ARDOT
ARKANSAS DEPARTMENT OF TRANSPORTATION

BRIDGE INSPECTION MANUAL

Edition of 2022

Revised March 31st, 2022

GUIDANCE DOCUMENT APPROVALS

This Bridge Inspection Manual aims to provide guidance and direction concerning the inspection of bridges in Arkansas. Any modifications to this Bridge Inspection Manual require approval of the Arkansas Highway and Transportation Department's (ARDOT) Heavy Bridge Maintenance Section (HBM) and Federal Highway Administration (FHWA). This Bridge Inspection Manual will be reviewed and updated as needed by the State Bridge Inspection Program Manager or designated representative. However, ARDOT reserves the right to make interim updates to the procedures to address lessons learned, evolving approaches, updates to federal, state, local laws, regulations, and policies, provided updates are reviewed with ARDOT and FHWA oversight.

ARKANSAS DEPARTMENT OF TRANSPORTATION
BRIDGE INSPECTION MANUAL
March 2022 Edition

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Chapter 1: Bridge Inspection Program

Foreword

This Bridge Inspection Manual is to establish a uniform and formal procedure for the bridge inspection process for ARDOT and to comply with the Code of Federal Regulations, Part 650 Subpart C. These requirements provide for regular and systematic inspection of bridges on, under, or over public highways and streets in the interest of public safety and protection of the public investments in such structures.

The ARDOT Bridge Inspection Manual is a combination of guidelines, example forms, charts, policies, and procedures designed to aid all concerned with bridge inspections. This manual is used in conjunction with the following documents:

1. 1995 FHWA "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges," 2012, 2018 Errata;
2. 1986 FHWA "Inspection of Fracture Critical Bridge Members";
3. The Manual for Bridge Evaluation, 3rd Edition, 2018 with 2020 Interim Revisions;
4. NHI Course No. 130055 "Safety Inspection of In-Service Bridges" Participant's Workbook;
5. 1986 FHWA "Culvert Inspection Manual";
6. Manual for Bridge Element Inspection, 2nd Edition, 2019;
7. 1989 FHWA, "Underwater Inspection of Bridges";
8. Bridge Inspector's Reference Manual (BIRM), 2012;
9. Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition, with 2015 Interim Revisions;
10. Metrics for the Oversight of the National Bridge Inspection Program, 2017;
11. Arkansas's current "Local Government Procedures For Compliance With The National Bridge Inspection Standards."

History and Purpose

Federal law required all states to develop and implement a bridge inspection program following the 1967 collapse of the Silver Bridge over the Ohio River that resulted in 46 deaths.

As a result of this bridge failure, the Federal-Aid Highway Act of 1968 required the Secretary of Transportation, with the state highway agencies, to develop National Bridge Inspection Standards (NBIS). The Act also required each state to establish and maintain a current inventory of all bridges on the Federal-Aid Highway System. The Surface Transportation Assistant Act of 1978 significantly expanded the program to require all bridge length structures on the public highway system (state, county, city) to be inspected. There are approximately 12,800 structures and 72.5 million ft^2 of deck area in Arkansas' bridge inventory.

ARDOT has an agreement with local owners to be responsible for the inspection and load rating of bridge length structures on the state and locally owned public road systems in compliance with the NBIS. ARDOT will annually bill local owners 20% of the associated administration costs for the bridges under their jurisdiction. In addition, a voluntary program was developed where local owners could secure load posting materials from ARDOT stock piles at a reduced cost if program procedures were followed. Initially, this assistance was only for the initial posting of the bridges, but it was expanded to enable material requisition to be made as needed.

In January 1985, ARDOT's Bridge Inspection Program was significantly reorganized to address the workload and more effectively use its personnel. The District Construction Engineer was designated as the District Bridge Inspection Engineer. This person is responsible for coordinating and monitoring the program at the District level. Full-time District Bridge Inspectors perform the inventory and inspection of bridges within the District. Also, as part of this reorganization, the Structures Inventory and Rating Section in Bridge Division was created to consolidate the functions of report processing and load capacity rating. Overall the Heavy Bridge Maintenance Section provides coordination of the Bridge Inspection Program. Local governments were made aware that failure to comply with their posting responsibilities could result in Federal Aid Highway Funding loss.

In July 2004, inspection data was no longer reported on paper forms but entered into a computer program called PONTIS. PONTIS served as the Bridge Management file, and queries could now be run from its database.

