next Report Type: Full

Prepared By: Jason Triplett, P.E.

Date of Report: 09/28/2011

Organization: Short Elliott Hendrickson, Inc.

Report Approved: 9/29/2011

## Recommended Work and Estimated Costs

Estimated Remaining Life (Years): ..... > 10

(At current load limits without major repairs or rehabilitation.)

# of Recommendation Items: 1

Item	Recommendation (See Footnote 1)	Risk Assessment	Maint/Repair/ Rehab	Replacement												
1	Install signs in accordance with 'Sign Recommendations' in the next section of this report. Material: \$250, Labor: 4 Hours at \$30=\$120. Adjustment for Location: None.	Unknown	\$470	\$0												
	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">a. Construction Estimate: \$470</td> <td style="width: 30%;">f. Subtotal: \$470</td> <td rowspan="6" style="width: 30%; vertical-align: middle; text-align: center;"> <input type="checkbox"/> Urgent Item                             </td> </tr> <tr> <td>b. Construction Contingency: \$0</td> <td>g. G.A.S.: \$0</td> </tr> <tr> <td>c. Planning/Design/Const. Mgmt.: \$0 (See footnote 2)</td> <td>h. Project Total for Year of Estimate 2009 : \$470</td> </tr> <tr> <td>d. Planning/Design: \$0 (See footnote 3)</td> <td>i. Escalation for Current Year 2009 : \$470</td> </tr> <tr> <td>e. Const. Mgmt.: \$0 (See footnote 3)</td> <td>i. Escalation for Future Year 2011 : \$517</td> </tr> <tr> <td></td> <td></td> </tr> </table>	a. Construction Estimate: \$470	f. Subtotal: \$470	<input type="checkbox"/> Urgent Item	b. Construction Contingency: \$0	g. G.A.S.: \$0	c. Planning/Design/Const. Mgmt.: \$0 (See footnote 2)	h. Project Total for Year of Estimate 2009 : \$470	d. Planning/Design: \$0 (See footnote 3)	i. Escalation for Current Year 2009 : \$470	e. Const. Mgmt.: \$0 (See footnote 3)	i. Escalation for Future Year 2011 : \$517				
a. Construction Estimate: \$470	f. Subtotal: \$470	<input type="checkbox"/> Urgent Item														
b. Construction Contingency: \$0	g. G.A.S.: \$0															
c. Planning/Design/Const. Mgmt.: \$0 (See footnote 2)	h. Project Total for Year of Estimate 2009 : \$470															
d. Planning/Design: \$0 (See footnote 3)	i. Escalation for Current Year 2009 : \$470															
e. Const. Mgmt.: \$0 (See footnote 3)	i. Escalation for Future Year 2011 : \$517															
<b>Totals</b>			\$470	\$0												

Footnotes:

1/Recommended work are items noted by the inspection team on the date of inspection. Urgent items are those which pose a current threat to the strength or stability of the bridge, or involve a significant safety concern. Items are listed in their order of importance. Item 1 considered most important. Adjustments for location include geographical region and remoteness of the bridge adjustment. For multi-use structures such as water control structures or dam spillways, repair or reconstruction estimates, if applicable, are for the bridge component only.

2/Item c., when needed, is used for items up to \$100,000 in construction value, except replacements, and includes a mark-up of approximately 18% assuming MMS program accomplishment. If the item is accomplished by other than MMS, the mark-up should be adjusted accordingly.

3/Items d. and e., when needed, are used for replacements, and work items over \$100,000 in construction value, and use a sliding scale based on the construction estimate. If the item is accomplished by MMS, the mark-up should be adjusted accordingly.

**Work Recommendation Remarks**

# Sign Recommendations and Load Ratings

## Sign Recommendations

Sign Recommendations

No load posting required. Install object markers at all corners of bridge.

Sign Status

Sign Recommendation Remarks

## Load Ratings (Tons)

Bridge Element	DECK		GIRDER							
	INV	OPER	INV	OPER	INV	OPER	INV	OPER	INV	OPER
AASHTO TRUCK TYPE										
TYPE HS 20-44	63.1	99.9	37.5	62.6						
TYPE 3 (25T)										
TYPE 3S2 (36T)										
TYPE 3-3 (40T)										

INV = Inventory Rating      OPER = Operating Rating

Load posting sign recommendations are based on operating ratings. See note regarding posting recommendations below.

Load Rating Remarks

DECK: No asphalt or fill on 8 1/2" thick, cast-in-place concrete deck. GIRDERS: AASHTO Type IV prestressed concrete I-girders, spaced at 9'-6", spanning 100'-0". Stresses Used: Concrete Compressive Stress=9,000 psi, Prestressed Steel Yield Stress=270,000 psi.

RATING PREPARED BY: I. Cem Ayan, 10/12/07

RATING VERIFIED BY: Jim Inglis, 9/4/09

The load rating from 2007 is still considered valid. No significant changes in the condition of the bridge which would affect the rating were observed during the 2009 inspection. The load capacity and weight limit posting recommendations remain as shown above.

### Important Note Regarding Posting Recommendations

Project leaders (and others) should be aware that the posting recommendations are for the absolute maximum load levels to which a structure may safely be subjected for limited passages of the loads. Should the need arise to subject the bridge to sustained loading at or near this level, the Project Leader should contact the Regional Engineer for guidance regarding an appropriate safe load capacity.





**II. URGENT ITEM FORM**



~U.S. FISH & WILDLIFE SERVICE~  
URGENT BRIDGE WORK  
RECOMMENDATION ITEMS

STATION: \_\_\_\_\_ REGION: \_\_\_\_\_

BRIDGE NAME: \_\_\_\_\_

BRIDGE NUMBER: \_\_\_\_\_

URGENT ITEMS REQUIRING ACTION:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

THE ABOVE ITEMS WERE FIRST NOTED DURING THE \_\_\_\_\_  
INSPECTION. (date)

THE BRIDGE REQUIRES POSTING OF \_\_\_\_\_ TONS, \_\_\_\_\_ TONS, \_\_\_\_\_ TONS  
FOR AASHTO TRUCK TYPES 3, 3S2, & 3-3, OR \_\_\_\_\_ TONS FOR A SINGLE  
LOAD LIMIT SIGN, BUT WAS NOT POSTED AT THE TIME OF INSPECTION.

THE POSTING RECOMMENDATION IS UNCHANGED FROM THE PREVIOUS  
INSPECTION REPORT.

URGENT ITEMS ARE THOSE THAT POSE A CURRENT THREAT TO THE  
STRENGTH OR STABILITY OF THE BRIDGE, OR INVOLVE A SIGNIFICANT  
SAFETY CONCERN.

INSPECTOR: \_\_\_\_\_ DATE: \_\_\_\_\_

ORGANIZATION: \_\_\_\_\_

ACKNOWLEDGED BY: \_\_\_\_\_ DATE: \_\_\_\_\_

TITLE: \_\_\_\_\_

Note: Questions regarding this information should be directed to the Bridge Safety  
Program Manager/Division of Engineering/Ron\_Begin@fws.gov/703-358-2354

Original: Station  
cc: Regional Engineer (Attention Regional Bridge Coordinator)  
Division of Engineering (Bridge Safety Program Manager)  
Inspector



### III. BRIDGE CLOSURE GUIDANCE

This guidance is for those situations where an existing bridge is temporarily closed due to safety concerns or for major rehabilitation or replacement.

If you have questions or concerns, contact your Regional Engineering Division or Ron Begin, Service Engineering, Arlington, VA (703-358-2354 or ron\_begin@fws.gov).

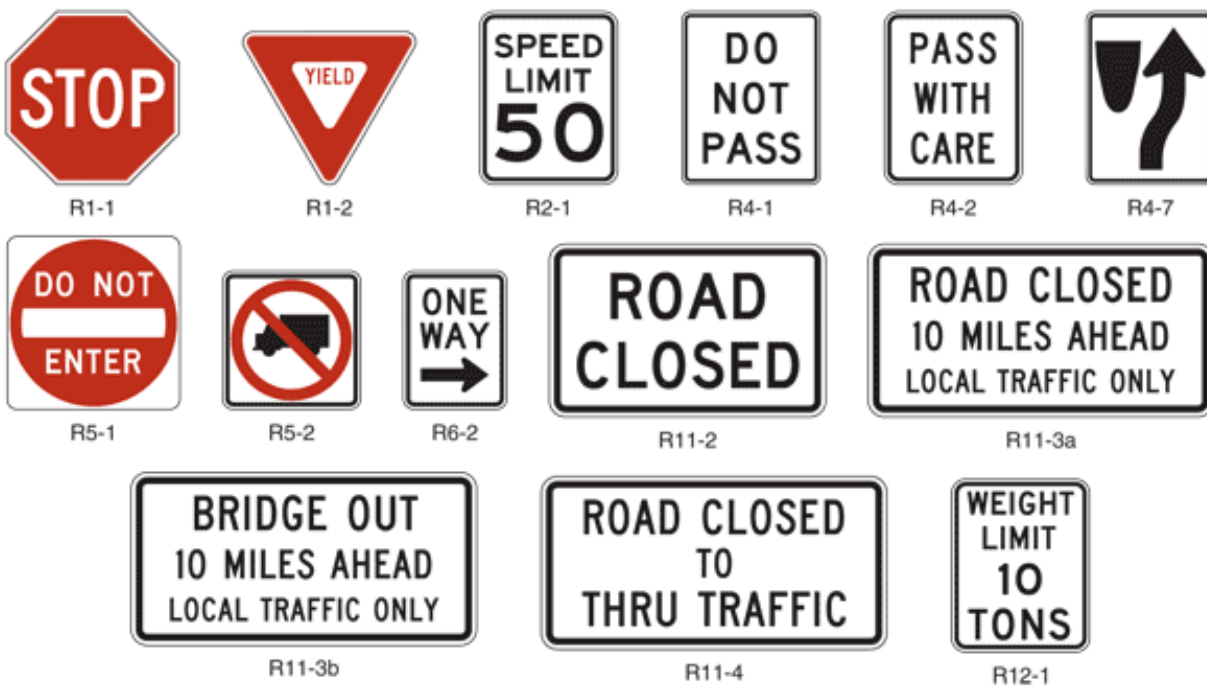
#### Signs and Sign Placement

Place all bridge-related signs in accordance with latest edition of FHWA's *Manual on Uniform Traffic Control Devices (MUTCD)*. MUTCD requires signs on each approach roadway (*i.e.*, provide a minimum of one sign on each side of the bridge).

Section 6F.08 of MUTCD specifies a type R11-2 'Road Closed' for bridge closures. R11-2 is a 48" x 30" horizontal, rectangular white sign with a black border and the words "ROAD CLOSED" in black on two lines (See Figure 5B-1). For bridge closures, the words BRIDGE CLOSED (or BRIDGE OUT) are substituted for ROAD CLOSED.

Install the BRIDGE CLOSED sign at or near the center of the roadway on or above a *Type 3 Barricade* that closes the roadway (see next section).

Figure 5B-1. Regulatory Signs on Low-Volume Roads



## Ordering Signs

Check with your county Department of Transportation (DOT) or your State DOT sign shop to see if you can purchase signs from them. Commercial vendors to consider are:

<http://www.zumar.com>

<http://www.newmansigns.com/trafficsigns.htm>

<http://www.emedco.com>

<http://www.seton.com>

## Barricades

A barricade is a portable or fixed device having from one to three rails with appropriate markings. We use them to close, restrict, or delineate all or a portion of the roadway.

Warning lights meeting MUTCD requirements may be added to channelizing devices in areas with frequent fog, snow, or severe roadway curvature, or where visual distractions are present.

As shown in Figure 6F-7, barricades are classified as Type 1, Type 2, or Type 3. Use Type 3 barricades to close or partially close a road or bridge. You can put a Type 3 barricades for a road closure completely across a roadway or from curb to curb.

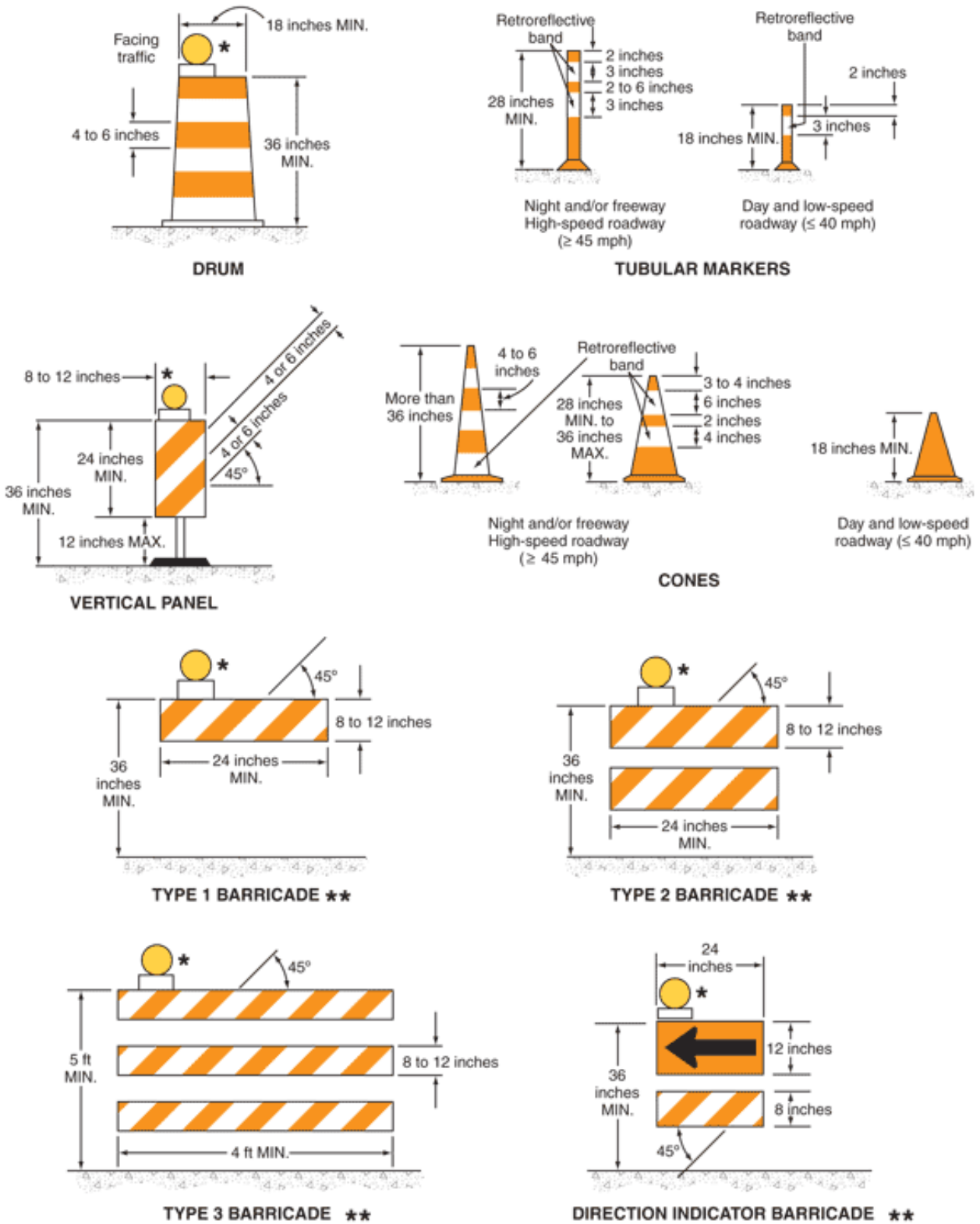
When used, barricade rails have alternating orange and white reflective 6" wide stripes sloping downward at an angle of 45 degrees. Position the stripes to slope downward toward the center of the barricade or barricades.

The minimum length for Type 3 barricades is 48 inches. Each barricade rail is 8 to 12 inches wide.

Support barricade rails so that road users can easily see them, and to ensure stability so that they are not easily blown over or displaced.

Use ballasting in situations where the wind might overturn barricades. You may also place sandbags on the lower parts of the frame or the stays of barricades to provide the required ballast.

Figure 6F-7. Channelizing Devices



\* Warning lights (optional)

\*\* Rail stripe widths shall be 6 inches, except that 4-inch wide stripes may be used if rail lengths are less than 36 inches. The sides of barricades facing traffic shall have retroreflective rail faces.