FHWA introduced a bridge safety initiative in 2011 with subsequent revisions to systematically perform QA. The initiative measures are a data-driven, risk-based review and analysis of 23 metrics that determine how states perform their bridge inspection programs.

In May 2011, the State Heavy Bridge Maintenance Engineer was designated the Bridge Inspection Program Manager. The Staff Heavy Bridge Maintenance Engineer was appointed the Assistant Bridge Inspection Program Manager. The District Construction Engineers were assigned the District Bridge Inspection Program Managers. These title changes were made to define better the roles and responsibilities of personnel involved with the bridge inspection program.

In June 2011, the Bridge Management Engineer position was transferred from the Bridge Division to the Maintenance Division to develop a bridge management program. The process started with improvements to the Maintenance Activities (Form V) Database to track maintenance needs, critical findings, and completed work on bridges.

In December 2013, the Department and the Federal Highway Administration signed a Systematic Bridge Preservation Agreement to allow preapproval of Federal participation on bridge preservation activities without the need for the Department to provide separate justification for each project. This Agreement was updated in June of 2018. The Department personnel can now use it as a systematic approach in determining when bridge preservation activities meet the criteria for eligible Federal participation. Bridge Preservation Guidelines were developed to more clearly define the goals and strategies of bridge preservation called for in the Systematic Bridge Preservation Agreement.

In June 2014, the Department hired Bentley to provide the next generation of bridge inspection software (InspectTech) and integrate the maintenance needs database into the bridge inspection software. The software includes an IPad app for the collection of field data and sync with a web version. Besides mobile data collection, it provides inspection management, performance measure management, maintenance need management, and MAP-21 compliance. The software was put into production on March 2, 2015.

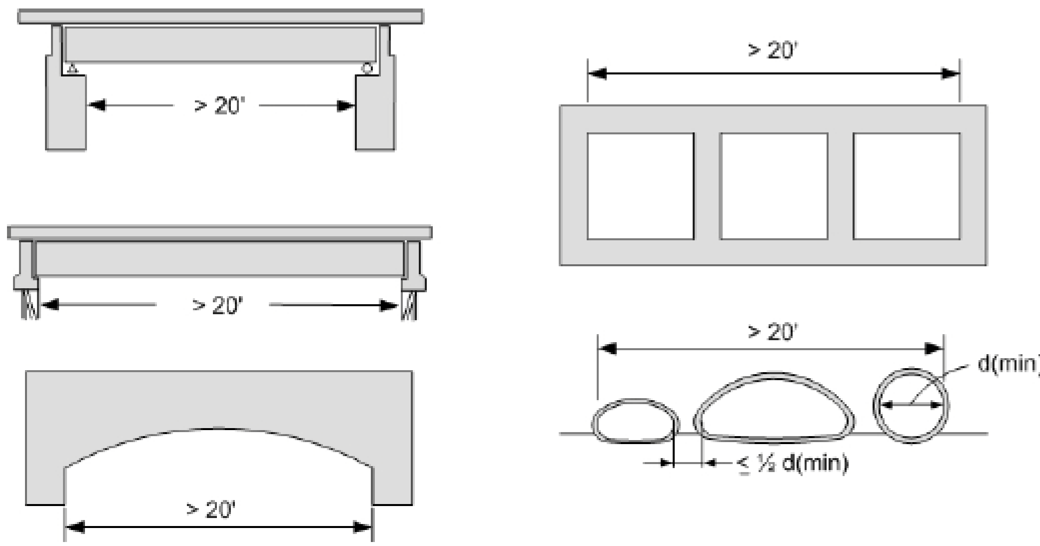
In January 2020, the Department moved to the InspectX mobile bridge inspection platform and the bridge data to the cloud.

This Manual is not intended to supplant proper training or the exercise of judgment by the Inspector or a Program Manager. It communicates only the minimum requirements necessary to provide for public safety. Any Program Manager may require the sophistication of inspection, load rating, or materials testing to be higher than the minimum requirements.

<u>General Definitions</u>

1. DEFINITION OF A BRIDGE: A bridge is 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 under-copings of abutments or spring lines of arches, or extreme ends of openings. To determine the length, measure back-to-back of back-walls of abutments or from paving notch to paving notch. If the location of the backs of back-walls cannot be precisely determined, Inspectors can then measure the distance between the paving notches to determine structure length.

   A multiple pipe culvert shall also be classified as a bridge length structure if the clear distance between openings is less than half of the smaller adjacent opening and the overall structure length (out to out of pipe openings) is 20 feet or more.



2. SIDE DRAIN STRUCTURE: If side drain structures on the State Highway System are bridge length and are known to carry public, commercial, industrial, or major farm transportation will be inventoried, assigned a bridge number, and inspected under the bridge inspection program.

   Even though bridge length in nature, all other side drain structures will be considered minor drainage structures.

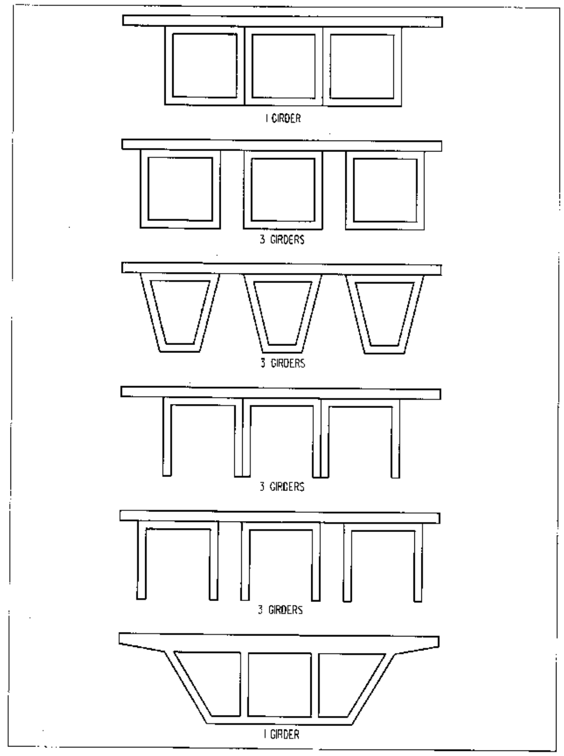
3. FRACTURE CRITICAL: Fracture critical bridges are non-redundant such that failure of a single tension-steel member or tension-steel component could be expected to result in the collapse of the structure.

4. MAINTENANCE: Routine or incidental work that generally restores the bridge's condition and does not significantly increase the structural or durability characteristics of the original bridge.

5. REHABILITATION: The major work necessary to restore the structural integrity of portions of the original bridge that are deteriorated, and work is required to correct major safety defects. Rehabilitation may include, where necessary, complete removal and replacement of deteriorated components of the existing bridge.

6. NUMBER OF GIRDERS: See the following diagram showing examples for determining the number of girders in various situations.

Girder Numbering Conventions



<u>Overview and Funding</u>

Following established guidelines and practices, the District Bridge Inspectors use their specialized training and experience to enter inspection data into the InspectX inspection software. The District Bridge Construction Engineer serves as the Local Program Manager, supervises the inspection process, and is responsible for the accuracy of the reports. Bridge Division's Inventory and Rating Section utilizes the information gathered by the Bridge Inspector to perform a detailed review and load rating. This data is submitted at least annually by the HBM Section to the FHWA Washington Office, where it is compiled to form the National Bridge Inventory (NBI) report to Congress.

<u>Goals of the Bridge Inspection Program</u>

The ultimate objectives of the Bridge Inspection Program are to facilitate safe travel over public bridges and maximize benefits from the use of public funds. Bridge Inspection data is the foundation for the entire bridge management system. Information obtained during the inspection will be used to determine needed maintenance and repairs, identify preservation needs, prioritize rehabilitations and replacements, allocate resources, and evaluate and improve design for new bridges. The accuracy and consistency of the inspection and documentation are vital because it impacts programming and management of the bridge inventory and affects public safety.

Quality Control

Quality Control (QC) is the enforcement of procedures intended to maintain the caliber of bridge inspection and documentation at or above the NBIS standard. Quality control is the responsibility of every person involved in the daily activities of the bridge inspection program.

District (QC) - The Routine Inspections in the District bridge inventory will be alternated between bridge inspecting teams. When it is not logistically feasible to rotate through the entire inventory within the District, the District Construction Engineer may implement an alternate procedure of rotating through a minimum of 30% of the inventory. This rotation of bridge inventory supports the peer-to-peer exchange of ideas and indicates if the inspection teams are performing similarly.

To ensure that the minimum number of routine inspection of bridges within the District bridge inventory is alternated between bridge inspection teams, the Heavy Bridge Maintenance Section will check the percent of rotation within each District monthy.