## IV. GLOSSARY OF COMMON ENGINEERING AND CONSTRUCTION TERMS

### A

AASHTO - American Association of State Highway and Transportation Officials, name changed from AASHO (American Association of State Highway Officials) in 1973

abrasion - wearing or grinding away of material by friction; usually caused by sand, gravel, or stones, carried by wind or water

absorption - the process of a liquid being taken into a permeable solid (e.g., the wetting of concrete)

abutment - part of bridge substructure at either end of bridge that transfers loads from superstructure to foundation and provides lateral support for the approach roadway embankment

ADT - Average Daily Traffic

ADTT - Average Daily Truck Traffic

admixture - an ingredient added to concrete other than cement, aggregate or water (e.g., air entraining agent)

aggradation - progressive raising of a streambed by deposition of sediment

aggregate - hard inert material such as sand, gravel, or crushed rock that may be combined with a cementing material to form mortar or concrete

air entrainment - the addition of air into a concrete mixture in order to increase the durability and resist thermal forces

alignment - the relative horizontal and vertical positioning between components, such as the bridge and its approaches

alignment bearing - a bearing embedded in a bridge seat to prevent lateral movements (see BEARING)

alligator cracking - cracks initiated by inadequate base support or drainage that form on the surface of a road in adjacent, rectangular shapes (like the skin of an alligator)

alloy - two or more metals, or metal and non-metal, intimately combined, usually by dissolving together in a molten state to form a new base metal

anchorage - the complete assemblage of members and parts, embedded in concrete, rock, or other fixed material, designed to hold a portion of a structure in correct position

anchor bolt - a metal rod or bar commonly threaded and fitted with a nut and washer at one end only, used to secure in a fixed position on the substructure the bearings of a bridge, the base of a column, a pedestal, shoe, or other member of a structure

anchor span - the span that counterbalances and holds in equilibrium the cantilevered portion of an adjacent span; also called the back span; see CANTILEVER BEAM, GIRDER, or TRUSS

angle - a basic member shape, usually steel, in the form of an "L"

anisotropy - the property of certain materials, such as crystals, that exhibits different strengths in different directions

anode - the positively charged pole of a corrosion cell at which oxidation occurs

anti-friction bearing - a ball or roller-type bearing; a bearing that reduces transfer of horizontal loads between components

appraisal rating - a judgment of a bridge component's adequacy in comparison to current standards

approach - the part of the roadway immediately before and after the bridge structure

approach slab - a reinforced concrete slab placed on the approach embankment adjacent to and usually resting on the abutment back wall; the function of the approach slab is to carry wheel loads on the approaches directly to the abutment, thereby transitioning any approach roadway misalignment due to approach embankment settlement

appurtenance - an element that contributes to the general functionality of the bridge site (e.g., lighting, signage)

apron - a form of scour (erosion) protection consisting of timber, concrete, riprap, paving, or other construction material placed adjacent to abutments and piers to prevent undermining

arc strike - a blemish or surface defect on metal caused by a strike of an electric welding arc

arch - a curved structure element primarily in compression that transfers vertical loads through inclined reactions to its end supports

arch barrel - a single arch member that extends the width of the structure

arch rib - the main support element used in open spandrel arch construction; also known as arch ring

armor - a secondary steel member installed to protect a vulnerable part of another member, e.g., steel angles placed over the edges of a joint; also scour protection such as rip rap

as-built plans - plans made after the construction of a project, showing all field changes to the final design plans (i.e., showing how the bridge was actually built)

asphalt - a brown to black bituminous substance that is found in natural beds and is also obtained as a residue in petroleum refining and that consists chiefly of hydrocarbons; an asphaltic composition used for pavements and as a waterproof cement

ASTM - American Society for Testing and Materials

auger - a drill with a spiral channel used for boring

axial - in line with the longitudinal axis of a member

axle load - the load borne by one axle of a traffic vehicle, a movable bridge, or other motive equipment or device and transmitted through a wheel or wheels

**B**

back - see EXTRADOS

backfill - material, usually soil or coarse aggregate, used to fill the unoccupied portion of a substructure excavation such as behind an abutment stem and backwall

backstay - cable or chain attached at the top of a tower and extending to and secured on the anchorage to resist overturning stresses exerted on the tower by a suspended span

backwall - the topmost portion of an abutment above the elevation of the bridge seat, functioning primarily as a retaining wall with a live load surcharge; it may serve also as a support for the extreme end of the bridge deck and the approach slab

backwater - the back up of water in a stream due to a downstream obstruction or constriction

bank - sloped sides of a waterway channel or approach roadway, short for embankment

bascule bridge - a bridge over a waterway with one or two leaves that rotate from a horizontal to a near vertical position, providing unlimited overhead clearance

base course - a layer of compacted material found just below the wearing course that supports the pavement

base metal - the surface metal of a steel element to be incorporated in a welded joint; also known as structure metal, parent metal

base plate - steel plate, whether cast, rolled or forged, connected to a column, bearing or other member to transmit and distribute its load to the substructure

batten plate - a plate with two or more fasteners at each end used in lieu of lacing to tie together the shapes comprising a built-up member

batter - the inclination of a surface in relation to a horizontal or a vertical plane; commonly designated on bridge detail plans as a ratio (e.g., 1:3, H:V); see RAKE

battered pile - a pile driven in an inclined position to resist horizontal forces as well as vertical forces

bay - the area of a bridge floor system between adjacent multi-beams or between adjacent floor beams

beam - a linear structural member designed to span from one support to another and support vertical loads

bearing - a support element transferring loads from superstructure to substructure while permitting limited movement capability

bearing capacity - the load per unit area that a structural material, rock, or soil can safely carry

bearing failure - crushing of material under extreme compressive load

bearing pile - a pile that provides support through the tip (or lower end) of the pile

bearing plate - a steel plate that transfers loads from the superstructure to the substructure

bearing pressure - the bearing load divided by the area to which it is applied

bearing seat - a prepared horizontal surface at or near the top of a substructure unit on which the bearings are placed

bearing stiffener - a vertical web stiffener at the bearing location bearing stress - see BEARING PRESSURE

bedding - the soil or backfill material used to support pipe culverts

bedrock - the undisturbed rock layer below the surface soil

bench mark - an established reference point with known elevation and coordinates, used to document dimensions, elevations, or position movement

bending moment - the internal force within a beam resulting from transverse loading

bent - a substructure unit made up of two or more column or column-like members connected at their topmost ends by a cap, strut,

or other member holding them in their correct positions

berm - the line that defines the location where the top surface of an approach embankment or causeway is intersected by the surface of the side slope

beveled washer - a wedge-shaped washer used in connections incorporating members with sloped flange legs, e.g., channels and S-beams

bitumen - a black sticky mixture of hydrocarbons obtained from natural deposits or from distilling petroleum; tar

bituminous concrete - a mixture of aggregate and liquid asphalt or bitumen, which is compacted into a dense mass

blanket - a streambed protection against scour placed adjacent to abutments and piers

BMS - Bridge Management System

bolt - a mechanical fastener with machine threads at one end to receive a nut, and an integral head at the other end

bolster - a block-like member used to support a bearing on top of a pier cap or abutment bridge seat; see PEDESTAL

bond - in reinforced concrete, the grip of the concrete on the reinforcing bars, which prevents slippage of the bars relative to the concrete mass

bond stress - a term commonly applied in reinforced concrete construction to the stress developed by a force tending to produce movement or slippage at the interface between the concrete and the reinforcement bars

bowstring truss - a general term applied to a truss of any type having a polygonal arrangement of its top chord members conforming to or nearly conforming to the arrangement required for a parabolic truss; a truss with a curved top chord

box beam - a hollow structural beam with a square, rectangular, or trapezoidal cross-section that supports vertical loads and provides torsional rigidity

box culvert - a culvert of rectangular or square cross-section

box girder - a hollow, rectangular or trapezoidal shaped girder, a primary member along the longitudinal axis of the bridge, which provides good torsional rigidity

bracing - a system of secondary members that maintains the geometric configuration of primary members

bracket - a projecting support fixed on two intersecting members to strengthen and provide rigidity to the connection

breast wall - the portion of an abutment between the wings and beneath the bridge seat; the breast wall supports the superstructure loads, and retains the approach fill; see STEM

bridge - a structure spanning and providing passage over a river, chasm, road, or similar obstacle

bridge deficiency - a defect in a bridge component or member that makes the bridge less capable or less desirable for use

bridge pad - the raised, leveled area on which the pedestal, masonry plate, or other corresponding element of the superstructure bears on the substructure; also called bridge seat bearing area

bridge seat - the top surface of an abutment or pier on which the superstructure span is placed and supported; for an abutment, it is the surface forming the support for the superstructure and from which the backwall rises; for a pier, it is the entire top surface

bridge site - the position or location of a bridge and its surrounding area

bridging - a carpentry term applied to the cross-bracing fastened between timber beams to increase the rigidity of the floor construction, limit differential deflection, and minimize the effects of impact and vibration

brittle fracture - the failure of a steel member occurring without warning, prior to plastic deformation

brush curb - a narrow curb, 9 inches or less in width, which prevents a vehicle from brushing against the railing or parapet

buckle - to fail by an inelastic change in alignment (deflection) as a result of compression in axial loaded members

buckle plate - an obsolete style of steel deck using dished steel plates as structural members

built-up member - a column or beam composed of plates and angles or other structural shapes united by bolting, riveting, or welding to enhance section properties

bulb t-girder - a t-shaped concrete girder with a bulb shape at the bottom of the girder cross section

bulkhead - a retaining wall-like structure commonly composed of driven sheet piles or a barrier of wooden timbers or reinforced concrete members

buoyancy - upward pressure exerted by the fluid in which an object is immersed

butt joint - a joint between two pieces of metal that have been connected in the same plane

buttress - a bracket-like wall, of full or partial height, projecting from another wall; the buttress strengthens and stiffens the wall against overturning forces; all parts of a buttress act in compression

buttressed wall - a retaining wall designed with projecting buttresses to provide strength and stability

butt weld - a weld joining two plates or shapes end to end; also splice weld

## C

cable - a tension member comprised of numerous individual steel wires or strands twisted and wrapped to form a rope of steel; see SUSPENSION BRIDGE

**cable band** - a steel casting with clamp bolts that fixes a floor system suspender cable to the catenary cable of a suspension bridge

**cable-stayed bridge** - a bridge in which the superstructure is directly supported by cables, or stays, passing over or attached to towers located at the main piers

**caddisfly** - a winged insect closely related to the moth and butterfly whose aquatic larvae seek shelter by digging small shallow holes into submerged timber elements

**caisson** - a rectangular or cylindrical chamber for keeping water or soft ground from flowing into an excavation

**camber** - the slightly arched or convex curvature provided in beams to compensate for dead load deflection; in general, a structure built with perfectly straight lines appears slightly sagged

**cantilever** - a structural member that has a free end projecting beyond a support; length of span overhanging the support

**cantilever abutment** - an abutment that resists lateral earth pressure through the opposing cantilever action of a vertical stem and horizontal footing

**cantilever bridge** - a general term applying to a bridge having a superstructure incorporating cantilever design

**cantilever span** - a superstructure span composed of two cantilever arms, or of a suspended span supported by one or two cantilever arms

**cap** - the topmost portion of a pier or a pile bent serving to distribute the loads on the columns or piles and to hold them in their proper relative positions; see PIER CAP, PILE CAP

**cap beam** - the top member in a bent that ties together the supporting members

**capstone** - the topmost stone of a masonry pillar, column, or other structure requiring the use of a single capping element

**carbon steel** - steel (iron with dissolved carbon) owing its properties principally to its carbon content; ordinary, unalloyed steel

**cast-in-place (C.I.P.)** - the act of placing and curing concrete within formwork to construct a concrete element in its final position

**cast iron** - relatively pure iron, smelted from iron ore, containing 1.8 to 4.5% free carbon and cast to shape

**catch basin** - a receptacle, commonly box shaped and fitted with a grilled inlet and a pipe outlet drain, designed to collect the rainwater and floating debris from the roadway surface and retain the solid material so that it may be periodically removed

**catchment area** - see DRAINAGE AREA

**catenary** - the curve obtained by suspending a uniformly loaded rope or cable between two points

**cathode** - the negatively charged pole of a corrosion cell that accepts electrons and does not corrode

**cathodic protection** - a means of preventing metal from corroding by making it a cathode through the use of impressed direct current or by attaching a sacrificial anode

**catwalk** - a narrow walkway for access to some part of a structure

**causeway** - an elevated roadway crossing a body of water

**cellular abutment** - an abutment in which the space between wings, abutment stem, approach slab, and footings is hollow. Also known as a vaulted abutment

**cement mortar** - a mixture of sand and cement with enough water to make it plastic  
**cement paste** - the plastic combination of cement and water that supplies the cementing action in concrete

**centerline of bearings** - a horizontal line that passes through the centers of the bearings, used in abutment/pier layout and beam erection

center of gravity - the point at which the entire mass of a body acts; the balancing point of an object

centroid - that point about which the static moment of all the elements of area is equal to zero

chain drag - a chain or a series of short medium weight chains attached to a T-shaped handle; used as a preliminary technique for sounding a large deck area for delamination

chamfer - an angled edge or corner, typically formed in concrete

channel - a waterway connecting two bodies of water or containing moving water; a rolled steel member having a C-shaped cross section

channel profile - a longitudinal section of a channel along its centerline

check - a crack in wood occurring parallel with the grain and through the rings of annual growth

cheek wall - see KNEE WALL

chipping hammer - hammer such as a geologist's pick or masonry hammer used to remove corrosion from steel members and to sound concrete for delamination; a welder's tool for cleaning slag from steel after welding

chloride - an ingredient in deicing agents that can damage concrete and steel bridge elements

chord - a generally horizontal member of a truss

circular arch - an arch in which the intrados surface has a constant radius

clearance - the unobstructed vertical or horizontal space provided between two objects

clear headroom - the vertical clearance beneath a bridge structure available for navigational use

clear span - the unobstructed space or distance between support elements of a bridge or bridge member

clip angle - see CONNECTION ANGLE

closed spandrel arch - a stone, brick, or reinforced concrete arch span having walls to

retain the fill above the extrados or to support either entirely or in part the floor system of the structure when there is no fill

coarse aggregate - aggregate that stays on a sieve of 5 mm (¼") square opening

coating - a material that provides a continuous film over a surface in order to protect or seal it; a film formed by the material

coefficient of thermal expansion - the unit change in dimension produced in a material by a change of one degree in temperature

cofferdam - a temporary dam-like structure constructed around an excavation to exclude water; see SHEET PILE COFFERDAM

cold chisel - short bar with a sharp end used for cold-cutting soft metals when struck with a hammer

column - a general term applying to a vertical member resisting compressive stresses and having, in general, a considerable length in comparison with its transverse dimensions

column bent - a bent shaped pier that uses columns incorporated with a cap beam

compaction - the process by which a sufficient amount of energy (compressive pressure) is applied to soil or other material to increase its density

component - a general term reserved to define a bridge deck, superstructure or substructure

composite action - the contribution of a concrete deck to the moment resisting capacity of the superstructure beam when the superstructure beams are not the same material as the deck

composite construction - a method of construction whereby a cast-in-place concrete deck is mechanically attached to superstructure members by shear connectors

compression - a type of stress involving pressing together; tends to shorten a member; opposite of tension

compression failure - buckling, crushing, or collapse caused by compression stress

compression flange - the part of a beam that is compressed due to a bending moment

compression seal joint - a joint consisting of a neoprene elastic seal squeezed into the joint opening

concentrated load - a force applied over a small contact area; also known as point load

concrete - a stone-like mass made from a mixture of aggregates and cementing material, which is moldable prior to hardening; see BITUMINOUS CONCRETE and PORTLAND CEMENT CONCRETE

concrete beam - a structural member of reinforced concrete designed to carry bending loads

concrete pile - a pile constructed of reinforced concrete either precast and driven into the ground, or cast-in-place in a hole bored into the ground

concrete tee team - a T-shaped section of reinforced concrete; cast-in-place monolithic deck and beam system

condition rating - a judgment of a bridge component condition in comparison to its original as-built condition

conductor - a material that is suitable for carrying electric current

connection angle - a piece of angle serving to connect two elements of a member or two members of a structure; also known as clip angle

consolidation - the time dependent change in volume of a soil mass under compressive load caused by water slowly escaping from the pores or voids of the soil

construction joint - a pair of adjacent surfaces in reinforced concrete where two pours have met, reinforcement steel extends through this joint

continuous beam - a general term applied to a beam that spans uninterrupted over one or more intermediate supports

continuous bridge - a bridge designed to extend without joints over one or more interior supports

continuous footing - a common footing that is underneath a wall, or columns

continuous span - spans designed to extend without joints over one or more intermediate supports

continuous truss - a truss without hinges having its chord and web members arranged to continue uninterrupted over one or more intermediate points of support

continuous weld - a weld extending throughout the entire length of a connection

contraction - the thermal action of the shrinking of an object when cooled; opposite of expansion

coping - a course of stone laid with a projection beyond the general surface of the masonry below it and forming the topmost portion of a wall; a course of stone capping the curved or V-shaped extremity of a pier, providing a transition to the pier head proper, when so used it is commonly termed the "starling coping," "nose coping," the "cutwater coping" or the "pier extension coping"

corbel - a piece constructed to project from the surface of a wall, column or other portion of a structure to serve as a support for another member

core - a cylindrical sample of concrete or timber removed from a bridge component for the purpose of destructive testing to determine the condition of the component

corrosion - the general disintegration of metal through oxidation

corrugated - an element with alternating ridges and valleys



counter - a truss web member that undergoes stress reversal and resists only live load tension; see WEB MEMBERS

counterfort - a bracket-like wall connecting a retaining wall stem to its footing on the side of the retained material to stabilize the wall against overturning; a counterfort, as opposed to a buttress, acts entirely in tension

counterforted abutment - an abutment that develops resistance to bending moment in the stem by use of counterforts. This permits the breast wall to be designed as a horizontal beam or slab spanning between counterforts, rather than as a vertical cantilever slab

counterforted wall - a retaining wall designed with projecting counterforts to provide strength and stability

counterweight - a weight used to balance the weight of a movable member; in bridge applications, counterweights are used to balance a movable span so that it rotates or lifts with minimum resistance. Also sometimes used in continuous structures to prevent uplift

couplant - a viscous fluid material used with ultrasonic gauges to enhance transmission of sound waves

couple - two forces that are equal in magnitude, opposite in direction, and parallel with respect to each other

coupon - a sample of steel taken from an element in order to test material properties

course - a horizontal layer of bricks or stone

cover - the clear thickness of concrete between a reinforcing bar and the surface of the concrete; the depth of backfill over the top of a pipe or culvert

covered bridge - an indefinite term applied to a wooden bridge having its roadway protected by a roof and enclosing sides

cover plate - a plate used in conjunction with a flange or other structural shapes to increase flange section properties in a beam, column, or similar member

crack - a break without complete separation of parts; a fissure

cracking (reflection) - visible cracks in an overlay indicating cracks in the concrete underneath

crack initiation - the beginning of a crack, usually at some microscopic defect

crack propagation - the growth of a crack due to energy supplied by repeated stress cycles

creep - an inelastic deformation that occurs under a constant load, below the yield point, and increases with time

creosote - an oily liquid obtained by the distillation of coal or wood tar and used as a wood preservative

crib - a structure consisting of a foundation grillage combined with a superimposed framework providing compartments or coffer that are filled with gravel, concrete, or other material satisfactory for supporting the structure to be placed on them

cribbing - a construction consisting of wooden, metal, or reinforced concrete units so assembled as to form an open cellular-like structure for supporting a superimposed load or for resisting horizontal or overturning forces acting against it

cribwork - large timber cells that are submerged full of concrete to make an underwater foundation

cross - transverse bracings between two main longitudinal members; see DIAPHRAGM, BRACING

cross frame - steel elements placed in X-shaped patterns to act as stiffeners between the main carrying superstructure members

cross girders - transverse girders, supported by bearings, which support longitudinal beams or girders

cross-section - the shape of an object cut transversely to its length

**crown** - the highest point of the transverse cross section of a roadway, pipe or arch; also known as soffit or vertex

**crown of roadway** - the vertical dimension describing the total amount the surface is convexed or raised from gutter to centerline; this is sometimes termed the cross fall or cross slope of roadway

**culvert** - a drainage structure beneath an embankment (e.g., corrugated metal pipe, concrete box culvert)

**curb** - a low barrier at the side limit of the roadway used to guide the movement of vehicles

**curb inlet** - see SCUPPER

**curtain wall** - a term commonly applied to a thin wall between main columns designed to withstand only secondary loads. Also the wall portion of a buttress or counterfort abutment that spans between the buttresses or counterforts

**curvature** - the degree of curving of a line or surface

**curved girder** - a girder that is curved in the horizontal plane in order to adjust to the horizontal alignment of the bridge

**cutoff wall** - vertical wall at the end of an apron or slab to prevent scour undermining

**cutwater** - a sharp-edged structure, facing the water channel current, built around a bridge pier to protect it from the flow of water and debris in the water

**cyclic stress** - stress that varies with the passage of live loads; see STRESS RANGE

## D

**dead load** - a static load due to the weight of the structure itself

**debris** - material including floating wood, trash, suspended sediment, or bed load moved by a flowing stream

**deck** - that portion of a bridge that provides direct support for vehicular and pedestrian traffic, supported by a superstructure

**deck arch** - an arch bridge with the deck above the top of the arch

**deck bridge** - a bridge in which the supporting members are all beneath the roadway

**decking** - bridge flooring installed in panels, e.g., timber planks

**deck joint** - a gap allowing for rotation or horizontal movement between two spans or an approach and a span

**deficiency** - see BRIDGE DEFICIENCY

**deflection** - elastic movement of a structural member under a load

**deformation** - distortion of a loaded structural member; may be elastic or inelastic

**deformed bars** - concrete reinforcement consisting of steel bars with projections or indentations (deformations) to increase the mechanical bond between the steel and concrete