As part of the QC, either the Assistant Bridge Inspector or Inspector shall review the inspection information entered by the other team member. The following items are the minimum required for the review of an inspection:

- Review NBI Items 90, 91, 92, and 93 (Inspection dates and Frequencies) for completeness and accuracy.
- A bridge layout and cross-section view shall be stored as a pdf file in the Asset Files/Plans tab for state bridges.
- Photos should be included for:
    - Bridge looking down roadway (Routine Inspections)
    - Elevation view of the bridge and set as the default image (Routine Inspections)
    - Posting and clearance signs (Routine & Under Record Clearance Inspections)
    - Maintenance items that warrant either a “CF,” “A” or “B” priority
    - Conditions that rate 4 or lower on the NBI scale
    - Elements that rate a Condition State 4: “ Severe”
    - Repaired bridge elements
    - Deck on a state bridge representing “typical” deck conditions showing both top and bottom of the deck
- Review ARDOT Agency Tab for accuracy and verify an email is included for Local Owners
- Review Under Records Tab for accuracy
- Review Element Inspection Tab for accuracy for State Bridges and Local Bridges on NHS
- If inspection is late, the proper documentation has been entered into the Late Reason drop-down box on the ARDOT Agency Form
- Maintenance items have been entered if required
- Attach any drawings, plans, or files that support the inspection under the appropriate tabs
- Verify that the inspection schedule has been updated for the next inspector
- Verify that any “Special Inspections” left in the schedule are necessary and removed if not
- Verify that NBI Items 58,59,60 or 62 correlate well with the Elements Conditions and the Maintenance Items

The Assistant should also ask questions if there is something that they disagree with in the report. In an ideal situation, everyone will agree, but ultimately it is the Inspector's responsibility.

The Bridge Inspector **shall always** be on-site during the inspection. The Assistant Bridge Inspector shall always (with rare exceptions) be on site with the Bridge Inspector so that two sets of trained eyes are looking at the bridge. If the Assistant cannot accompany the Inspector, other personnel should accompany the Inspector during the bridge inspection for safety considerations.

The InspectX Bridge Inspection Software is used to manage the bridge inspection process. The system eliminates transfer errors from written reports, automates the scheduling and type of inspections performed, and performs data validation checks. The database is regularly backed up, and it is part of the permanent bridge record. Changes to the database are restricted to authorized personnel only.

Only personnel familiar with Arkansas's Bridge Inspection Manual and qualified by NBIS standards are used in conducting bridge inspections and oversight. The Heavy Bridge Maintenance Section maintains documentation of the qualifications and training of all bridge inspection personnel. The Section also maintains the Bridge Inspection Manual and updates the manual as directed by the State Bridge Inspection Program Manager or designated representative.

The Bridge Inspection Manual contains the Department's policy and procedures for the Bridge Inspection Program. The Bridge Inspector must be fully aware of all these policies and procedures. Therefore, each Bridge Inspector shall certify that they have read the Bridge Inspection Manual. The State Bridge Inspection Program Manager shall retain this certification with the Bridge Inspector's training documentation. New Inspectors are responsible for sending this certification to HBM.

Bridge Inspectors and Program Managers are assigned to all public bridges in Arkansas by the ARKANSAS DEPARTMENT OF TRANSPORTATION. Having one entity administrate the bridge inspection program promotes uniformity and control throughout the program.

Central Office (QC) - The Central Office conducts checks on the data from the bridge inspection database. Discrepancies are investigated and resolved. Procedural recommendations for improvements are made to the Program Manager where common errors are found. These are SQL data query checks that run through power automation processes. These checks send auto emails to the Heavy Bridge Maintenance Section and are forwarded to respective parties. The following is a list of data checks:

Frequency	**Check**
Monthly	Rotation of Recent Routine Inspections – Percentage.
Monthly	Maintenance items in Open state for over 30 days.
Monthly	Posting - beginning and ending both match calculated posting and is not closed
Monthly	Ensure bridges that should be posted are marked as such in Item 41.
Monthly	Maintenance items must have completion date if completed
Monthly	Check that bridges that have a maintenance need and that are not owned by the state have owner email address.
Monthly	Check if number of bridges inspector plans to visit in the next 6 months exceeds 30.

Monthly	If bridge condition is poor, ensure routine scheduled for 24 months is offset by 12 months with other special recurring.
Monthly	PowerBI check to verify that bridges have inspection scheduled with active inspector.
Monthly	Check that NBIS bridges have routine inspection set for either 24 or 48 month frequency.
Monthly	Check to see if inspections are listed incorrectly as UWI.
Monthly	Check that locally owned bridges with maintenance items have owner email address.
Monthly	Check for UWI that are due in the next 18 months.