**degradation** - general progressive lowering of a stream channel by scour

**delamination** - surface separation of concrete into layers; separation of glue laminated timber plies

**design load** - the force for which a structure is designed; the most severe combination of loads

**deterioration** - decline in quality over a period of time due to chemical or physical degradation

**diagonal** - a sloping structural member of a truss or bracing system

**diagonal stay** - a cable support in a suspension bridge extending diagonally from the tower to the roadway to add stiffness to the structure and diminish the deformations and undulations resulting from traffic service

**diagonal tension** - the tensile force due to horizontal and vertical shear in a beam

diaphragm - a transverse member placed within a member or superstructure system to distribute stresses and improves strength and rigidity; see BRACING

diaphragm wall - a wall built transversely to the longitudinal centerline of a spandrel arch serving to tie together and reinforce the spandrel walls, together with providing a support for the floor system in conjunction with the spandrel walls; also known as cross wall

differential settlement - uneven settlement of individual or independent elements of a substructure; tilting in the longitudinal or transverse direction due to deformation or loss of foundation material

dike - an earthen embankment constructed to retain or redirect water; when used in conjunction with a bridge, it prevents stream erosion and localized scour and/or directs the stream current such that debris does not accumulate; see SPUR

discharge - the volume of fluid per unit of time flowing along a pipe or channel

displacement induced stress - stresses caused by differential deflection of adjacent parts

distributed load - a load uniformly applied along the length of an element or component of a bridge

ditch - a trough-like excavation made to collect water

diver - a specially trained individual who inspects the underwater portion of a bridge substructure and the surrounding channel

dolphin - a group of piles driven close together or a caisson placed to protect portions of a bridge exposed to possible damage by collision with river or marine traffic

double movable bridge - a bridge in which the clear span over the navigation channel is produced by joining the arms of two adjacent swing spans or the leaves of two adjacent bascule spans at or near the center of the navigable channel; see MOVABLE BRIDGE

dowel - a length of bar embedded in two parts of a structure to hold the parts in place and to transfer stress

drainage - a system designed to remove water from a structure

drainage area - an area in which surface run-off collects and from which it is carried by a drainage system; also known as catchment area

drain hole - hole in a box shaped member or a wall to provide means for the exit of accumulated water or other liquid; also known as drip hole; see WEEP HOLE

drain pipes - pipes that carry storm water

drawbridge - a general term applied to a bridge over a navigable body of water having a movable superstructure span of any type

drift bolt - a short length of metal bar used to connect and hold in position wooden members placed in contact; similar to a dowel

drift pin - tapered steel rod used by ironworkers to align bolt holes

drip notch - a recess cast on the underside of an overhang that prevents water from following the concrete surface onto the supporting beams

drop inlet - a type of inlet structure that conveys the water from a higher elevation to a lower outlet elevation smoothly without a free fall at the discharge

duct - the hollow space where a prestressing tendon is placed in a post-tensioned prestressed concrete girder ductile - capable of being molded or shaped without breaking; plastic

ductile fracture - a fracture characterized by plastic deformation

ductility - the ability to withstand non-elastic deformation without rupture

dumbbell pier - a pier consisting of two cylindrical or rectangular shaped piers joined by an integral web

dummy member - truss member that carries no primary loads; may be included for bracing or for appearance

## E

E - modulus of elasticity of a material; Young's modulus; the stiffness of a material

efflorescence - a deposit on concrete or brick caused by crystallization of carbonates brought to the surface by moisture in the masonry or concrete

elastic - capable of sustaining deformation without permanent loss of shape

elastic deformation - non-permanent deformation; when the stress is removed, the material returns to its original shape

elasticity - the property whereby a material changes its shape under the action of loads, but recovers its original shape when the loads are removed

elastomer - a natural or synthetic rubber-like material

elastomeric pad - a synthetic rubber pad used in bearings that compresses under loads and accommodates horizontal movement by deforming

electrolyte - a medium of air, soil, or liquid carrying ionic current between two metal surfaces, the anode and the cathode

electrolytic cell - a device for producing electrolysis consisting of the electrolyte and the electrodes

electrolytic corrosion - corrosion of a metal associated with the flow of electric current in an electrolyte

elevation view - a drawing of the side view of a structure

elliptic arch - an arch in which the intrados surface is a full half of the surface of an elliptical cylinder; this terminology is sometimes incorrectly applied to a multicentered arch

elongation - the elastic or plastic extension of a member

embankment - a mound of earth constructed above the natural ground surface to carry a road or to prevent water from passing beyond desirable limits; also known as bank

end bent - the last (end) substructure unit made up of two or more column or column-like members connected at their topmost ends by a cap, strut, or other member holding them in their correct positions

end block - in a prestressed concrete I-beam, the widened beam web at the end to provide adequate anchorage bearing for the post-tensioning steel and to resist high shear stresses; similarly, the solid end diaphragm of a box beam

end post - the end compression member of a truss, either vertical or inclined in position and extending from top chord to bottom chord

end section - a concrete or steel appurtenance attached to the end of a culvert for the purpose of hydraulic efficiency, embankment retention or anchorage

end span - a span adjacent to an abutment

epoxy - a synthetic resin that cures or hardens by chemical reaction when components are mixed together shortly before use

epoxy coated reinforcement - reinforcement steel coated with epoxy; used to prevent corrosion

equilibrium - in statics, the condition in which the forces acting on a body are such that no external effect (or movement) is produced

equivalent uniform load - a load having a constant intensity per unit of its length producing an effect equal to that of a live load consisting of vehicle axle or wheel concentrations spaced at varying distances

erosion - wearing away of soil by flowing water not associated with a channel; see SCOUR

expansion - an increase in size or volume

expansion bearing - a bearing designed to permit longitudinal or lateral movements resulting from temperature changes and

superimposed loads with minimal transmission of horizontal force to the substructure; see BEARING

expansion dam - the part of an expansion joint serving as an end form for the placing of concrete at a joint; also applied to the expansion joint device itself; see EXPANSION JOINT

expansion joint - a joint designed to permit expansion and contraction movements produced by temperature changes, loadings, or other forces

expansion rocker - a bearing device at the expansion end of a beam or truss that allows the longitudinal movements resulting from temperature changes and superimposed loads through a tilting motion

expansion roller - a cylinder so mounted that by revolution it facilitates expansion, contraction, or other movements resulting from temperature changes, loadings, or other forces

expansion shoe - expansion bearing, generally of all metal construction

exterior girder - an outermost girder supporting the bridge floor

extrados - the curve defining the exterior (upper) surface of an arch; also known as back

eyebar - a member consisting of a rectangular bar with enlarged forged ends having holes for engaging connecting pins

## F

Factor – see LOAD FACTOR

failure - a condition at which a structure reaches a limit state such as cracking or deflection where it is no longer able to perform its usual function; collapse; fracture

falsework - a temporary wooden or metal framework built to support the weight of a structure during the period of its construction and until it becomes self-supporting

fascia - an outside, covering member designed on the basis of architectural effect rather than

strength and rigidity, although its function may involve both

fascia girder - an exposed outermost girder of a span sometimes treated architecturally or otherwise to provide an attractive appearance

fatigue - the tendency of a member to fail at a stress below the yield point when subjected to repetitive loading

fatigue crack - any crack caused by repeated cyclic loading at a stress below the yield point

fatigue damage - member damage (crack formation) due to cyclic loading

fatigue life - the length of service of a member subject to fatigue, based on the number of cycles it can undergo

fender - a structure that acts as a buffer to protect the portions of a bridge exposed to floating debris and water-borne traffic from collision damage; sometimes called an ice guard in regions with ice floes

fender pier - a pier-like structure that performs the same service as a fender, but is generally more substantially built; see GUARD PIER

field coat - a coat of paint applied after the structure is assembled and its joints completely connected; quite commonly a part of the field erection procedure; field painting

fill - material, usually earth, used to change the surface contour of an area, or to construct an embankment

filler - a piece used primarily to fill a space beneath a batten, splice plate, gusset, connection angle, stiffener, or other element; also known as filler plate

filler metal - metal prepared in wire, rod, electrode, or other form to be fused with the structure metal in the formation of a weld

filler plate - see FILLER

fillet - a curved portion forming a junction of two surfaces that would otherwise intersect at an angle

fillet weld - a weld of triangular or fillet shaped cross-section between two pieces at right angles

filling - see FILL

fine aggregate - sand or grit for concrete or mortar that passes a No. 4 sieve (4.75 mm)

finger dam - expansion joint in which the opening is spanned by meshing steel fingers or teeth

fish belly - a term applied to a girder or a truss having its bottom flange or its bottom chord constructed either haunched or bow-shaped with the convexity downward; see LENTICULAR TRUSS

fixed beam - a beam with a fixed end

fixed bearing - a bearing that allows only rotational movement; see BEARING

fixed bridge - a bridge having constant position, i.e., without provision for movement to create increased navigation clearance

fixed end - movement is restrained

fixed-ended arch - see VOUSSOIR ARCH

fixed span - a superstructure span having its position practically immovable, as compared to a movable span

fixed support - a support that will allow rotation only, no longitudinal movement

flange - the (usually) horizontal parts of a rolled I-shaped beam or of a built-up girder extending transversely across the top and bottom of the web

flange angle - an angle used to form a flange element of a built-up girder, column, strut or similar member

floating bridge - see PONTOON BRIDGE

floating foundation - a soil-supported raft or mat foundation with low bearing pressures; sometimes applied to a "foundation raft" or "foundation grillage"

flood frequency - the average time interval in years in which a flow of a given magnitude will recur

flood plain - area adjacent to a stream or river subject to flooding

floor - see DECK

floorbeam - a primary horizontal member located transversely to the general bridge alignment

floor system - the complete framework of members supporting the bridge deck and the traffic loading

flow capacity - maximum flow rate that a channel, conduit, or culvert structure is hydraulically capable of carrying

flux - a material that protects the weld from oxidation during the fusion process

footbridge - a bridge designed and constructed to provide means of traverse for pedestrian traffic only; also known as pedestrian bridge

footing - the enlarged, lower portion of a substructure, which distributes the structure load either to the earth or to supporting piles; the most common footing is the concrete slab; footer is a colloquial term for footing

foot wall - see TOE WALL

force - an influence that tends to accelerate a body or to change its movement

forms - the molds that hold concrete in place while it is hardening; also known as form work, shuttering; see LAGGING, STAY-IN-PLACE FORMS

form work - see FORMS

foundation - the supporting material on which the substructure portion of a bridge is placed

foundation excavation - the excavation made to accommodate a footing for a structure; also known as foundation pit

foundation failure - failure of a foundation by differential settlement or by shear failure of the soil

foundation grillage - a construction consisting of steel, timber, or concrete members placed in layers; each layer is perpendicular to those above and below it and the members within a layer are generally parallel, producing a crib or grid-like effect. Grillages are usually placed under very heavy concentrated loads

foundation load - the load resulting from traffic, superstructure, substructure, approach embankment, approach causeway, or other incidental load increment imposed on a given foundation area

foundation pile - see PILE

foundation pit - see FOUNDATION EXCAVATION

foundation seal - a mass of concrete placed underwater within a cofferdam for the base portion of structure to close or seal the cofferdam against incoming water; see TREMIE

fracture - see BRITTLE FRACTURE

fracture critical member - a member in tension or with a tension element whose failure would probably cause a portion of or the entire bridge to collapse

frame - a structure that transmits bending moments from the horizontal beam member through rigid joints to vertical or inclined supporting members

framing - the arrangement and connection of the component members of a bridge superstructure

free end - movement is not restrained

friction pile - a pile that provides support through friction resistance between the pile and the surrounding earth along the lateral surface of the pile

friction roller - a roller placed between members intended to facilitate change in their relative positions by reducing the frictional resistance to translation movement

frost heave - the upward movement of, or force exerted by, soil due to freezing of retained moisture

frost line - the depth at which soil may be frozen

## G

gabion - rock filled wire baskets used to retain earth and provide erosion control

galvanic action - electrical current between two unlike metals

galvanize - to coat with zinc

gauge - the distance between parallel lines of rails, rivet holes, etc; a measure of thickness of sheet metal or wire; also known as gage

geometry - shape or form; relationship between lines or points

girder - a horizontal flexural member that is the main or primary support for a structure; any large beam, especially if built up

girder bridge - a bridge whose superstructure consists of two or more girders supporting a separate floor system as differentiated from a multi-beam bridge or a slab bridge

girder span - a span in which the major longitudinal supporting members are girders

glue laminated - a member created by gluing together two or more pieces of lumber G-20

grade - the fall or rise per unit horizontal length; see GRADIENT

grade crossing - a term applicable to an intersection of two highways, two railroads or a railroad and a highway at a common grade or elevation; now commonly accepted as meaning the last of these combinations

grade intersection - the location where two roadway slopes meet in profile; to provide a smooth transition from one to the other they are connected by a vertical curve and the resulting profile is a sag or a crest

grade separation - roadways crossing each other at different elevations; see OVERPASS, UNDERPASS

gradient - the rate of inclination of the roadway and/or sidewalk surface(s) from the horizontal,

applying to a bridge and its approaches; it is commonly expressed as a percentage relation (ratio) of horizontal to vertical dimensions

gravity abutment - a thick abutment that resists horizontal earth pressure through its own dead weight

gravity wall - a retaining wall that is prevented from overturning or sliding by its own dead weight

grid flooring - a steel floor system comprising a lattice pattern that may or may not be filled with concrete

grillage - assembly of parallel beams, usually steel or concrete, placed side by side, often in layers with alternating directions; see FOUNDATION GRILLAGE

groin - a wall built out from a river bank to check scour

grout - mortar having a sufficient water content to render it free-flowing, used for filling (grouting) the joints in masonry, for fixing anchor bolts, and for filling cored spaces; usually a thin mix of cement, water, and sometimes sand or admixtures

grouting - the process of filling in voids with grout

guard pier - a pier-like structure built to protect a swing span in its open position from collision with passing vessels or water-borne debris; may be equipped with a rest pier on which the swing span in its open position may be latched; see FENDER PIER

guardrail - a safety feature element intended to redirect an errant vehicle

guide rail - see GUARDRAIL

gunite - the process of blowing Portland cement mortar or concrete onto a surface using compressed air

gusset plate - a plate that connects the members of a structure and holds them in correct position at a joint

gutter - a paved ditch; area adjacent to a roadway curb used for drainage

guy - a cable member used to anchor a structure in a desired position

## H

H Loading - a combination of loads used to represent a two-axle truck developed by AASHTO

hairline cracks - very narrow cracks that form in the surface of concrete due to tension caused by loading

hammer - hand tool used for sounding and surface inspection

hammerhead pier - a pier with a single cylindrical or rectangular shaft and a relatively long, transverse cap; also known as a tee pier or cantilever pier

hand hole - hole provided in component plate of built-up box section to permit access to the interior for construction and maintenance purposes

hand rail - commonly applies only to sidewalk railing presenting a latticed, barred, balustered, or other open web construction

hands-on access - close enough to the member or component so that it can be touched with the hands and inspected visually

hanger - a tension member serving to suspend an attached member; allows for expansion between a cantilevered and suspended span

haunch - an increase in the depth of a member usually at points of support; the outside areas of a pipe between the spring line and the bottom of the pipe

haunched girder - a horizontal beam whose cross sectional depth varies along its length

H-beam - a rolled steel member having an H-shaped cross-section (flange width equals beam depth) commonly used for piling; also H-pile

head - a measure of water pressure expressed in terms of an equivalent weight or pressure



exerted by a column of water; the height of the equivalent column of water is the head

head loss - the loss of energy between two points along the path of a flowing fluid due to fluid friction; reported in feet of head

headwall - a concrete structure at the ends of a culvert to retain the embankment slopes, anchor the culvert, and prevent undercutting

headwater - the source or the upstream waters of a stream

heat treatment - any of a number of various operations involving controlled heating and cooling that are used to impart specific properties to metals; examples are tempering, quenching, and annealing

heave - the upward motion of soil caused by outside forces such as excavation, pile driving, moisture, or soil expansion; see FROST HEAVE

heel - the portion of a footing behind the stem

helical - having the form of a spiral

high carbon steel - carbon steel containing 0.5 to 1.5% dissolved carbon

high strength bolt - bolt and nut made of high strength steel, usually A325 or A490

high water mark - a point that represents the maximum rise of a body of water over land. Such a mark is often the result of a flood, although high water marks may reflect an all-time high, an annual high (i.e., highest level to which water rose that year), or the high point for some other division of time

hinge - a point in a structure at which a member is free to rotate

hinged joint - a joint constructed with a pin, cylinder segment, spherical segment, or other device permitting rotational movement

honeycomb - an area in concrete where mortar has separated and left spaces between the coarse aggregate, usually caused by improper vibration during concrete construction

horizontal alignment - a roadway's centerline or baseline alignment in the horizontal plane

horizontal curve - a roadway baseline or centerline alignment defined by a radius in the horizontal plane

Howe truss - a truss of the parallel chord type with a web system composed of vertical (tension) rods at the panel points with an X pattern of diagonals

HS Loading - a combination of loads developed by AASHTO used to represent a truck and trailer

hybrid girder - a girder whose flanges and web are made from steel of different grades

hydraulics - the mechanics of fluids

hydrology - study of the accumulation and flow of water from watershed areas

hydroplaning - loss of contact between a tire and the roadway surface when the tire planes or glides on a film of water

## I

I-beam - a structural member with a cross-sectional shape similar to the capital letter "I"

ice guard - see FENDER

impact - A factor that describes the effect on live load due to dynamic and vibratory effects of a moving load; in bridge design, a load based on a percentage of live load to include dynamic and vibratory effects; in fracture mechanics, a rapidly applied load, such as a collision or explosion

incomplete fusion - a weld flaw where the weld metal has not combined metallurgically with the base metal

indeterminate stress - stress in a structural member that cannot be calculated directly; it is computed by the iterative application of mathematical equations, usually with an electronic computer; indeterminate stresses arise in continuous span and frame type structures

individual column footing - footing supporting one column

inelastic compression - compression beyond the yield point

inlet - an opening in the floor of a bridge leading to a drain; roadway drainage structure which collects surface water and transfers it to pipes

inspection frequency - the frequency with which the bridge is inspected -- normally every 2 years

integral abutment - an abutment cast monolithically with the end diaphragm of the deck; such abutments usually encase the ends of the deck beams and are pile supported

integral deck - a deck that is monolithic with the superstructure; concrete tee beam bridges have integral decks

intercepting ditch - a ditch constructed to prevent surface water from flowing in contact with the toe of an embankment or causeway or down the slope of a cut

interior girder - any girder between exterior or fascia girders

interior span - a span where both supports are intermediate substructure units

intermittent weld - a noncontinuous weld commonly composed of a series of short welds separated by spaces of equal length

intrados - the curve defining the interior (lower) surface of the arch; also known as soffit

inventory item - data contained in the structure file pertaining to bridge identification, structure type and material, age and service, geometric data, navigational data, classification, load rating and posting, proposed improvements, and inspections

inventory rating - the capacity of a bridge to withstand loads under normal service conditions based on 55% of yield strength

invert elevation - the bottom or lowest point of the internal surface of the transverse cross section of a pipe or culvert

iron - a metallic element used in cast iron, wrought iron, and steel

isotropic - having the same material properties in all directions, e.g., steel

## J

jack arch - a deck support system comprised of a brick or concrete arch springing from the bottom flanges of adjacent rolled steel beams

jacking - the lifting of elements using a type of jack (e.g., hydraulic), sometimes acts as a temporary support system

jack stringer - the outermost stringer supporting the bridge floor in a panel or bay

jacket - a protective shell surrounding a pile made of fabric, concrete, or other material

jersey barrier - a concrete barrier with sloping front face that was developed by the New Jersey Department of Transportation

joint - in masonry, the space between individual stones or bricks; in concrete, a division in continuity of the concrete; in a truss, point at which members of a truss are joined

## K

keeper plate - a plate that is connected to a sole plate, designed to prohibit a beam from becoming dislodged from the bearing

key - a raised portion of concrete on one face of a joint that fits into a depression on the adjacent face

keystone - the symmetrically shaped, wedge-like stone located in a head ring course at the crown of an arch; the final stone placed, thereby closing the arch

king-post - the vertical member in a "king-post" type truss; also known as king rod

king-post truss - two triangular panels with a common center vertical; the simplest of triangular system trusses

kip - a kilo pound (1000 lb.); convenient unit for structural calculations

knee brace - a short member engaging at its ends two other members that are joined to form a right angle or a near-right angle to strengthen and stiffen the connecting joint

knee wall - a return of the abutment backwall at its ends to enclose the bridge seat on three of its sides; also called cheek wall

knife edge - a condition in which corrosion of a steel member has caused a sharp edge

knuckle - an appliance forming a part of the anchorage of a suspension bridge main suspension member permitting movement of the anchorage chain

K-truss - a truss having a web system wherein the diagonal members intersect the vertical members at or near the mid-height; the assembly in each panel forms a letter "K"

## L

L-abutment - a cantilever abutment with the stem flush with the toe of the footing, forming an "L" in cross section

laced column - a riveted, steel built-up column of usually four angles or two channels tied together laterally with lacing

lacing - small flat plates, usually with one rivet at each end, used to tie individual sections of built up members; see LATTICE

lagging - horizontal members spanning between piles to form a wall; forms used to produce curved surfaces; see FORMS

lamellar tear - incipient cracking parallel to the face of a steel member

laminated timber - timber planks glued together face to face to form a larger member; see GLUE LAMINATED

lane loading - a design loading that represents a line of trucks crossing over a bridge

lap joint - a joint between two members in which the end of one member overlaps the end of the other

lateral - a member placed approximately perpendicular to a primary member

lateral bracing - the bracing assemblage engaging a member perpendicular to the plane of the member; intended to resist transverse movement and deformation; also keeps primary

parallel elements in truss bridges and girder bridges aligned; see BRACING

lattice - a crisscross assemblage of diagonal bars, channels, or angles on a truss; also known as latticing, lacing

lattice truss - in general, a truss having its web members inclined, but more commonly the term is applied to a truss having two or more web systems composed entirely of diagonal members at any interval and crossing each other without reference to vertical members

leaching - the action of removing substances from a material by passing water through it

lead line - a weighted cord incrementally marked, used to determine the depth of a body of water; also known as sounding line

leaf - the movable portion of a bascule bridge that forms the span of the structure

lenticular truss - a truss having parabolic top and bottom chords curved in opposite directions with their ends meeting at a common joint; also known as a fish belly truss

levee - an embankment built to prevent flooding of low-lying land

leveling course - a layer of bituminous concrete placed to smooth an irregular surface

light-weight concrete - concrete of less than standard unit weight; may be no-fines concrete, aerated concrete, or concrete made with lightweight aggregate

link - a hanger plate in a pin and hanger assembly whose shape is similar to an eyebar, e.g., the head (at the pinhole) is wider than the shank

link and roller - a movable bridge element consisting of a hinged strut-like link fitted with a roller at its bottom end, supported on a shoe plate or pedestal and operated by a thrust strut serving to force it into a vertical position and to withdraw it; when installed at each outermost end of the girders or the trusses of a swing span, their major function is to lift them to an extent that their camber or droop will be

removed and the arms rendered free to act as simple spans; when the links are withdrawn to an inclined position fixed by the operating mechanism, the span is free to be moved to an open position

live load - a temporary dynamic load such as vehicular traffic that is applied to a structure; also accompanied by vibration or movement affecting its intensity

load - a force carried by a structure component

load factor – an objective or subjective multiplier applied to a load for design purposes

load factor design - a design method used by AASHTO, based on limit states of material and subjectively factored loads

load indicating washer - a washer with small projections on one side, which compress as the bolt is tightened; gives a direct indication of the bolt tension that has been achieved

load rating - calculation of the amount of load a bridge can carry based on actual member size and condition

load and resistance factor design (LRFD) - design method used by AASHTO, based on limit states of material with increased loads and reduced member capacity based on statistical probabilities

local buckling – folding of a beam's plate element, can lead to failure of member

longitudinal bracing - bracing that runs lengthwise with a bridge and provides resistance against longitudinal movement and deformation of transverse members

loss of prestress – reduction of induced internal compressive force in a prestressed member due to a variety of factors, including shrinkage and creep of concrete, creep of the prestressing tendons, and loss of bond

low-carbon steel - steel with 0.04 to 0.25% dissolved carbon; also called mild steel

low water crossing - waterway crossings other than bridges where construction improvements have been made in the stream, river, or lake

bed to provide a firm surface for vehicles to travel across the water course. The crossings are designed and constructed to be passable to traffic most of the year during periods of ordinary stream flow, but are impassable to traffic during periods of high water

lower chord - the bottom horizontal member of a truss

luminaire - a lighting fixture

## M

macadam - roadway pavement made with crushed stone aggregate, of coarse open gradation, compacted in place; asphaltic macadam included asphalt as a binder

main beam - a horizontal structural member that supports the span and bears directly on a column or wall

maintenance - basic repairs performed on a facility to keep it at an adequate level of service

maintenance and protection of traffic - the management of vehicular and pedestrian traffic through a construction zone to ensure the safety of the public and the construction workforce; MPT; TRAFFIC PROTECTION

marine borers - mollusks and crustaceans that live in water and destroy wood by digesting it

masonry - that portion of a structure composed of stone, brick, or concrete block placed in courses and usually cemented with mortar

masonry cement - Portland cement and lime used to make mortar for masonry construction

masonry plate - a steel plate placed on the substructure to support a superstructure bearing and to distribute the load to the masonry beneath

mattress - a flexible scour protection blanket composed of interconnected timber, gabions, or concrete units.

meander - a twisting, winding action from side to side; characterizes the serpentine curvature of a narrow, slow flowing stream in a wide flood plain

median - separation between opposing lanes of highway traffic; also known as median strip

member - an individual angle, beam, plate, or built component piece intended ultimately to become an integral part of an assembled frame or structure

metal corrosion - oxidation of metal by electro-galvanic action involving an electrolyte (moisture), an anode (the metallic surface where oxidation occurs), a cathode (the metallic surface that accepts electrons and does not corrode), and a conductor (the metal piece itself)

midspan - a reference point half-way between the supports of a beam or span

mild steel - steel containing from 0.04 to 0.25% dissolved carbon; see LOW CARBON STEEL

military loading - a loading pattern used to simulate heavy military vehicles passing over a bridge

mill scale - dense iron oxide on iron or steel that forms on the surface of metal that has been forged or hot worked

modular joint - a bridge joint designed to handle large movements consisting of an assembly of several strip or compression seals

moisture content - the amount of water in a material expressed as a percent by weight

moment - the couple effect of forces about a given point; see BENDING MOMENT

monolithic - forming a single mass without joints

mortar - a paste of portland cement, sand, and water laid between bricks, stones or blocks

movable bridge - a bridge having one or more spans capable of being raised, turned, lifted, or slid from its normal service location to provide a clear navigation passage; see BASCULE BRIDGE, VERTICAL LIFT BRIDGE, PONTOON BRIDGE, RETRACTILE DRAW BRIDGE, ROLLING LIFT BRIDGE, and SWING BRIDGE

movable span - a general term applied to a superstructure span designed to be swung, lifted, or otherwise moved longitudinally, horizontally or vertically, usually to provide increased navigational clearance

moving load - a live load that is in motion, for example, vehicular traffic

MPT - see MAINTENANCE AND PROTECTION OF TRAFFIC

MSE - mechanically stabilized earth; see REINFORCED EARTH

mudline – See HIGH WATER MARK

multi-centered arch - an arch in which the intrados surface is outlined by two or more arcs symmetrically arranged and having different radii that intersect tangentially

## N

nail laminated - a laminated member produced by nailing two or more pieces of timber together face to face

NBIS - National Bridge Inspection Standards, first established in 1971 to set national policy regarding bridge inspection frequency, inspector qualifications, report formats, and inspection and rating procedures

NCHRP - National Cooperative Highway Research Program

NDE - nondestructive evaluation

NDT - nondestructive testing; any testing method of checking structural quality of materials that does not damage them

necking - the elongation and contraction in area that occurs when a ductile material is stressed

negative bending - bending of a member that causes tension in the surface adjacent to the load, e.g., moment at interior supports of a span or at the joints of a frame

negative moment - bending moment in a member such that tension stresses are produced in the top portions of the member; typically occurs in continuous beams and spans over the intermediate supports

neoprene - a synthetic rubber-like material used in expansion joints and elastomeric bearings

neutral axis - the internal axis of a member in bending along which the strain is zero; on one side of the neutral axis the fibers are in tension, and on the other side the fibers are in compression

nose - a projection acting as a cut water on the upstream end of a pier; see STARLING

notch effect - stress concentration caused by an abrupt discontinuity or change in section

## O

offset - a horizontal distance measured at right angles to a survey line to locate a point off the line

on center - a description of a typical dimension between the centers of the objects being measured

open spandrel arch - a bridge that has open spaces between the deck and the arch members allowing "open" visibility through the bridge

open spandrel ribbed arch - a structure in which two or more comparatively narrow arch rings, called ribs, function in the place of an arch barrel; the ribs are rigidly secured in position by arch rib struts located at intervals along the length of the arch; the arch ribs carry a column type open spandrel construction which supports the floor system and its loads

operating rating - the capacity of a bridge to withstand loads based on 75% of yield strength

operator's house - the building containing control devices required for opening and closing a movable bridge span

orthotropic - having different properties in two or more directions at right angles to each other (e.g., wood); see ANISOTROPY

outlet - in hydraulics, the discharge end of drains, sewers, or culverts

out-of-plane distortion - distortion of a member in a plane other than that which the member was designed to resist

overlay - see WEARING SURFACE

overload - a weight greater than the structure is designed to carry

overpass - bridge over a roadway or railroad

overturning - tipping over; rotational movement

oxidation - the chemical breakdown of a substance due to its reaction with oxygen from the air

oxidized steel - rust

## P

pack - a steel plate inserted between two others to fill a gap and fit them tightly together; also known as packing; fill; filler plate

pack rust - rust forming between adjacent steel surfaces in contact which tends to force the surfaces apart due to the increase in material volume

paddleboard - striped, paddle-shaped signs or boards placed on the roadside in front of a narrow bridge as a warning of reduced roadway width

panel - the portion of a truss span between adjacent points of intersection of web and chord members

panel point - the point of intersection of primary web and chord members of a truss

parabolic arch - an arch in which the intrados surface is a segment of a symmetrical parabolic surface (suited to concrete arches)

parabolic truss - a polygonal truss having its top chord and end post vertices coincident with the arc of a parabola, its bottom chord straight and its web system either triangular or quadrangular; also known as a parabolic arched truss

parapet - a low wall along the outmost edge of the roadway of a bridge to protect vehicles and pedestrians

pedestal - concrete or built-up metal member constructed on top of a bridge seat to provide a specific bearing seat elevation

pedestal pier - one or more piers built in block-like form that may be connected by an integrally built web between them; when composed of a single, wide block-like form, it is called a wall or solid pier

pedestrian bridge - see FOOT BRIDGE

penetration - when applied to creosoted lumber, the depth to which the surface wood is permeated by the creosote oil; when applied to pile driving, the depth a pile tip is driven into the ground

physical testing - the testing of bridge members in the field or laboratory

pier - a substructure unit that supports the spans of a multi-span superstructure at an intermediate location between its abutments

pier cap - the topmost horizontal portion of a pier that distributes loads from the superstructure to the vertical pier elements

pile - a shaft-like linear member that carries loads to underlying rock or soil strata

pile bent - a row of driven or placed piles extending above the ground surface supporting a pile cap; see BENT

pile bridge - a bridge carried on piles or pile bents

pile cap - a slab or beam that acts to secure the piles in position laterally and provides a bridge seat to receive and distribute superstructure loads

pile foundation - a foundation supported by enough piles deep enough to develop the bearing resistance required to support the substructure load

pile pier - see PILE BENT

piling - collective term applied to group of piles in a construction; see PILE, SHEET PILES

pin - a cylindrical bar used to connect elements of a structure

pin - connected truss of any type having its chord and web members connected at each panel point by a single pin

pin and hanger - a hinged connection detail designed to allow for expansion and rotation between a cantilevered and suspended span at a point between supports.

pin joint - a joint in a truss or other frame in which the members are assembled on a single cylindrical pin

pin packing - arrangement of truss members on a pin at a pinned joint

pin plate - a plate rigidly attached on the end of a member to develop the desired bearing on a pin or pinlike bearing, and secure additional strength and rigidity in the member; doubler plate

pintle - a relatively small steel pin engaging the rocker of an expansion bearing, in a sole plate or masonry plate, thereby preventing sliding of the rocker

pipe - a hollow cylinder used for the conveyance of water, gas, steam, etc.

pipng - removal of fine particles from within a soil mass by flowing water

plain concrete - concrete with no structural reinforcement except, possibly, light steel to reduce shrinkage and temperature cracking

plan and profile - a drawing that shows both the roadway plan view and profile view in the same scale; see PLAN VIEW, PROFILE

plan view - drawing that represents the top view of the road or a structure

plastic deformation - permanent deformation of material beyond the elastic range

plate - a flat sheet of metal that is relatively thick; see SHEET STEEL

plate girder - a large I-shaped beam composed of a solid web plate with flange plates attached to the web plate by flange angles or fillet welds

plug weld - a weld joining two members produced by depositing weld metal within holes

cut through one or more of the members; also known as slot weld

plumb bob - a weight hanging on a cord used to provide a true vertical reference

plumb line - a true vertical reference line established using a plumb bob

pneumatic caisson - an underwater caisson in which the working chamber is kept free of water by compressed air at a pressure nearly equal to the water pressure outside it

pointing - the compacting of the mortar into the outermost portion of a joint and the troweling of its exposed surface to secure water tightness or desired architectural effect; replacing deteriorated mortar

ponding - accumulation of water

pontoon bridge - a bridge supported by floating on pontoons moored to the riverbed; a portion may be removable to facilitate navigation

pony truss - a through truss without top chord lateral bracing

pop-out - conical fragment broken out of a concrete surface by pressure from reactive aggregate particles

portable bridge - a bridge that may be readily erected for a temporary communication-transport service and disassembled and reassembled at another location

portal - the clear unobstructed space of a through truss bridge forming the entrance to the structure

portal bracing - a system of sway bracing placed in the plane of the end posts of the trusses

portland cement - a fine dry powder made by grinding limestone clinker made by heating limestone in a kiln; this material reacts chemically with water to produce a solid mass

portland cement concrete - a mixture of aggregate, portland cement, water, and usually chemical admixtures

positive moment - a force applied over a distance that causes compression in the top fiber of a beam and tension in the bottom fiber

post - a member resisting compressive stresses, located vertical to the bottom chord of a truss and common to two truss panels; sometimes used synonymously for vertical; see COLUMN

posting - signage providing a limiting dimension, speed, or loading; larger dimensions, higher speeds, or greater loads cannot be safely accommodated by the bridge

post-stressing - see POSTTENSIONING

posttensioning - a method of prestressing concrete in which the tendons are stressed after the concrete has been cast and hardens

pot bearing - a bearing type that allows for multi-dimensional rotation by using a piston supported on an elastomer contained on a cylinder ("pot"), or spherical bearing element

pot holes - irregular shaped, disintegrated areas of bridge deck or roadway pavement caused by the failure of the surface material

Pratt truss - a truss with parallel chords and a web system composed of vertical posts with diagonal ties inclined outward and upward from the bottom chord panel points toward the ends of the truss; also known as an N-truss

precast concrete - concrete members that are cast and cured before being placed into their final positions on a construction site

prestressed concrete - concrete with strands, tendons, or bars that are stressed before the live load is applied

prestressing - applying forces to a structure to deform it in such a way that it will withstand its working loads more effectively; see POSTTENSIONING, PRETENSIONING

pretensioning - a method of prestressing concrete in which the strands are stressed before the concrete is placed; strands are released after the concrete has hardened, inducing internal compression into the concrete



primary member - a member designed to resist flexure and distribute primary live loads and dead loads

priming coat - the first coat of paint applied to the metal or other material of a bridge; also known as base coat, or primer

probing - investigating the location and condition of submerged foundation material using a rod or shaft of appropriate length; checking the surface condition of a timber member for decay using a pointed tool, e.g., an ice pick

profile - a section cut vertically along the center line of a roadway or waterway to show the original and final ground levels

programmed repair - those repairs that may be performed in a scheduled program

protective system - a system used to protect bridges from environmental forces that cause steel and concrete to deteriorate and timber to decay, typically a coating system

PS&E - Plans, Specifications, and Estimate; the final submission of the designers to the owner

punching shear - shear stress in a slab due to the application of a concentrated load

## Q

quality assurance - an independent evaluation of a product or activity (e.g., an inspection) to establish that a predescribed level of quality has been met

quality control - checks necessary to maintain a uniform level of quality

queen-post truss - a parallel chord type of truss having three panels with the top chord occupying only the length of the center panel

## R

railing - a fence-like construction built at the outermost edge of the roadway or the sidewalk portion of a bridge to protect pedestrians and vehicles; see HANDRAIL

rake - an angle of inclination of a surface in relation to a vertical plane; also known as batter

ramp - an inclined traffic-way leading from one elevation to another

range of stress - the algebraic difference between the minimum and maximum stresses in a member

raveling - the consistent loss of aggregate from a pavement resulting in a poor riding surface

reaction - the resistance of a support to a load

rebar - see REINFORCING BAR

redundancy - a structural condition where there are more elements of support than are necessary for stability so that, if a structural member fails, the remaining element can sustain the load

redundant member - a member in a bridge that renders it a statically indeterminate structure; the structure would be stable without the redundant member whose primary purpose is to reduce the stresses carried by the determinate structure

rehabilitation - significant repair work to a structure

reinforced concrete - concrete with steel reinforcing bars embedded in it to supply increased tensile strength and durability

reinforced concrete pipe - pipe manufactured of concrete reinforced with steel bars or welded wire fabric