<u>Quality Assurance</u>

Quality Assurance (QA) is a measurement of the level and consistency of the overall program. Quality assurance will measure the quality and uniformity of the inspection and documentation and identify specific items or procedures in the program where clarification, revision, or additional training is needed.

Federal Highway Administration (FHWA) (QA) **-** A bridge safety initiative was introduced by the FHWA in 2011 with subsequent revisions to perform QA systematically. The initiative measures are a data-driven, risk-based review and analysis of 23 metrics that determine how states perform their bridge inspection programs.

FHWA determines the Compliance Levels for each of the 23 metrics by sampling and data-mining bridge inspection and inventory information across the entire state. A **satisfactory** rating means that the State is adhering to the NBIS regulations with perhaps a few minor, isolated deficiencies that do not affect the program's overall effectiveness. A rating of **actively improving** means a Plan of Corrective Action (PCA) is in place to improve noncompliant metrics. FHWA will rate the State bridge inspection program as **unsatisfactory** if metrics rated as <u>noncompliant</u> do not have a PCA or a State is not actively complying with an existing PCA.

The 23 metrics are represented in 5 groups:

- Metric 1 – **Organization**
- Metrics 2-5 – **Qualifications of personnel**
- Metrics 6 – 11 – **Inspection Frequency**
- Metrics 12 – 21 – **Inspection Procedures**
- Metrics 22 & 23 - **Inventory**

District (QA) - The District Construction Engineer shall make periodic bridge site visits at various locations to compare report results and observed field conditions. Repeat QA inspections of the same structure should be kept to a minimum unless the rating has changed. The District Construction Engineer shall assess the accuracy of Items 58, 59, and 60 of the NBIS and determine if appropriate notes and photographs have been provided. Any discrepancies between the report and observed conditions shall be resolved with the Bridge Inspector. A Quality Assurance NBIS Report Form X shall then be submitted to the Bridge Inspection

Program Manager by E-mail. A minimum of one bridge per quarter per inspector (4 bridges/year/inspector) shall be reviewed. Since the review aims to compare how conditions are evaluated by the Inspector and the District Construction Engineer, it is necessary that the QA inspection closely follow the actual inspection. Therefore the QA inspection and its documentation shall be completed and turned in by the end of the month following the quarter in which the inspection was completed. It is also recommended that the majority of inspections reviewed be selected from those structures that have at least one of the following:

- A significant change in the condition rating(s) since the last inspection
- A designation of structurally deficient or functionally obsolete.
- Fracture critical structures
- Posted structures

In addition to the bridge site visits, the District Construction Engineer reviews every Maintenance item entered for any bridge. This process assures that an Engineer is aware of any severe concerns an Inspector may have on a bridge. State bridges receive additional scrutiny by the District Maintenance Engineer when the Maintenance Item is evaluated and either set to Monitor or Assigned for repair.

Central Office (QA) - Inspection teams from HBM will independently re-inspect approximately 4% of the Districts inspections yearly. The re-inspections shall occur within a few months of the District's inspection so as to limit the possible changes in bridge condition. The QA Inspection Teams will rate Items (58, 59, 60, or 62) and note any Maintenance Items that they rate as a "B" or higher. The teams will also identify elements and their quantity for state bridges. In addition to these items the QA teams will verify the following NBI items:

NBI 001: State Code	NBI 043B: Struc. Type, Main: Type Des./Con.
NBI 002: Highway Agency District	NBI 044A: Struc. Type, Appr. Spans: Mat./Des.
NBI 003: County (Parish) Code	NBI 044B: Struc. Type, Appr. Spans: Type Des/Con.
NBI 006: Feature Intersected	NBI 045: Number of Spans in Main Unit
NBI 007: Facility Carried by Structure	NBI 046: Number of Approach Spans
NBI 008: Structure Number	NBI 047: Inventory Route, Total Horizontal Clearance
NBI 009: Location	NBI 048: Length of Maximum Span
NBI 010: Minimum Vertical Clearance	NBI 049: Structure Length
NBI 016: Latitude	NBI 050A: Curb or Sidewalk Width: Left Side
NBI 017: Longitude	NBI 050B: Curb or Sidewalk Width: Right Side
NBI 028A: Lanes on the Structure	NBI 051: Bridge Roadway Width, Curb-To-Curb
NBI 028B: Lanes Under the Structure	NBI 052: Deck Width, Out-To-Out
NBI 032: Approach Roadway Width	NBI 053: Min. Vert. Clearance OVER Bridge Roadway
NBI 033: Bridge Median	NBI 054A: Min. Vert. Under Clearance: Ref. Feature
NBI 034: Skew	NBI 054B: Minimum Vertical Under Clearance
NBI 035: Structure Flared	NBI 055A: Min. Lat. Under Clearance on Rt.: Ref. Feat.
NBI 036A: Traffic Safety Feat.: BR. Railings	NBI 055B: Min. Lat. Under Clr. on Rt.: Min. Lat. Under Clr.
NBI 036B: Traffic Safety Features: Transitions	NBI 056: Minimum Lateral Under Clearance on Left
NBI 036C: Traf. Safety Feat.: Appr. Guardrail	NBI 061: Channel and Channel Protection
NBI 036D: Traf. Safety Feat.: Appr. Grail. Ends	NBI 071: Waterway Adequacy

NBI 041: Struc. Open, Posted, Closed to Traf.	NBI 072: Approach Roadway Alignment
NBI 042A: Type of Service: ON Bridge	NBI 107: Deck Structure Type
NBI 042B: Type of Service: UNDER Bridge	NBI 108A: Type of Wearing Surface
NBI 043A: Struc. Type, Main: Kind Mat./Des.	NBI 112: NBIS Bridge Length

Once the re-inspections are completed for a District, Central Office personnel shall review the inspections and compare them with the District's inspections. Variances of more than one for NBI items 58, 59, 60, and 62 shall be investigated along with Maintenance Items noted "B" or worse that were not pointed out in the District's inspection. A closeout training session shall be held with each District to go over the results.

Survey questionnaires are filled out periodically to collect feedback from the Bridge Inspectors and the Assistant Inspectors on their perception of the Inspection Program. This information is used internally to identify weaknesses, make improvements and track the progress of the bridge inspection program.

The State Bridge Inspection Program Manager schedules appropriate periodic refresher training as needed. Refresher training could include NHI training, in-house training, webinars, online training, or any other training approved by the Bridge Inspection Committee. Bridge Inspectors and Program Managers should attend this training every three years. Bridge Inspection Program personnel should provide the Program Manager documentation of additional relevant training that may be completed beyond mandatory training. The State Program Manager maintains a list of relevant training successfully completed by Bridge Inspectors, Assistant Bridge Inspectors, and Program Managers.

QUALITY ASSURANCE NBIS REPORT FORM X

BR. NO.	RT/SEC/LM	ITEM 58	ITEM 59	ITEM 60	COMMENTS	DATE

DISTRICT CONSTRUCTION ENGINEER   DATE   HEAVY BRIDGE ENGINEER   DATE

Qualifications of Program Personnel

The State Program Manager shall be the State Heavy Bridge Maintenance Engineer. This position shall meet all the requirements of 23 CFR, Subpart C 650.309(a) and 650.313(g).