Reinforced Earth - proprietary retaining structure made of earth and steel strips connected to concrete facing; the steel strips are embedded in backfill and interlock with the facing; see MSE

reinforcement - rods or mesh embedded in concrete to strengthen it

reinforcing bar - a steel bar, plain or with a deformed surface, which bonds to the concrete to supply tensile strength

relaxation - a decrease in stress caused by creep

residual stress - a stress that is trapped in a member after it is formed into its final shape

resistivity of soil - an electrical measurement in ohm-cm that estimates the corrosion activity potential of a given soil

resurfacing - a layer of wearing surface material that is put over the approach or deck surface in order to create a more uniform riding surface

Retained Earth - proprietary retaining structure made of weld wire fabric strips connected to concrete facing; see MSE

retaining wall - a structure designed to restrain and hold back a mass of earth

retractile draw bridge - a bridge with a superstructure designed to move horizontally, either longitudinally or diagonally, from "closed" to "open" position, the portion acting in cantilever being counterweighted by that supported on rollers; also known as traverse draw bridge

rib - curved structural member supporting a curved shape or panel

rigger - an individual who erects and maintains scaffolding or other access equipment such as that used for bridge inspection

rigid frame - a structural frame in which bending moment is transferred between horizontal and vertical or inclined members by joints

rigid frame bridge - a bridge with moment resisting joints between the horizontal portion of the superstructure and vertical or inclined legs

rigid frame pier - a pier with two or more columns and a horizontal beam on top constructed monolithically to act like a frame

rip-rap - stones, blocks of concrete, or other objects placed on river and stream beds and banks, lake, tidal, or other shores to prevent scour by water flow or wave action

rivet - a one-piece metal fastener held in place by forged heads at each end

riveted joint - a joint in which the assembled members are fastened by rivets

roadway - the portion of the road intended for the use of vehicular traffic

roadway shoulder - drivable area immediately adjoining the traveled roadway

rocker bearing - a bridge support that accommodates expansion and contraction of the superstructure through a tilting action

rocker bent - a bent hinged or otherwise articulated at one or both ends to provide the longitudinal movements resulting from temperature changes and superimposed loads

rolled shape - forms of rolled steel having "I", "H", "C", "Z" or other cross sectional shapes

rolled-steel section - any hot-rolled steel section including wide flange shapes, channels, angles, etc.

roller - a steel cylinder intended to provide longitudinal movements by rolling contact

roller bearing - a single roller or a group of rollers installed to permit longitudinal movement of a structure

roller nest - a group of steel cylinders used to facilitate the longitudinal movements resulting from temperature changes and superimposed loads

rolling lift bridge - a bridge of bascule type devised to roll backward and forward on supporting girders when operated through an "open and closed" cycle

rubble - irregularly shaped pieces of stone in the undressed condition obtained from a quarry and varying in size

runoff - the quantity of precipitation that flows from a catchment area past a given point over a certain period

## S

sacrificial anode - the anode in a cathodic protection system

sacrificial coating - a coating over the base material to provide protection to the base material

sacrificial protection - see CATHODIC PROTECTION

sacrificial thickness - additional material thickness provided for extra service life of a member in an aggressive environment

saddle - a member located on the topmost portion of the tower of a suspension bridge that acts as a bearing surface for the catenary cable passing over it

safe load - the maximum load that a structure can support with an appropriate factor of safety

safety belt - a belt worn in conjunction with a safety line to prevent falling a long distance when working at heights; no longer acceptable as fall protection under OSHA rules

safety curb - a curb between 9 inches and 24 inches wide serving as a limited use refuge or walkway for pedestrians crossing a bridge

safety factor - the difference between the ultimate strength of a member and the maximum load it is expected to carry

safety harness - harness with shoulder, leg, and waist straps of approved OSHA design used as personal fall protection in conjunction with appropriate lanyards and tie off devices

sag - to sink or bend downward due to weight or pressure

scab - a plank bolted over the joint between two timber members to hold them in correct alignment and strengthen the joint; a short piece of I-beam or other structural shape attached to the flange or web of a metal pile to increase its resistance to penetration; also known as scab piece

scaling - the gradual disintegration of a concrete surface due to the failure of the cement paste caused by chemical attack or freeze/thaw cycles

scour - removal of a streambed or bank area by stream flow

scour protection - protection of submerged material by steel sheet piling, rip rap, concrete lining, or combination thereof

scuba - self-contained underwater breathing apparatus; a portable breathing device for free swimming divers

scupper - an opening in the deck of a bridge to provide a way for water on the roadway surface to drain

seam weld - a weld joining the edges of two members placed in contact; in general, it is not a stress-carrying weld

seat - a base on which an object or member is placed

seat angle - a piece of angle attached to the side of a member to provide support for a connecting a member either temporarily during its erection or permanently; also known as a shelf angle

secondary member - a member that does not carry calculated live loads; bracing members

section loss - loss of a member's cross sectional area usually by corrosion or decay

section view - an internal representation of a structure element as if a slice was made through the element

seepage - the slow movement of water through a material

segmental - constructed of individual pieces or segments that are collectively joined to form the whole

segmental arch - a circular arch in which the intrados is less than a semi-circle

segregation - in concrete construction, the separation of large aggregate from the paste during placement

seismic - a term referring to earthquakes (e.g., seismic forces)

semi-stub abutment - cantilever abutment founded part way up the slope, intermediate in size between a full height abutment and a stub abutment

service load design - AASHTO's description for Working Stress Design

settlement - the movement of substructure elements due to changes in the soil properties

shear - the load acting across a beam near its support

shear connectors - devices that extend from the top flange of a beam and are embedded in the above concrete slab, forcing the beam and the concrete to act as a single unit

shear spiral - a coil-shaped component welded to the top flange of a beam, as a shear connector

shear stress - the shear force per unit of cross-sectional area; also referred to as diagonal tensile stress

shear stud - a type of shear connector in the form of a rod with a head that is attached to a beam with an automatic stud-welding gun

sheet pile cofferdam - a wall-like barrier composed of driven piling constructed to surround the area to be occupied by a structure and permit dewatering of the enclosure so that the excavation may be performed in the open air

sheet piles - flattened Z-shaped interlocking piles driven into the ground to keep earth or water out of an excavation or to protect an embankment

sheet piling - a general or collective term used to describe a number of sheet piles installed to form a crib, cofferdam, bulkhead, etc.; also known as sheeting

sheet steel - steel in the form of a relatively thin sheet or plate; for flat rolled steel, specific thicknesses vs. widths are classified by AISI as bar, strip, sheet or plate

shelf angle - see SEAT ANGLE

shim - a thin plate inserted between two elements to fix their relative position and to transmit bearing stress

shoe - a steel or iron member, usually a casting or weldment, beneath the superstructure bearing that transmits and distributes loads to the substructure bearing area

shop - a factory or workshop

shop drawings - detailed drawings developed from the more general design drawings used in the manufacture or fabrication of bridge components

shoring - a strut or prop placed against or beneath a structure to restrain movement; temporary soil retaining structure

shoulder abutment - a cantilever abutment extending from the grade line of the road below to that of the road overhead, usually set just off the shoulder; see FULL HEIGHT ABUTMENT

shoulder area - see ROADWAY SHOULDER

shrinkage - a reduction in volume caused by moisture loss in concrete or timber while drying

sidewalk - the portion of the bridge floor area serving pedestrian traffic only

sidewalk bracket - frame attached to and projecting from the outside of a girder to serve as a support for the sidewalk stringers, floor and railing or parapet

sight distance - the length of roadway ahead that is easily visible to the driver; required sight distances are defined by AASHTO's "A Policy on Geometric Design of Highways and Streets"

silt - very finely divided siliceous or other hard rock material removed from its mother rock through erosive action rather than chemical decomposition

simple span - beam or truss with two unrestraining supports near its ends

S-I-P forms - see STAY-IN-PLACE FORMS, FORMS

skew angle - the angle produced when the longitudinal members of a bridge are not perpendicular to the substructure; the skew angle is the acute angle between the alignment of the bridge and a line perpendicular to the centerline of the substructure units

skewback - the inclined support at each end of an arch

skewback shoe - the member transmitting the thrust of an arch to the skewback course or

cushion course of an abutment or piers; also known as skewback pedestal

slab - a wide beam, usually of reinforced concrete, which supports load by flexure

slab bridge - a bridge having a superstructure composed of a reinforced concrete slab constructed either as a single unit or as a series of narrow slabs placed parallel with the roadway alignment and spanning the space between the supporting substructure units

slide - movement on a slope because of an increase in load or a removal of support at the toe; also known as landslide

slip form - to form concrete by advancing a mold

slope - the inclination of a surface expressed as a ratio of one unit of rise or fall for so many horizontal units

slope protection - a thin surfacing of stone, concrete, or other material deposited on a sloped surface to prevent its disintegration by rain, wind, or other erosive action; also known as slope pavement

slot weld - see PLUG WELD

slump - a measurement taken to determine the stiffness of concrete; the measurement is the loss in height after a cone-shaped mold is lifted

soffit - underside of a bridge deck; also see INTRADOS

soldier beam - a steel pile driven into the earth with its projecting butt end used as a cantilever beam

soldier pile wall - a series of soldier beams supporting horizontal lagging to retain an excavated surface; commonly used in limited right-of-way applications

soil interaction structure - a subsurface structure that incorporates both the strength properties of a flexible structure and the support properties of the soil surrounding the structure

sole plate - a plate attached to the bottom flange of a beam that distributes the reaction of the bearing to the beam

solid sawn beam - a section of tree cut to the desired size at a saw mill

sounding - determining the depth of water by an echo-sounder or lead line; tapping a surface to detect delaminations (concrete) or decay (timber)

spall - depression in concrete caused by a separation of a portion of the surface concrete, revealing a fracture parallel with or slightly inclined to the surface

span - the distance between the supports of a beam; the distance between the faces of the substructure elements; the complete superstructure of a single span bridge or a corresponding integral unit of a multiple span structure; see CLEAR SPAN

spandrel - the space bounded by the arch extrados and the horizontal member above it

spandrel column - a column constructed on the rib of an arch span and serving as a support for the deck construction of an open spandrel arch; see OPEN SPANDREL ARCH

spandrel fill - the fill material placed within the spandrel space of a closed spandrel arch

spandrel tie - a wall or a beam-like member connecting the spandrel walls of an arch and securing them against bulging and other deformation; in stone masonry arches the spandrel tie walls served to some extent as counterforts

spandrel wall - a wall built on the extrados of an arch filling the space below the deck; see TIE WALLS

specifications - a detailed description of requirements, materials, tolerances, etc., for construction which are not shown on the drawings; also known as specs

spider - inspection access equipment consisting of a bucket or basket that moves vertically on

wire rope, driven by an electric or compressed air motor

spillway - a channel used to carry water away from the top of a slope to an adjoining outlet

splice - a structural joint between members to extend their effective length

spread footing - a foundation, usually a reinforced concrete slab, which distributes load to the earth or rock below the structure

spring line - the horizontal line along the face of an abutment or pier at which the intrados of an arch begins

spur - a projecting jetty-like construction placed adjacent to an abutment or embankment to prevent scour

stage - inspection access equipment consisting of a flat platform supported by horizontal wire-rope cables; the stage is then slid along the cables to the desired position; a stage is typically 20 inches wide, with a variety of lengths available

staged construction - construction performed in phases, usually to permit the flow of traffic through the site

statics - the study of forces and bodies at rest

station - 100 feet (U.S. customary); 100 meters (metric)

stationing - a system of measuring distance along a baseline

stay-in-place forms - a corrugated metal sheet for forming deck concrete that will remain in place after the concrete has set; the forms do not contribute to deck structural capacity after the deck has cured; see FORMS, S.I.P FORMS

stay plate - a tie plate or diagonal brace to prevent movement

steel - an alloy of iron, carbon, and various other elements

stem - the vertical wall portion of an abutment retaining wall, or solid pier; see BREASTWALL

stiffener - a small member attached to another member to transfer stress and to prevent buckling

stiffening girder - a girder incorporated in a suspension bridge to distribute the traffic loads uniformly among the suspenders and reduce local deflections

stiffening truss - a truss incorporated in a suspension bridge to distribute the traffic loads uniformly among the suspenders and reduce local deflections

stirrup - U-shaped bar used as a connection device in timber and metal bridges; U-shaped bar placed in concrete to resist diagonal tension (shear) stresses

stone masonry - the portion of a structure composed of stone, generally placed in courses with mortar

straight abutment - an abutment whose stem and wings are in the same plane or whose stem is included within a length of retaining wall

strain - the change in length of a body produced by the application of external forces, measured in units of length; this is the proportional relation of the amount of change in length divided by the original length

strand - a number of wires grouped together, usually by twisting

strengthening - adding to the capacity of a structural member

stress - the force acting across a unit area in a solid material

stress concentration - local increases in stress caused by a sudden change of cross section in a member

stress range - the variation in stress at a point with the passage of live load, from initial dead load value to the maximum additional live load value and back

stress raiser - a detail that causes stress concentration

stress reversal - change of stress type from tension (+) to compression (-) or vice versa

stress sheet - a drawing showing all computed stresses resulting from the application of a system of loads together with the design composition of the individual members resulting from the application of assumed unit stresses for the material to be used in the structure

stress-laminated timber - consists of multiple planks mechanically clamped together to perform as one unit

stringer - a longitudinal beam spanning between transverse floorbeams and supporting a bridge deck

strip seal joint - a joint using a relatively thin neoprene seal fitted into the joint opening

structural analysis - engineering computation to determine the carrying capacity of a structure

structural member - an individual piece, such as a beam or strut, that is an integral part of a structure

structural redundancy - the ability of an interior continuous span to resist total collapse by cantilever action in the event of a fracture

structural shapes - the various types of rolled iron and steel having flat, round, angle, channel, "I", "H", "Z" and other cross-sectional shapes adapted to heavy construction

structural stability - the ability of a structure to maintain its normal configuration, not collapse or tip in any way, under existing and expected loads

structural tee - a T-shaped rolled member formed by cutting a wide flange longitudinally along the centerline of web

structure - something, such as a bridge, that is designed and built to sustain a load

strut - a member acting to resist axial compressive stress; usually a secondary member

stub abutment - an abutment within the topmost portion of an embankment or slope having a relatively small vertical height and usually pile supported; stub abutments may also be founded on spread footings

subbase - a layer of material placed between the base course and the subgrade within a flexible pavement structure

subgrade - natural earth below the roadway pavement structure

sub-panel - a truss panel divided into two parts by an intermediate web member, generally a subdiagonal or a hanger

substructure - the abutments and piers built to support the span of a bridge superstructure

superelevation - the difference in elevation between the inside and outside edges of a roadway in a horizontal curve; required to counteract the effects of centrifugal force

superimposed dead load - dead load that is applied to a compositely designed bridge after the concrete deck has cured; for example, the weight of parapets or railings placed after the concrete deck has cured

superstructure - the entire portion of a bridge structure that primarily receives and supports traffic loads and in turn transfers these loads to the bridge substructure

surface corrosion - rust that has not yet caused measurable section loss

suspended span - a simple span supported from the free ends of cantilevers

suspender - a vertical wire cable, metal rod, or bar connecting the catenary cable of a suspension bridge or an arch rib to the bridge floor system, transferring loads from the deck to the main members

suspension bridge - a bridge in which the floor system is supported by catenary cables that are connected to towers and anchored at their extreme ends

suspension cable - a catenary cable that is one of the main members on which the floor system

of a suspension bridge is supported; a cable spanning between towers

swale - a drainage ditch with moderately sloping sides

sway anchorage - a guy, stay cable, or chain attached to the floor system of a suspension bridge and anchored on an abutment or pier to increase the resistance of the suspension span to lateral movement; also known as sway cable

sway bracing - diagonal brace located at the top of a through truss, transverse to the truss and usually in a vertical plane, to resist transverse horizontal forces

sway frame - a complete panel or frame of sway bracing

swedged anchor bolt - anchor bolt with deformations to increase bond in concrete; see ANCHOR BOLT

swing span bridge - a movable bridge in which the span rotates in a horizontal plane on a pivot pier, to permit passage of marine traffic

## T

tack welds - small welds used to hold member elements in place during fabrication or erection

tail water - water ponded below the outlet of a waterway, thereby reducing the amount of flow through the waterway; see HEADWATER

tape measure - a long, flexible strip of metal or fabric marked at regular intervals for measuring

tee beam - a rolled steel section shaped like a "T;" reinforced concrete beam shaped like the letter "T"

temperature steel - reinforcement in a concrete member to prevent cracks due to stresses caused by temperature changes

temporary bridge - a structure built for emergency or interim use, intended to be removed in a relatively short time

tendon - a prestressing cable, strand, or bar

tensile force - a force caused by pulling at the ends of a member; see TENSION

tensile strength - the maximum tensile stress at which a material fails

tension - stress that tends to pull apart material

thermal movement - contraction and expansion of a structure due to a change in temperature

three-hinged arch - an arch that is hinged at each support and at the crown

through arch - an arch bridge in which the deck passes between the arches

through girder bridge - normally a two-girder bridge where the deck is between the supporting girders

tie - a member carrying tension

tie plate - relatively short, flat member carrying tension forces across a transverse member; for example, the plate connecting a floor beam cantilever to the main floor beam on the opposite side of a longitudinal girder; see STAY PLATE

tie rod - a rod-like member in a frame functioning to transmit tensile stress; also known as tie bar

tie walls - one of the walls built at intervals above an arch ring connecting and supporting the spandrel walls; any wall designed to serve as a restraining member to prevent bulging and distortion of two other walls connected thereby; see DIAPHRAGM WALL

timber - wood suitable for construction purposes

toe - the front portion of a footing from the intersection of the front face of the wall or abutment to the front edge of the footing; the line where the side slope of an embankment meets the existing ground

toe of slope - the location defined by the intersection of the embankment with the surface existing at a lower elevation; also known as toe

toe wall - a relatively low retaining wall placed near the "toe-of-slope" location of an embankment to protect against scour or to



prevent the accumulation of stream debris; also known as footwall

ton - a unit of weight equal to 2,000 pounds

torque - the angular force causing rotation

torque wrench - a hand or power tool used to turn a nut on a bolt that can be adjusted to deliver a predetermined amount of torque

torsion - twisting about the longitudinal axis of a member

torsional rigidity - a beam's capacity to resist a twisting force along the longitudinal axis

tower - a pier or frame supporting the catenary cables of a suspension bridge

traffic control - modification of normal traffic patterns by signs, cones, flagmen, etc.

transducer - a device that converts one form of energy into another form, usually electrical into mechanical or the reverse; the part of ultrasonic testing device that transmits and receives sound waves

transverse bracing - the bracing assemblage engaging the columns of bents and towers in planes transverse to the bridge alignment that resists the transverse forces tending to produce lateral movement and deformation of the columns

transverse girder - see CROSS GIRDER

travel way - the roadway

tremie - a piece of construction equipment (e.g., pipe or funnel) used to place concrete underwater

trestle - a bridge structure consisting of spans supported on braced towers or frame bents

truck loading - a combination of loads used to simulate a single truck passing over a bridge

truss - a jointed structure made up of individual members primarily carrying axial loads arranged and connected in triangular panels

truss bridge - a bridge having a pair of trusses for a superstructure

trussed beam - a beam stiffened to reduce its deflection by a steel tie-rod that is held at a short distance from the beam by struts

truss panel - see PANEL

tubular sections - structural steel tubes, rectangular, square, or circular; also known as hollow sections

tubular truss - a truss whose chords and struts are composed of pipes or cylindrical tubes

tunnel - an underground passage, open to daylight at both ends

turnbuckle - a long, cylindrical, internally threaded nut with opposite hand threads at either end used to connect the elements of adjustable rod and bar members

two-hinged arch - a rigid frame that may be arch-shaped or rectangular with hinges at both supports