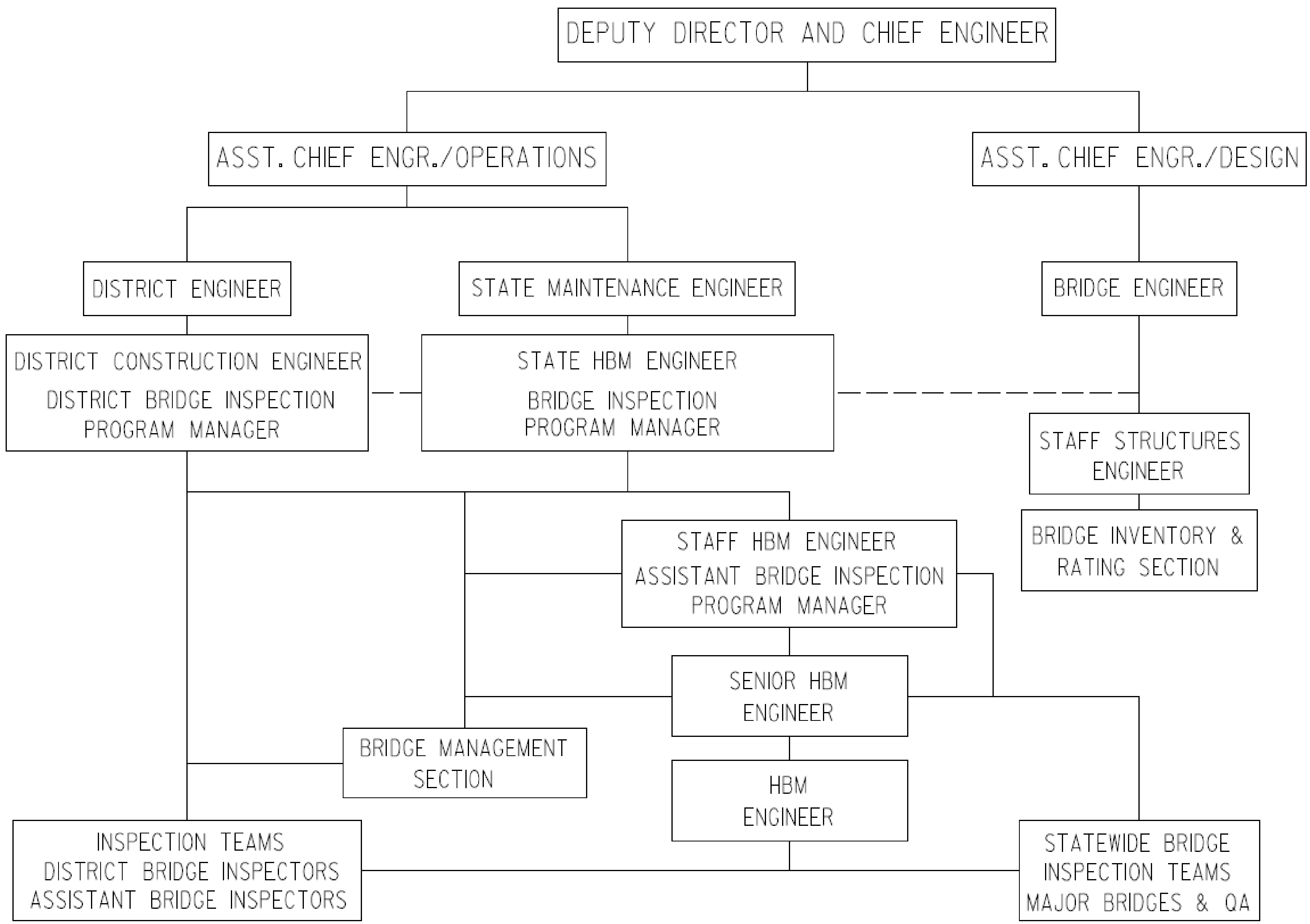
The Department policy is that District Bridge Inspection Engineer (DCE) serves as the Local Program Manager and is required to meet the requirements of 23 CFR, Subpart C 650.309(a) and 650.313(g). After accepting a position that requires NBIS program manager responsibility, the District Bridge Inspection Engineer shall complete the FHWA NHI "Safety Inspection of In-Service Bridges" comprehensive training course as availability allows. The goal is to complete this training within one year of assuming program manager responsibilities.

Bridge Inspectors are required to meet the requirements of 23 CFR, Subpart C 650.309(b) and 650.313(g), including already successfully completing the FHWA NHI "Safety Inspection of In-Service Bridges" comprehensive training course. Bridge Inspectors are also **required** to provide training and mentoring to Assistant Bridge Inspectors to assist in their development. This mentoring requires the Bridge Inspector and Assistant Bridge Inspector to work together with the Bridge Inspector providing direct oversight of the Assistant Bridge Inspector. Though the inspection is a team effort, the Bridge Inspector retains the ultimate responsibility, and the Bridge Inspector shall retain "ownership" of the inspection in InspectX.

The Assistant Bridge Inspector position was created to develop a pool of candidates for the Bridge Inspector position. Suppose the Assistant Bridge Inspector does not demonstrate progress in the skill set and knowledge required to be a Bridge Inspector. In that case, serious consideration should be given to removing the Assistant from the Bridge Inspection Program.

When no applicant for Bridge Inspector is received who meets the above minimum bridge inspection experience requirements, The State Program Manager, in concurrence with the local FHWA Division Office, may evaluate an applicant's total bridge experience and skill. Suppose the experience/skill is found satisfactory. In that case, that applicant may be selected and utilized for bridge inspections with the stipulation that additional quality assurance procedures will be required until that applicant meets the level of experience needed.