## U

U-bolt - a bar bent in the shape of the letter "U" and fitted with threads and nuts at its ends

ultimate strength - the highest stress that a material can withstand before breaking

ultrasonic thickness gauge - an instrument used to measure the thickness of a steel element using a probe which emits and receives sound waves

ultrasonic testing - nondestructive testing of a material's integrity using sound waves

underpass - the lowermost feature of a grade separated crossing; see OVERPASS

uniform load - a load of constant magnitude along the length of a member

unit stress - the force per unit of surface or cross-sectional area

uplift - a negative reaction or a force tending to lift a beam, truss, pile, or any other bridge element upwards

upper chord - the top longitudinal member of a truss

V

vertical - describes the axis of a bridge perpendicular to the underpass surface

vertical alignment - a roadway's centerline or baseline alignment in the vertical plane

vertical clearance - the distance between the structure and the underpass

vertical curve - a sag or crest in the profile of a roadway, usually in the form of a parabola, to transition between grades

vertical lift bridge - a bridge in which the span moves up and down while remaining parallel to the roadway

viaduct - a series of spans carried on piers at short intervals

vibration - the act of shaking concrete to compact it

Vierendeel truss - a truss with only chords and verticals joined with rigid connections designed to transfer moment

voided slab - a precast concrete deck unit cast with cylindrical voids to reduce dead load

voids - an empty or unfilled space in concrete

Voussoir - one of the truncated wedge-shaped stones composing a ring course in a stone arch; also known as ring stone

voussoir arch - an arrangement of wedge shaped blocks set to form an arched bridge

W

wale, waler - horizontal bracing running along the inside walls of a sheeted pit or cofferdam

Warren truss - a triangular truss consisting of sloping members between the top and bottom chords and no verticals; members form the letter W

washer - a small metal ring used beneath the nut or the head of a bolt to distribute the load or reduce galling during tightening

water/cement ratio - the weight of water divided by the weight of portland cement in

concrete; this ratio is a major factor in the strength of concrete

waterproofing membrane - an impervious layer placed between the wearing surface and the concrete deck, used to protect the deck from water and corrosive chemicals that could damage it

waterway opening - the available width for the passage of water beneath a bridge

wearing surface - the topmost layer of material applied on a roadway to receive the traffic loads and to resist the resulting disintegrating action; also known as wearing course

web - the portion of a beam located between and connected to the flanges; the stem of a dumbbell type pier

web crippling - damage caused by high compressive stresses resulting from concentrated loads

web members - the intermediate members of a truss, not including the end posts, usually vertical or inclined

web plate - the plate forming the web element of a plate girder, built-up beam or column

web stiffener - a small member welded to a beam web to prevent buckling

web weephole - a hole in a concrete retaining wall to provide drainage of the water in the retained soil

weld - a joint between pieces of metal at faces that have been made plastic and caused to flow together by heat or pressure

weldability - the degree to which steel can be welded without using special techniques, such as pre-heating

welded bridge structure - a structure whose metal elements are connected by welds

welded joint - a joint in which the assembled elements and members are connected by welds

welding - the process of making a welded joint

weld layer - a single thickness of weld metal composed of beads (runs) laid in contact to form a pad weld or a portion of a weld made up of superimposed beads

weld metal - fused filler metal added to the fused structure metal to produce a welded joint or a weld layer

weld penetration - the depth beneath the original surface to which the structure metal has been fused in the making of a fusion weld; see PENETRATION

weld sequence - the order of succession required for making the welds of a built-up piece or the joints of a structure, to minimize distortion and residual stresses

weld toe - particularly in a fillet weld, the thin end of the taper furthest from the center of the weld cross section

wheel guard - a raised curb along the outside edge of traffic lanes to safeguard constructions outside the roadway limit from collision with vehicles

wheel load - the load carried by and transmitted to the supporting structure by one wheel of a traffic vehicle, a movable bridge, or other motive equipment or device; see AXLE LOAD

weep hole - a hole in a concrete element (abutment backwall or retaining wall) used to drain water from behind the element; any small hole installed for drainage

Whipple truss - a double-intersecting through Pratt truss where the diagonals extend across two panels

wide flange - a rolled I-shaped member having flange plates of rectangular cross section, differentiated from an S-beam (American Standard) in that the flanges are not tapered

wind bracing - the bracing systems that function to resist the stresses induced by wind forces

wind lock - a lateral restraining device found on steel girder and truss bridges

wingwall - the retaining wall extension of an abutment intended to restrain and hold in place the side slope material of an approach roadway embankment

wire mesh reinforcement - a mesh made of steel wires welded together at their intersections used to reinforce concrete; welded wire fabric

wire rope - steel cable of multiple strands which are composed of steel wires twisted together

working stress - the unit stress in a member under service or design load

working stress design - a method of design using the yield stress of a material and a factor of safety that determine the maximum allowable stresses

wrought iron - cast iron that has been mechanically worked to remove slag and undissolved carbon

wythe - a single layer of brick or stone in the thickness direction

## X

X-ray testing - nondestructive testing technique used for detecting internal flaws by passing X-rays through a material to film or other detector

## Y

yield - permanent deformation (permanent set) that a metal piece takes when it is stressed beyond the elastic limit

yield point - see YIELD STRESS

yield stress - the stress at which noticeable, suddenly increased deformation occurs under slowly increasing load

## Z

zee - steel member shaped like a modified "Z" in cross section

**V. NATIONAL BRIDGE INSPECTION STANDARDS**



National Bridge Inspection Standards – 23 CFR Part 650

Subpart C—National Bridge Inspection Standards

Source: 69 FR 74436, Dec. 14, 2004, unless otherwise noted.

§ 650.301 Purpose.

This subpart sets the national standards for the proper safety inspection and evaluation of all highway bridges in accordance with 23 U.S.C. 151.

§ 650.303 Applicability.

The National Bridge Inspection Standards (NBIS) in this subpart apply to all structures defined as highway bridges located on all public roads.

§ 650.305 Definitions.

Terms used in this subpart are defined as follows:

American Association of State Highway and Transportation Officials (AASHTO) Manual. “Manual for Condition Evaluation of Bridges,” second edition, published by the American Association of State Highway and Transportation Officials (incorporated by reference, see §650.317).

Bridge. A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

Bridge inspection experience. Active participation in bridge inspections in accordance with the NBIS, in either a field inspection, supervisory, or management role. A combination of bridge design, bridge maintenance, bridge construction and bridge inspection experience, with the predominant amount in bridge inspection, is acceptable.

Bridge inspection refresher training. The National Highway Institute “Bridge Inspection Refresher Training Course” 1 or other State, local, or federally developed instruction aimed to improve quality of inspections, introduce new techniques, and maintain the consistency of the inspection program.

1 The National Highway Institute training may be found at the following URL: <http://www.nhi.fhwa.dot.gov/>

Bridge Inspector's Reference Manual (BIRM). A comprehensive FHWA manual on programs, procedures and techniques for inspecting and evaluating a variety of in-service highway bridges. This manual may be purchased from the U.S. Government Printing Office, Washington, DC 20402 and from National Technical Information Service, Springfield, Virginia 22161, and is available at the following URL: <http://www.fhwa.dot.gov/bridge/bripub.htm>.

Complex bridge. Movable, suspension, cable stayed, and other bridges with unusual characteristics.

Comprehensive bridge inspection training. Training that covers all aspects of bridge inspection and enables inspectors to relate conditions observed on a bridge to established criteria (see the Bridge Inspector's Reference Manual for the recommended material to be covered in a comprehensive training course).

Critical finding. A structural or safety related deficiency that requires immediate follow-up inspection or action.

Damage inspection. This is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions.

Fracture critical member (FCM). A steel member in tension, or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse.

Fracture critical member inspection. A hands-on inspection of a fracture critical member or member components that may include visual and other nondestructive evaluation.

Hands-on. Inspection within arms length of the component. Inspection uses visual techniques that may be supplemented by nondestructive testing.

Highway. The term “highway” is defined in 23 U.S.C. 101(a)(11).

In-depth inspection. A close-up, inspection of one or more members above or below the water level to identify any deficiencies not readily detectable using routine inspection procedures; hands-on inspection may be necessary at some locations.

Initial inspection. The first inspection of a bridge as it becomes a part of the bridge file to provide all Structure Inventory and Appraisal (SI&A) data and other relevant data and to determine baseline structural conditions.

Legal load. The maximum legal load for each vehicle configuration permitted by law for the State in which the bridge is located.

Load rating. The determination of the live load carrying capacity of a bridge using bridge plans and supplemented by information gathered from a field inspection.

National Institute for Certification in Engineering Technologies (NICET). The NICET provides nationally applicable voluntary certification programs covering several broad engineering technology fields and a number of specialized subfields. For information on the NICET program certification contact: National Institute for Certification in Engineering Technologies, 1420 King Street, Alexandria, VA 22314–2794.

Operating rating. The maximum permissible live load to which the structure may be subjected for the load configuration used in the rating.

Professional engineer (PE). An individual, who has fulfilled education and experience requirements and passed rigorous exams that,

under State licensure laws, permits them to offer engineering services directly to the public. Engineering licensure laws vary from State to State, but, in general, to become a PE an individual must be a graduate of an engineering program accredited by the Accreditation Board for Engineering and Technology, pass the Fundamentals of Engineering exam, gain 4 years of experience working under a PE, and pass the Principles of Practice of Engineering exam.

Program manager. The individual in charge of the program, that has been assigned or delegated the duties and responsibilities for bridge inspection, reporting, and inventory. The program manager provides overall leadership and is available to inspection team leaders to provide guidance.

Public road. The term “public road” is defined in 23 U.S.C. 101(a)(27).

Quality assurance (QA). The use of sampling and other measures to assure the adequacy of quality control procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program.

Quality control (QC). Procedures that are intended to maintain the quality of a bridge inspection and load rating at or above a specified level.

Routine inspection. Regularly scheduled inspection consisting of observations and/or measurements needed to determine the physical and functional condition of the bridge, to identify any changes from initial or previously recorded conditions, and to ensure that the structure continues to satisfy present service requirements.

Routine permit load. A live load, which has a gross weight, axle weight or distance between axles not conforming with State statutes for legally configured vehicles, authorized for unlimited trips over an extended period of time to move alongside other heavy vehicles on a regular basis.

Scour. Erosion of streambed or bank material due to flowing water; often considered as being

localized around piers and abutments of bridges.

Scour critical bridge. A bridge with a foundation element that has been determined to be unstable for the observed or evaluated scour condition.

Special inspection. An inspection scheduled at the discretion of the bridge owner, used to monitor a particular known or suspected deficiency.

State transportation department. The term "State transportation department" is defined in 23 U.S.C. 101(a)(34).

Team leader. Individual in charge of an inspection team responsible for planning, preparing, and performing field inspection of the bridge.

Underwater diver bridge inspection training. Training that covers all aspects of underwater bridge inspection and enables inspectors to relate the conditions of underwater bridge elements to established criteria (see the Bridge Inspector's Reference Manual section on underwater inspection for the recommended material to be covered in an underwater diver bridge inspection training course).

Underwater inspection. Inspection of the underwater portion of a bridge substructure and the surrounding channel, which cannot be inspected visually at low water by wading or probing, generally requiring diving or other appropriate techniques.

#### § 650.307 Bridge inspection organization.

(a) Each State transportation department must inspect, or cause to be inspected, all highway bridges located on public roads that are fully or partially located within the State's boundaries, except for bridges that are owned by Federal agencies.

(b) Federal agencies must inspect, or cause to be inspected, all highway bridges located on public roads that are fully or partially located within the respective agency responsibility or jurisdiction.

(c) Each State transportation department or Federal agency must include a bridge inspection organization that is responsible for the following:

(1) Statewide or Federal agencywide bridge inspection policies and procedures, quality assurance and quality control, and preparation and maintenance of a bridge inventory.

(2) Bridge inspections, reports, load ratings and other requirements of these standards.

(d) Functions identified in paragraphs (c)(1) and (2) of this section may be delegated, but such delegation does not relieve the State transportation department or Federal agency of any of its responsibilities under this subpart.

(e) The State transportation department or Federal agency bridge inspection organization must have a program manager with the qualifications defined in §650.309(a), who has been delegated responsibility for paragraphs (c)(1) and (2) of this section.

#### § 650.309 Qualifications of personnel.

(a) A program manager must, at a minimum:

(1) Be a registered professional engineer, or have 10 years bridge inspection experience; and

(2) Successfully complete a Federal Highway Administration (FHWA) approved comprehensive bridge inspection training course.

(b) There are five ways to qualify as a team leader. A team leader must, at a minimum:

(1) Have the qualifications specified in paragraph (a) of this section; or

(2) Have 5 years bridge inspection experience and have successfully completed an FHWA approved comprehensive bridge inspection training course; or

(3) Be certified as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies (NICET) and have successfully completed an



FHWA approved comprehensive bridge inspection training course, or

(4) Have all of the following:

(i) A bachelor's degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;

(ii) Successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination;

(iii) 2 years of bridge inspection experience; and

(iv) Successfully completed an FHWA approved comprehensive bridge inspection training course, or

(5) Have all of the following:

(i) An associate's degree in engineering or engineering technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;

(ii) 4 years of bridge inspection experience; and

(iii) Successfully completed an FHWA approved comprehensive bridge inspection training course.

(c) The individual charged with the overall responsibility for load rating bridges must be a registered professional engineer.

(d) An underwater bridge inspection diver must complete an FHWA approved comprehensive bridge inspection training course or other FHWA approved underwater diver bridge inspection training course.

§ 650.311 Inspection frequency.

(a) Routine inspections. (1) Inspect each bridge at regular intervals not to exceed 24 months.

(2) Certain bridges require inspection at less than twenty-four-month intervals. Establish criteria to determine the level and frequency to which these bridges are inspected considering such factors as age, traffic characteristics, and known deficiencies.

(3) Certain bridges may be inspected at greater than twenty-four month intervals, not to exceed 48 months, with written FHWA approval. This may be appropriate when past inspection findings and analysis justifies the increased inspection interval.

(b) Underwater inspections. (1) Inspect underwater structural elements at regular intervals not to exceed 60 months.

(2) Certain underwater structural elements require inspection at less than sixty-month intervals. Establish criteria to determine the level and frequency to which these members are inspected considering such factors as construction material, environment, age, scour characteristics, condition rating from past inspections and known deficiencies.

(3) Certain underwater structural elements may be inspected at greater than sixty-month intervals, not to exceed 72 months, with written FHWA approval. This may be appropriate when past inspection findings and analysis justifies the increased inspection interval.

(c) Fracture critical member (FCM) inspections. (1) Inspect FCMs at intervals not to exceed 24 months.

(2) Certain FCMs require inspection at less than twenty-four-month intervals. Establish criteria to determine the level and frequency to which these members are inspected considering such factors as age, traffic characteristics, and known deficiencies.

(d) Damage, in-depth, and special inspections. Establish criteria to determine the level and frequency of these inspections.

§ 650.313 Inspection procedures.

(a) Inspect each bridge in accordance with the inspection procedures in the AASHTO Manual (incorporated by reference, see §650.317).

(b) Provide at least one team leader, who meets the minimum qualifications stated in §650.309, at the bridge at all times during each initial, routine, in-depth, fracture critical member and underwater inspection.

(c) Rate each bridge as to its safe load-carrying capacity in accordance with the AASHTO Manual (incorporated by reference, see §650.317). Post or restrict the bridge in accordance with the AASHTO Manual or in accordance with State law, when the maximum unrestricted legal loads or State routine permit loads exceed that allowed under the operating rating or equivalent rating factor.

(d) Prepare bridge files as described in the AASHTO Manual (incorporated by reference, see §650.317). Maintain reports on the results of bridge inspections together with notations of any action taken to address the findings of such inspections. Maintain relevant maintenance and inspection data to allow assessment of current bridge condition. Record the findings and results of bridge inspections on standard State or Federal agency forms.

(e) Identify bridges with FCMs, bridges requiring underwater inspection, and bridges that are scour critical.

(1) Bridges with fracture critical members. In the inspection records, identify the location of FCMs and describe the FCM inspection frequency and procedures. Inspect FCMs according to these procedures.

(2) Bridges requiring underwater inspections. Identify the location of underwater elements and include a description of the underwater elements, the inspection frequency and the procedures in the inspection records for each bridge requiring underwater inspection. Inspect those elements requiring underwater inspections according to these procedures.

(3) Bridges that are scour critical. Prepare a plan of action to monitor known and potential deficiencies and to address critical findings. Monitor bridges that are scour critical in accordance with the plan.

(f) Complex bridges. Identify specialized inspection procedures, and additional inspector training and experience required to inspect complex bridges. Inspect complex bridges according to those procedures.

(g) Quality control and quality assurance. Assure systematic quality control (QC) and quality assurance (QA) procedures are used to maintain a high degree of accuracy and consistency in the inspection program. Include periodic field review of inspection teams, periodic bridge inspection refresher training for program managers and team leaders, and independent review of inspection reports and computations.

(h) Follow-up on critical findings. Establish a statewide or Federal agency wide procedure to assure that critical findings are addressed in a timely manner. Periodically notify the FHWA of the actions taken to resolve or monitor critical findings.

### § 650.315 Inventory.

(a) Each State or Federal agency must prepare and maintain an inventory of all bridges subject to the NBIS. Certain Structure Inventory and Appraisal (SI&A) data must be collected and retained by the State or Federal agency for collection by the FHWA as requested. A tabulation of this data is contained in the SI&A Form distributed by the FHWA as part of the "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges," (December 1995) together with subsequent interim changes or the most recent version. Report the data using FHWA established procedures as outlined in the "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges."

(b) For routine, in-depth, fracture critical member, underwater, damage and special inspections enter the SI&A data into the State or Federal agency inventory within 90 days of the date of inspection for State or Federal agency bridges and within 180 days of the date of inspection for all other bridges.

(c) For existing bridge modifications that alter previously recorded data and for new bridges, enter the SI&A data into the State or Federal agency inventory within 90 days after the completion of the work for State or Federal

agency bridges and within 180 days after the completion of the work for all other bridges.

(d) For changes in load restriction or closure status, enter the SI&A data into the State or Federal agency inventory within 90 days after the change in status of the structure for State or Federal agency bridges and within 180 days after the change in status of the structure for all other bridges.

§ 650.317 Reference manuals.

(a) The materials listed in this subpart are incorporated by reference in the corresponding sections noted. These incorporations by reference were approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. These materials are incorporated as they exist on the date of the approval, and notice of any change in these documents will be published in the Federal Register. The materials are available for purchase at the address listed below, and are available for inspection at the National Archives and Records Administration (NARA). These materials may also be reviewed at the Department of Transportation Library, 400 Seventh Street, SW., Washington, DC, in Room 2200. For information on the availability of these materials at NARA call (202) 741-6030, or go to the following URL: [http://www.archives.gov/federal\\_register/code](http://www.archives.gov/federal_register/code)

[\\_of\\_federal\\_regulations/ibr\\_locations.html](#). In the event there is a conflict between the standards in this subpart and any of these materials, the standards in this subpart will apply.

(b) The following materials are available for purchase from the American Association of State Highway and Transportation Officials, Suite 249, 444 N. Capitol Street, NW., Washington, DC 20001. The materials may also be ordered via the AASHTO bookstore located at the following URL: <http://www.transportation.org/aashto/home.nsf/FrontPage>.

(1) The Manual for Condition Evaluation of Bridges, 1994, second edition, as amended by the 1995, 1996, 1998, and 2000 interim revisions, AASHTO, incorporation by reference approved for §§650.305 and 650.313.

(2) 2001 Interim Revision to the Manual for Condition Evaluation of Bridges, AASHTO, incorporation by reference approved for §§650.305 and 650.313.

(3) 2003 Interim Revision to the Manual for Condition Evaluation of Bridges, AASHTO, incorporation by reference approved for §§650.305 and 650.313.

**VI. FEDERAL HIGHWAY ADMINISTRATION MEMORANDA**



# Bridges & Structures



U.S. Department of  
Transportation  
**Federal Highway  
Administration**

**MEMORANDUM**

Subject: **INFORMATION:** Bridge Load Ratings for the National  
Bridge Inventory

Date: October 30, 2006

From: /s/ Original Signed by  
M. Myint Lwin, P.E., S.E. Director,  
Office of Bridge Technology

Refer To: HIBT-30

To: Directors of Field Services  
Division Administrators  
Federal Lands Highway Division Engineers

Several State and FHWA Bridge Engineers have suggested that we clarify our policy regarding the appropriate methodology and loads to be used in reporting operating and inventory rating data (Items 63, 64, 65 and 66 of the 1995 Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (Coding Guide), Report No. FHWA-PD-96-001) to the National Bridge Inventory (NBI). An overview of our past bridge load rating policies are provided in the attached appendix and our current policy and future direction is provided herein.

With the adoption of the AASHTO Load and Resistance Factor Design (LRFD) Specifications, our June 28, 2000, policy memorandum requiring all new bridges to be designed by the LRFD Specifications after October 1, 2007, and the ongoing effort to merge the Manual for Condition Evaluation of Bridges and the Guide Manual for Condition Evaluation and Load and Resistance Factor Rating of Highway Bridges (LRFR Manual), we believe that it is necessary to accommodate and support Load and Resistance Factor Rating (LRFR), while continuing to accept Load Factor Rating (LFR) for the large inventory of in-service bridges that have been designed by another method other than LRFD. The FHWA does not intend to mandate re-rating existing and valid bridge load ratings by LRFR.

Therefore, FHWA's policy for Items 63, 64, 65, and 66 of the Coding Guide is as follows (see [Table 1](#) for more information):

1. For bridges and total replacement bridges designed by LRFD Specifications using HL-93 loading, prior to October 1, 2010, Items 63, 64, 65 and 66 are to be computed and reported to the NBI as either a Rating Factor (RF) or in metric tons. Rating factors shall be based on LRFR methods using HL-93 loading (see [Appendix A - Example 1](#)) or LFR methods using MS18 loading (see [Appendix A - Example 2](#)). Metric ton rating values shall be reported in terms of MS18 (32.4 metric tons) loading derived from a RF calculated using LRFR methods and HL-93 loading, or LFR methods using MS18 loading (see [Appendix A - Example 3](#)).
2. For bridges and total replacement bridges designed by LRFD Specifications using HL-93, after October 1, 2010 Items 63, 64, 65 and 66 are to be computed and reported to the NBI as a RF based on LRFR methods using HL-93 loading (see [Appendix A - Example 1](#)).
3. For bridges designed or reconstructed by either Allowable Stress Design (ASD) or Load Factor Design (LFD) Specifications, Items 63, 64, 65 and 66 are to be computed and reported to the NBI as a RF or in metric tons. Rating factors shall be based on LRFR methods using HL-93 loading (see [Appendix A - Example 1](#)) or

LFR methods using MS18 loading (see [Appendix A - Example 2](#)). Metric ton rating values shall be reported in terms of MS18 (32.4 metric tons) loading derived from a RF calculated using LRFR methods and HL-93 loading, or LFR methods using MS18 loading (see [Appendix A - Example 3](#))

4. For bridges partially reconstructed resulting in the use of combination specifications (e.g. a reconstructed superstructure designed by LRFD supported by the original substructure designed by ASD) or unknown specifications, Items 63, 64, 65 and 66 are to be computed and reported to the NBI as a RF or in metric tons. Rating factors shall be based on LRFR methods using HL-93 loading (see [Appendix A - Example 1](#)) or LFR methods using MS18 loading (see [Appendix A - Example 2](#)). Metric ton rating values shall be reported in terms of MS18 (32.4 metric tons) loading derived from a RF calculated using LRFR methods and HL-93 loading, or LFR methods using MS18 loading (see [Appendix A - Example 3](#))
5. For bridges designed or reconstructed by either ASD or LFD Specifications and for bridges partially reconstructed resulting in the use of combination specifications or unknown specifications, after October 1, 2010, Items 63, 64, 65 and 66 are to be computed and reported to the NBI as a RF or in metric tons. Rating factors shall be based on LRFR methods using HL-93 loading (see [Appendix A - Example 1](#)) or LFR methods using MS18 loading (see [Appendix A - Example 2](#)). Metric ton rating values shall be based on LFR methods using MS18 loading (see [Appendix A - Example 3](#)). The NBI Code of 3 (Load and Resistance Factor Rating reported in metric tons using MS loading) for Items 63 and 65 will no longer be valid for new load ratings of new or existing bridges after October 1, 2010 (see [Appendix C](#)).
6. For bridges load rated by load testing methods, Items 63, 64, 65 and 66 are to be computed and reported to the NBI as Load Testing in metric tons based on MS18 loading, even though the actual load test was likely performed with another vehicle configuration.
7. For those cases where the condition or the loading of a bridge warrants a re-rating (existing load rating is invalid), follow the Load Rating Methodology Options presented in [Table 1](#) for computing and reporting Items 63, 64, 65 and 66.

It is recognized that there will be situations that require engineering judgment with respect to the selection of an appropriate rating method for computing and reporting Items 63, 64, 65 and 66. For example, States have the option of LRFR, LFR, or Allowable Stress Rating (ASR) for timber and masonry bridges. Please work with your State DOT to develop consistent procedures for these exceptions to policy.

Policy exceptions and reporting procedures to the NBI may be revised in the future once LRFR methods and software are further developed and the Coding Guide is updated. For example, as proposed in the update to the Coding Guide, future reporting of load ratings in the NBI will likely be based entirely on RF rather than tons. The options in Table 1 will be revised to accommodate future changes as they occur.

As in the past, the load rating used to report NBI Item 70, Bridge Posting may be computed either by LRFR, LFR, or ASR methods using the maximum unrestricted legal loads to establish load limits for the purpose of load posting. Item 70 evaluates the load capacity of a bridge in comparison to the State legal loads. For load ratings based on LRFR methods using an HL-93 loading, this item represents the minimum LRFR of all legal load configurations in the State (e.g. if the minimum LRFR of all State legal loads = 0.85, then by using the current Coding Guide table, Item 70 would be coded a 3).

Please share this clarification with your State DOT counterparts and feel free to contact either Everett Matias (202) 366-6712 ([everett.matias@dot.gov](mailto:everett.matias@dot.gov)) or Gary Moss (202) 366-4654 ([gary.moss@dot.gov](mailto:gary.moss@dot.gov)) if any further questions arise.

Attachments

DESIGN OR RECONSTRUCTION SPECIFICATION USED	EXISTING AND VALID LOAD RATING	LOAD RATING OR RE-RATING METHODOLOGY OPTIONS	LOADING	CODING GUIDE ITEMS				
				63	64	65	66	
<b>Load and Resistance Factor Design (LRFD)</b>	None or Invalid	LRFR	HL-93	8	Rating Factor (RF)	8	Rating Factor (RF)	
		LRFR	MS185	3 2	Metric Tons	3 2	Metric Tons	
		LFR 1	MS18	6	Rating Factor (RF)	6	Rating Factor (RF)	
		LFR 1	MS18	1	Metric Tons	1	Metric Tons	
		ASR 4	MS18	7	Rating Factor (RF)	7	Rating Factor (RF)	
		ASR 4	MS18	2	Metric Tons	2	Metric Tons	
	Load and Resistance Factor Rating (LRFR)	LRFR	HL-93	8	Rating Factor (RF)	8	Rating Factor (RF)	
		LRFR	MS185	3 2	Metric Tons	3 2	Metric Tons	
	Load Factor Rating (LFR) or Allowable Stress Rating (ASR)	LRFR	HL-93	8	Rating Factor (RF)	8	Rating Factor (RF)	
		LRFR	MS185	3 2	Metric Tons	3 2	Metric Tons	
		LFR	MS18	6	Rating Factor (RF)	6	Rating Factor (RF)	
		LFR	MS18	1	Metric Tons	1	Metric Tons	
		ASR 3, 4	MS18	7	Rating Factor (RF)	7	Rating Factor (RF)	
		ASR 3, 4	MS18	2	Metric Tons	2	Metric Tons	
	Load Testing	Load Testing	Equivalent MS18	4	Metric Tons	4	Metric Tons	
	<b>Load Factor Design (LFD) or Allowable Stress Design (ASD)</b>	None or Invalid	LRFR	HL-93	8	Rating Factor (RF)	8	Rating Factor (RF)
			LRFR	MS185	3 2	Metric Tons	3 2	Metric Tons
			LFR	MS18	6	Rating Factor (RF)	6	Rating Factor (RF)
LFR			MS18	1	Metric Tons	1	Metric Tons	
ASR 4			MS18	7	Rating Factor (RF)	7	Rating Factor (RF)	
ASR 4			MS18	2	Metric Tons	2	Metric Tons	
Load and Resistance Factor Rating (LRFR)		LRFR	HL-93	8	Rating Factor (RF)	8	Rating Factor (RF)	
		LRFR	MS185	3 2	Metric Tons	3 2	Metric Tons	
Load Factor Rating (LFR) or Allowable		LRFR	HL-93	8	Rating Factor (RF)	8	Rating Factor (RF)	
		LRFR	MS185	3 2	Metric Tons	3 2	Metric Tons	
		LFR	MS18	6	Rating Factor (RF)	6	Rating Factor (RF)	



	Stress Rating (ASR)	LFR	MS18	1	Metric Tons	1	Metric Tons
		ASR 3, 4	MS18	7	Rating Factor (RF)	7	Rating Factor (RF)
		ASR 3, 4	MS18	2	Metric Tons	2	Metric Tons
	Load Testing	Load Testing	Equivalent MS18	4	Metric Tons	4	Metric Tons
<b>Combination of Specifications (LRFD, LFD, ASD) or Unknown</b>	None or Invalid	LRFR	HL-93	8	Rating Factor (RF)	8	Rating Factor (RF)
		LRFR	MS185	3 2	Metric Tons	3 2	Metric Tons
		LFR	MS18	6	Rating Factor (RF)	6	Rating Factor (RF)
		LFR	MS18	1	Metric Tons	1	Metric Tons
		ASR 4	MS18	7	Rating Factor (RF)	7	Rating Factor (RF)
		ASR 4	MS18	2	Metric Tons	2	Metric Tons
		Load Testing	Equivalent MS18	4	Metric Tons	4	Metric Tons
	Load and Resistance Factor Rating (LRFR)	LRFR	HL-93	8	Rating Factor (RF)	8	Rating Factor (RF)
		LRFR	MS185	3 2	Metric Tons	3 2	Metric Tons
	Load Factor Rating (LFR) or Allowable Stress Rating (ASR)	LRFR	HL-93	8	Rating Factor (RF)	8	Rating Factor (RF)
		LRFR	MS185	3 2	Metric Tons	3 2	Metric Tons
		LFR	MS18	6	Rating Factor (RF)	6	Rating Factor (RF)
		LFR	MS18	1	Metric Tons	1	Metric Tons
		ASR 3, 4	MS18	7	Rating Factor (RF)	7	Rating Factor (RF)
		ASR 3, 4	MS18	2	Metric Tons	2	Metric Tons
	Load Testing	Load Testing	Equivalent MS18	4	Metric Tons	4	Metric Tons

<sup>1</sup> Bridges and Total Replacement Bridges Designed by LRFD prior to October 1, 2010. Bridges and Total Replacement Bridges Designed by LRFD after October 1, 2010 are to be computed and reported based on LRFR methods.

<sup>2</sup> The NBI Code of 3 for Items 63 and 65 will no longer be valid for new load ratings of new or existing bridges after October 1, 2010.

<sup>3</sup> Non-NHS Bridges Constructed, Replaced, Rehabilitated and Load Rated prior to January 1, 1994. Bridges Load Rated or Re-Rated after January 1, 1994 are to be computed and reported based on LFR or LRFR methods.

<sup>4</sup> Policy exceptions such as timber and masonry bridges.

<sup>5</sup> Report metric tons in terms of MS18 (32.4 metric tons) loading derived from a RF calculated using LRFR methods and HL-93 loading.

## Appendix - A Examples

**Input options for Coding Guide Items 63 and 65 ([March 22, 2004 memorandum](#))**

Code	Description
1	Load factor (LF) reported in metric tons using MS18 loading.
2	Allowable Stress (AS) reported in metric tons using MS18 loading.
3	Load and Resistance Factor Rating (LRFR) reported in metric tons using MS18 loading.
4	Load testing reported in metric tons using equivalent MS18 loading.
5	No rating analysis performed.
6	Load Factor (LF) rating reported by rating factor (RF) method using MS18 loading.
7	Allowable Stress (AS) rating reported by rating factor (RF) method using MS18 loading.
8	Load and Resistance Factor Rating (LRFR) rating reported by rating factor (RF) method using HL-93 loading.

**Example 1**

**Given:**

LRFR of HL-93 Loading  
Computed Operating Rating Factor = 1.17  
Computed Inventory Rating Factor = 0.90

**Therefore:**

Code Item 63: 8  
Code Item 64: 117  
Code Item 65: 8  
Code Item 66: 090

**Example 2:**

**Given:**

LFR of MS18 Loading by Rating Factor  
Computed Operating Rating Factor =  $54.1/32.4 = 1.67$   
Computed Inventory Rating Factor =  $32.4/32.4 = 1.00$

**Therefore:**

Code Item 63: 6  
Code Item 64: 167  
Code Item 65: 6  
Code Item 66: 100

**Example 3:**

**Given:**

LFR of MS18 Loading in metric tons  
Computed Operating Rating = 54.1 metric tons

Computed Inventory Rating = 32.4 metric tons

**Therefore:**

Code Item 63:1

Code Item 64: 541

Code Item 65: 1

Code Item 66: 324

## Appendix - B Background and History

The FHWA memoranda issued on [November 5, 1993](#) and [December 22, 1993](#), and the Coding Guide established a policy whereby the operating and inventory ratings (Items 64 and 66) of all bridges constructed, replaced, or rehabilitated after January 1, 1994, as reported to the NBI were to be computed by the LFR method using MS loading (HS metric equivalent) as the national standard. In addition, the load ratings of all bridges that did not have a valid load rating or required a re-rating due to changes in condition or loading were to be computed by the LFR method. Through our field offices, target dates were established with the State DOT's for updating all NBI load ratings using the LFR method, starting with all bridges on the National Highway System (NHS). For bridges off of the NHS that were constructed, replaced, or rehabilitated prior to January 1, 1994, a valid load rating computed by LFR, ASR or LRFR was acceptable. For any bridge that required posting or overweight load permits, States had the option of using LFR, ASR, or LRFR methods to establish load limits.

With the adoption of the AASHTO LRFD Specifications, FHWA issued a proposal letter, dated April 19, 2000, to the Chairman of the AASHTO Technical Subcommittee on Bridge Management, Evaluation, and Rehabilitation (T-18) requiring all new load ratings to be computed and reported to the NBI by the LRFR method. Bridges previously designed and currently under design using LRFD were to be rated by the LFR or LRFR methods, until adoption of the LRFR Manual. FHWA also proposed that within 10 years of adoption, all load ratings in the NBI would be in accordance with the LRFR Manual. In recognition of the state-of-development and understanding of the LRFR methodology, and concern by the AASHTO State members over the resources required to re-rate all bridges once again, FHWA rescinded the April 19, 2000, proposal letter via a second letter to the Chairman of T-18 on November 15, 2001.

Since that time, the bridge community's understanding of LRFD and LRFR methods has improved and several State DOT's have started using the load and resistance factor method for design and rating of bridges. On [June 28, 2000](#), FHWA issued a policy memorandum that required all new bridges be designed by LRFD Specifications after October 1, 2007, and all new culverts, retaining walls and other standard structures be designed by LRFD Specifications after October 1, 2010. For modification to existing structures, States had the option of using LRFD Specifications or the specifications that were used for the original design.

Our [March 22, 2004](#), memorandum revised the Coding Guide by providing three additional codes to the Method Used to Determine Operating Rating and Method Used to Determine Inventory Rating (Items 63 and 65). The additions were made to accommodate the reporting of RF determined by LRFR, LFR, or ASR methods. This memorandum did not require bridges to be rated or re-rated using LRFR methods, nor did it change our position on using LFR with MS loading as the preferred method for bridges designed by LFD or ASD. Instead, this memorandum provided the additional option of reporting RF and encouraged the use of LRFR methods with HL-93 loading for all new and reconstructed bridges that were designed by LRFD Specifications.

At the request of T-18, FHWA produced a report in June 2005 titled, the *Impact of Load Rating Methods on Federal Bridge Program Funding*. A copy of the report is available at <http://www.fhwa.dot.gov/bridge/bridgelo01.cfm>. The report concluded that there would be less than a 2 percent change in deck area on deficient bridges if all the inventory ratings were suddenly based on LRFR. The report also indicated that implementation of LRFR is likely to occur gradually, making any changes in deck area on deficient bridges, and therefore Federal bridge funding levels,

difficult to detect.

Based on the results of our study, the advancement and development of LRFD and LRFR methodologies, and our March 22, 2004, memorandum, FHWA's current practice is to accept the reporting of operating and inventory load ratings as outlined in Table 1.

Copies of each of the referenced memorandums are available on our website at <http://www.fhwa.dot.gov/bridge/memos.htm>.

## Appendix - C Code of 3 - Load and Resistance Factor Rating (LRFR) reported in metric tons using MS loading

The code of 3 (Load and Resistance Factor Rating (LRFR) reported in metric tons using MS loading) for Items 63 and 65 had been included in the Coding Guide prior to the full development of the LRFD Specifications and the LRFR Manual. With the adoption of the LRFR Manual, load ratings computed by LRFR methods produce a RF based on HL-93 loading. An HL-93 loading cannot be equated to an MS loading, therefore a direct conversion from RF to MS loading is not possible.

A valid code of 3 involves reporting metric tons in terms of MS18 (32.4 metric tons) loading derived from a RF calculated using LRFR methods and HL-93 loading. This procedure does not produce an equivalent MS18 load. This procedure enables those States that utilize PONTIS, which currently does not support RF's, to input a LRFR as a tonnage value.

The methodology for LRFR allows the user to verify bridge safety and serviceability through a number of distinct procedures (LRFR Manual APPENDIX A.6.1, LOAD AND RESISTANCE FACTOR RATING FLOW CHART). Following these procedures, a RF based on an HL-93 loading will always be calculated while the RF for Legal Loads may be calculated. Therefore, it is the intent of FHWA that the NBI Code of 3 for Items 63 and 65 will no longer be valid for new load ratings of new or existing bridges after October 1, 2010. Bridges currently and correctly coded a 3 are not required to be re-rated.



# Bridges & Structures



U.S. Department of  
Transportation  
**Federal Highway  
Administration**

**MEMORANDUM**

Subject: **Action:** Revisions to the Recording and Coding Guide for the Structure, Inventory and Appraisal of the Nation's Bridges (Coding Guide) - Item 31, Design Load, and Items 63 and 65, Method Used to Determine Operating and Inventory Ratings

Date: February 2, 2011

From: M. Myint Lwin, P.E., S.E.  
Director, Office of Bridge Technology

Reply to: HIBT-30  
Attn. of:

To: Federal Lands Highway Division Engineers  
Division Administrators

The purpose of this memorandum is to notify your offices that we are revising National Bridge Inventory (NBI) Item 31 - Design Load, Item 63 - Method Used to Determine Operating Rating, and Item 65 - Method Used to Determine Inventory Rating in the Recording and Coding Guide for the Structure, Inventory and Appraisal of the Nation's Bridges, (Coding Guide) report number; FHWA-PD-96-001. Attached are the revised NBI Items, which include new and revised codes and additional commentary.

## **Item 31 - Design Load**

Three new codes are added and two existing code definitions are modified. The changes are being made to support the migration to the Load and Resistance Factor Rating method. The new and modified codes for Item 31 are as follows:

Code	Metric Description	English Description
9	MS 22.5 or greater	HS 25 or greater
0	Unknown	Unknown
A	HL93	HL 93
B	Greater than HL93	Greater than HL93
C	Other	Other

Please note that there are two distinct codes for "Unknown" and "Other" now. Code 0 has been modified to only describe "Unknown" situations. This code is to be used where the design live load is unknown due to the absence of plans, design calculations, or other information. Code C for "Other" has been added for situations which increase the design load but are not based upon AASHTO design trucks. State specific design trucks that exceed AASHTO loading would be reported as a "C". Code A is to be used only for HL93 AASHTO design load configurations. Code B is to be used only for increased design loads which are based on the HL93 AASHTO design load configuration. Code 9 has been modified from MS 22.5 or HS 25 to MS 22.5 or greater

or HS 25 or greater and is to be used for increased design loads which are based on those configurations.

**Item 63 - Method Used to Determine Operating Rating and  
Item 65 - Method Used to Determine Inventory Rating**

One new code is added and one existing code definition is clarified for each item. These changes are being made to differentiate between bridges that have not been load rated or load rating documentation does not exist and bridges that have been load rated by field evaluation or engineering judgment.

The new and modified codes for Items 63 and 65 are as follows:

Code	Description
0	Field evaluation and documented engineering judgment
5	No rating analysis or evaluation performed

Existing code 5 is clarified to only be used for bridges that have not been load rated or load rating documentation does not exist. Code 0 has been added for use when the load rating is determined by field evaluation and documented engineering judgment, typically done when plans are not available or severe deterioration exists. Field evaluation and engineering judgment ratings must be documented. Bridges that are currently coded 5 must be reviewed to determine if code 0 or 5, or another code, is appropriate.

The NBI will be modified to accept the revised items beginning with the April 2012 NBI submittal. Accordingly, we request that State DOTs and Federal Agencies update Items 31, 63, and 65 for all affected bridges no later than the next scheduled routine inspection.

Please share this information and request with your State DOT or Federal Agency. If you have any questions you can contact Tom Everett (202) 366-4675 ([thomas.everett@dot.gov](mailto:thomas.everett@dot.gov)),

Attachments

cc:  
Directors of Field Services  
Resource Center

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**Item 31 - Design Load**

1 digit

Use the codes below to indicate the live load for which the structure was designed.

Code	Metric Description	English Description
<b>0</b>	<b>Unknown</b>	<b>Unknown</b>
1	M 9 or	H 10
2	M 13.5	H 15
3	MS 13.5	HS 15
4	M 18	H 20
5	MS 18	HS 20

6	MS 18 + Mod	HS 20 + Mod
7	Pedestrian	Pedestrian
8	Railroad	Railroad
9	MS 22.5 or greater	HS 25 or greater
A	HL 93	HL 93
B	Greater than HL 93	Greater than HL 93
C	Other	Other

Code other H, M, HS, or MS design live loads using the nearest equivalent of the numerical portion of the loading.

Code 0 refers to situations where the design live load is unknown due to the absence of plans, design calculations, or other information.

Code 6 references MS 18 + Mod (HS20+Mod). In this context 'Mod' indicates the inclusion of military loading.

Use Code 9 in situations where the design live load is MS 22.5 (HS 25) or greater.

Code A refers to the standard AASHTO LRFD HL 93 design live load.

Code B refers to the standard AASHTO LRFD HL 93 configuration modified to be greater than the standard HL 93 design live load.

Code C refers to other situations where the design live load is not based upon AASHTO design live load configurations, such as designs based on specific truck loads.

Item 63 - Method Used to Determine Operating Rating 1 digit

Item 65 - Method Used to Determine Inventory Rating 1 digit

Use one of the codes below to indicate which load rating method was used to determine the Operating Rating/Inventory Rating coded in Item 64/Item 66 for this structure.

Code	Description
<b>0</b>	<b>Field evaluation and documented engineering judgment</b>
1	Load Factor (LF)
2	Allowable Stress (AS)
3	Load and Resistance Factor (LRFR)
4	Load Testing
<b>5</b>	<b>No rating analysis or evaluation performed</b>
6	Load Factor (LF) rating reported by rating factor (RF) method using MS18 loading.
7	Allowable Stress (AS) rating reported by rating factor (RF) method using MS18 loading.
8	Load and Resistance Factor Rating (LRFR) rating reported by rating factor (RF) method using HL-93 loadings.



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Code 0 is to be used when the load rating is determined by field evaluation and documented engineering judgment, typically done when plans are not available or in cases of severe deterioration. Field evaluation and engineering judgment ratings must be documented.

Code 5 is to be used when the bridge has not been load rated or load rating documentation does not exist.

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U.S. Department of  
Transportation  
**Federal Highway  
Administration**

**MEMORANDUM**

Subject: **Action:** Assigned Load Ratings

Date: September 29, 2011

From: /s/ Original Signed by  
M. Myint Lwin, P.E., S.E.  
Director, Office of Bridge Technology

In Reply HIBT-30  
Refer To:

To: Division Administrators

The purpose of this memorandum is to clarify FHWA's position on the use of assigned load ratings as a means of complying with the requirements of the National Bridge Inspection Standards (NBIS). Section 650.313 of the NBIS stipulates each bridge is to be load rated in accordance with the AASHTO Manual for Bridge Evaluation (MBE), First Edition/2008, which is incorporated into the regulation by reference. The recently published MBE, Second Edition/2011, introduced changes in the load rating section, specifically the concept of assigning ratings for certain bridges based on the design loading. As a result, some confusion exists over the applicability of the second edition of the MBE and the acceptability of the assigned load rating method under the current NBIS regulation.

The intent of the load rating provisions of the NBIS is to insure that all bridges are appropriately evaluated for their safe load carrying capacity. An established bridge analysis and rating model can be an important element of the bridge records, allowing bridge owners to make quick management decisions regarding the safe load carrying capacity when emergencies arise. FHWA recognizes that certain bridges currently in service with benign condition deterioration, designed and checked by modern methods for modern bridge loadings, and with no changes to dead loads and State legal and routine permit vehicular loads since the design was completed may adequately have those capacities already calculated.

Although the second edition of the MBE is not currently part of the NBIS regulation, FHWA has determined that the inventory or operating level ratings may be assigned based on the design loading, at the discretion of the bridge owner, provided the following conditions, outlined in the commentary to the MBE Second Edition/2011, sections C6A.1.1 and C6B.1 are all met:

1. The bridge was designed and checked using either the AASHTO Load and Resistance Factor Design (LRFD) or Load Factor Design (LFD) methods to at least HL-93 or HS-20 live loads, respectively; and
2. The bridge was built in accordance with the design plans; and
3. No changes to the loading conditions or the structure condition have occurred that could reduce the inventory rating below the design load level; and
4. An evaluation has been completed and documented, determining that the force effects from State legal loads or permit loads do not exceed those from the design load; and
5. The checked design calculations, and relevant computer input and output information, must be accessible and referenced or included in the individual bridge records.

A summary of the assigned load rating, which demonstrates these five conditions are met, is to be included in the bridge records and approved by the individual charged with the overall responsibility for load rating bridges, or by an individual meeting 23 CFR 650.309(c) qualifications and delegated, in writing, this approval authority. If any of these conditions cannot be met for a bridge at any point during its service life, load ratings cannot be assigned and must be determined by other methods defined in the MBE.

If complete design files have not been retained for existing bridges, design plans that clearly identify the loading as at least HL-93 or HS-20 and bear the stamp of a licensed professional engineer may be used by the individual responsible for load rating under 23 CFR 650.309(c) as the basis for an assigned load rating. The approval needs to be documented as the basis for the assigned rating and become part of the official bridge records. This information demonstrates satisfaction of conditions (1) and (5) above. Conditions (2), (3), and (4) still need to be met. Please contact Lubin Gao of our office with any questions regarding this interpretation.

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# Bridges & Structures



U.S. Department of  
Transportation  
**Federal Highway  
Administration**

**MEMORANDUM**

Subject: ACTION-Revisions to the Recording and Coding Guide for the Structure, Inventory and Appraisal of the Nation's Bridges (Coding Guide) Items 63 and 65, Method Used to Determine Operating and Inventory Ratings Date: November 15, 2011

From: /s/ Original Signed by  
M. Myint Lwin, P.E., S.E. Director,  
Office of Bridge Technology

Refer To: HIBT-30

To: Federal Lands Highway Division Engineers  
Division Administrators

The purpose of this memorandum is to notify your offices that we are revising the National Bridge Inventory (NBI) Item 63 - Method Used to Determine Operating Rating, and Item 65 - Method Used to Determine Inventory Rating in the Coding Guide report number, FHWA-PD-96-001. Following are the six new codes for the items. These codes are being added to properly identify Assigned Load Ratings.

Code	Description
A	Assigned rating based on Load Factor Design (LFD) reported in metric tons
B	Assigned ratings based on Allowable Stress Design (ASD) reported in metric tons
C	Assigned ratings based on Load and Resistance Factor Design (LRFD) reported in metric tons
D	Assigned rating based on Load Factor Design (LFD) reported by rating factor (RF) using MS18 loading
E	Assigned ratings based on Allowable Stress Design (ASD) reported by rating factor (RF) using MS18 loadings
F	Assigned ratings based on Load and Resistance Factor Design (LRFD) reported by rating factor (RF) using HL93 loadings

All new bridges entered into the NBI inventory are expected to use these new codes if an assigned load rating method was used. Past bridges that used and meet the requirements for assigned load ratings are to be re-coded indicating the correct method by the April 2014 NBI submittal.

If there are any questions regarding these codes please direct them to [Ann.Shemaka@dot.gov](mailto:Ann.Shemaka@dot.gov), 202-366-1575, or [Gary.Moss@dot.gov](mailto:Gary.Moss@dot.gov), 202-366-4654.

Attached are the revised coding guide pages that contain the complete list of codes that are available for these 2 items.

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Attachment

Item 63 - Method Used to Determine Operating Rating  
1 digit

Item 63 - Method Used to Determine Inventory Rating  
1 digit

Use one of the codes below to indicate which load rating method was used to determine the Operating Rating/Inventory Rating in Item 64/Item 66 for this structure.

Code	Description
0	Field evaluation and documented engineering judgment
1	Load Factor (LF)
2	Allowable Stress (AS)
3	Load and Resistance Factor (LRFR)
4	Load Testing
5	No rating analysis or evaluation performed
6	Load Factor (LF) rating reported by rating factor (RF) method using MS18 loading.
7	Allowable Stress (AS) rating reported by rating factor (RF) method using MS18 loading.
8	Load and Resistance Factor Rating (LRFR) rating reported by rating factor (RF) method using HL-93 loadings.
A	Assigned rating based on Load Factor Design (LFD) reported in metric tons
B	Assigned ratings based on Allowable Stress Design (ASD) reported in metric tons
C	Assigned ratings based on Load and Resistance Factor Design (LRFD) reported in metric tons
D	Assigned rating based on Load Factor Design (LFD) reported by rating factor (RF) using MS18 loading
E	Assigned ratings based on Allowable Stress Design (ASD) reported by rating factor (RF) using MS18 loadings
F	Assigned ratings based on Load and Resistance Factor Design (LRFD) reported by rating factor (RF) using HL93 loadings

Code 0 is to be used when the load rating is determined by field evaluation and documented engineering judgment, typically done when plans are not available or in cases of severe deterioration. Field evaluation and engineering judgment ratings must be documented.

Code 5 is to be used when the bridge has not been load rated or load rating documentation does not exist.

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# Bridges & Structures



U.S. Department of  
Transportation  
**Federal Highway  
Administration**

**MEMORANDUM**

Subject: **INFORMATION:** Load Rating of Specialized Hauling  
Vehicles

Date: November 15, 2013

From: /s/ *Original Signed by*  
Joseph S. Krolak  
Acting Director, Office of Bridge Technology

Reply to HIBT-10  
Attn. of:

To: Federal Lands Highway Division Engineers  
Division Administrators

The purpose of this memorandum is to clarify FHWA's position on the analysis of *Specialized Hauling Vehicles* (SHVs) as defined in the AASHTO Manual for Bridge Evaluation (MBE) during bridge load rating and posting to comply with the requirements of the *National Bridge Inspection Standards* (NBIS). The intent of the load rating and posting provisions of the NBIS is to insure that all bridges are appropriately evaluated to determine their safe live load carrying capacity considering all unrestricted legal loads, including State routine permits, and that bridges are appropriately posted if required, in accordance with the MBE.

The SHVs are closely-spaced multi-axle single unit trucks introduced by the trucking industry in the last decade. Examples include dump trucks, construction vehicles, solid waste trucks and other hauling trucks. SHVs generally comply with Bridge Formula B and are for this reason considered legal in all States, if a States' laws do not explicitly exclude the use of such vehicles.

NCHRP Project 12-63 (Report 575, 2007) studied the developments in truck configurations and State legal loads and found that AASHTO Type 3, 3-S2 and 3-3 legal vehicles are not representative of all legal loads, specifically SHVs. As a result, legal load models for SHVs were developed and adopted by AASHTO in 2005, recognizing that there is an immediate need to incorporate SHVs into a State's load rating process, if SHVs operate within a State. The SHV load models in the MBE include SU4, SU5, SU6 and SU7 representing four-to seven-axle SHVs respectively, and a Notional Rating Load (NRL) model that envelopes the four single unit load models and serves as a screening load. If the load rating factor for the NRL model is 1.0 or greater, then there is no need to rate for the single-unit SU4, SU5, SU6 and SU7 loads. However, if the load rating factor for the NRL is less than 1.0, then the single-unit SU4, SU5, SU6 and SU7 loads need to be considered during load rating and posting.

The SHVs create higher force effects, and thus result in lower load ratings for certain bridges, especially those with a shorter span or shorter loading length such as transverse floor beams, when compared to AASHTO Type 3, 3-S2 and 3-3 legal loads and HS20 design load. Therefore, SHVs, i.e., SU4, SU5, SU6 and SU7 or NRL, are to be included in rating and posting analyses in accordance with Article 6A.2.3 and Article 6B.9.2 of the 1st Edition of the MBE (Article 6B.7.2 of the 2nd Edition of the MBE), unless one of the following two conditions is met:

**Condition A:** The State verifies that State laws preclude SHV use; or

**Condition B:** The State has its own rating vehicle models for legal loads and verifies that the State legal load models envelope the applicable AASHTO SHV loading models specified in Appendix D6A and Figure 6B.9.2-2 of the 1st Edition of the MBE (Figure 6B.7.2-2 of the 2nd Edition of the MBE), and the State legal load models have been included in rating/posting analyses of all bridges. The SHV types, e.g. six- or seven-axle SHVs, precluded by State laws need not be considered.

The SHV load models apply to Allowable Stress Rating, Load Factor Rating, and Load and Resistance Factor Rating in accordance with Section 6A and 6B of the MBE.

The FHWA recognizes that there are bridges in the inventory that have not been rated for SHVs and that it is not feasible to include SHVs in the ratings for the entire inventory at once. FHWA is establishing the following timelines for rating bridges for SHVs, if neither Condition A or B is met:

Group 1: Bridges with the shortest span not greater than 200 feet should be re-rated after their next NBIS inspection, but no later than December 31, 2017, that were last rated by:

- a. either Allowable Stress Rating (ASR) or Load Factor Rating (LFR) method and have an operating rating for the AASHTO Routine Commercial Vehicle either Type 3, Type 3S2, or Type 3-3 less than 33 tons (English), 47 tons (English), or 52 tons (English) respectively; or
- b. Load and Resistance Factor Rating (LRFR) method and have a legal load rating factor for the AASHTO Routine Commercial Vehicle, either Type 3, Type 3S2 or Type 3-3, less than 1.3.

Group 2: Rate those bridges not in Group 1 no later than December 31, 2022.

For either group, if a re-rating is warranted due to changes of structural condition, loadings, or configuration, or other requirements, the re-rating should include SHVs.

The selection of load rating method should comply with FHWA's Policy Memorandum [Bridge Load Ratings for the National Bridge Inventory, dated October 30, 2006](#).

A State may utilize an alternative approach in lieu of the above to address the load rating for SHVs for bridges in their inventory; however, the approach must be reviewed and formally accepted by FHWA.

The timeline presented above will be incorporated into the review of Metric 13 under the National Bridge Inspection Program (NBIP); specifically, it is expected that all bridges meeting Group 1 criteria be load rated for SHVs by the end of 2017. Please work with your State to assist them in developing appropriate actions to meet those timelines. If your State is currently developing or implementing a Plan of Corrective Actions (PCA) for load rating bridges, the PCA should be reviewed and modified as necessary to take into account the rating of SHVs for those bridges and these timelines.

We request that you share this memorandum with your State or Federal agency partner. All questions that cannot be resolved at the Division Office level should be directed to Lubin Gao at [lubin.gao@dot.gov](mailto:lubin.gao@dot.gov) or at 202-366-4604.