BRIDGE INSPECTION PROGRAM ORGANIZATIONAL CHART



Bridge Inspection Program Charges

The purchase of supplies, inspection equipment, and training for the inspection program will be handled by the following procedure:

1. Each District will purchase all necessary supplies on a District Requisition charged to the District Budget and Function 1520. This is for items being taken into stock and issued to the inspection team as needed.
2. The District Storeroom's supplies to the inspection teams will be to Budget 895, Function 3400, and the appropriate Job Number and FAP Number as shown in the following table.
3. Instead of the method described in 1 and 2 above, individual, small purchase items may be purchased by Confirmation Purchase Order using the District Requisition Number and described in the Accounting Manual under Section 30, pages 30-2. Charges are to be made to Budget 895, Function 3400, and the appropriate Job Number as shown in the following table.
4. Training chargeable to the Bridge Inspection Program will have a Job Number and FAP Number assigned to it and should be charged to Budget 895 and Function 3400.

BRIDGE INSPECTION PROGRAM CHARGES

Effective Date October 1, 2021

FUNCTIONAL CLASS CODE (SI & A, ITEM 26)	OWNER (SI & A ITEM 22)	CHARGES (TIME, EQUIPMENT, SUPPLIES)*		
		JOB NO.	**FUNCTION**	**FAP NUMBER**
01, 02, 06, 07, 11, 12, 14, 16, or 17 (ON - FA SYSTEM)	STATE COUNTY CITY	012402 012403 012404	3400 3400 3400	Z24E-NBIS-081 Z24E-NBIS-082 Z24E-NBIS-083
08, 09 OR 19 (OFF-FA SYSTEM)	STATE COUNTY CITY	012402 012403 012404	3400 3400 3400	Z233-NBIS-081 Z233-NBIS-082 Z233-NBIS-083

*See notes 1 and 2 concerning methods for purchasing and charging equipment and supplies

Inspection Equipment

The following list is the inspection equipment authorized for purchase. Additional equipment needs authorization from the Heavy Bridge Maintenance Engineer.

1. Boat, 15’ aluminum or metal alloy
2. Ladder, aluminum extension 24’
3. Steel Tape, in case, 50’ white clad
4. Steel Tape, 100’
5. Reel, Fold Crack, 100’ tape (reel only)
6. Measuring wheel tape
7. Non-Metallic Tape, 50’ with case
8. Hand Level, with case
9. Carpenter Level, 18”
10. Grade Level
11. Plumb Bob, brass with sheath, 14 oz.
12. Level Rod, fiber glass 25’ oval type
13. Range Pole, 8’, two section
14. Calipers, 6” outside
15. Hammer, geological type, 22 oz.
16. Clip Board, legal size, heavy duty
17. Binoculars, 7x, with case
18. Digital Camera, with case
19. Tool Belt, with pouch
20. Ball Peen Hammer, 12 oz., fiber glass handle
21. Hammer, claw, 16 oz.
22. Hammer, shop, double face sledge, 3 lb., 15” handle
23. Pick, garden pick mattock, 36” handle
24. Round Point Shovel, D handle, hollow back
25. Folding Rule, 6’ w/extension
26. Pocket Rule, 12’, white clad w/hook and lock
27. Inspection Mirrors, 2” x 4”, 18” extension handle
28. Hip Boots
29. Waders with Suspenders
30. Screw Driver, square blade, stand tip 15”
31. Pliers, heavy duty
32. Wrench, crescent, 12” regular handle, 1 5/16” capacity
33. Brace and Bits, bits ½” dia. X 12” – 15”
34. Brush, wire, 1 1/8” x 6”, four rows
35. Center Punch, ½” x 5 ½”
36. Cold Chisel, ¾” x 7 ½”
37. Carpenter Wrecking Bar, 24”
38. Life Preserver Work Vest, A and P Type V
39. Drop Harness
40. Lanyard, for drop harness
41. First Aid Kit
42. Chain Drag, lamination detector
43. IPad with case (Supplied by HBM)

44. Electronic Depth Finder
45. Reflective Safety Vest
46. Leather Gloves
47. Safety Goggles
48. Snake Chaps
49. Dye Penetrant
50. Flashlight
51. Electronic Range Finder
52. Ultrasonic Thickness Gauge (Phase II UTG-2900 Recommended)
53. Lever Pit Gauge
54. Grinder or drill with Grinding Disk
55. Toolbox
56. Borescope or endoscope
57. Rebar Scanner
58. Miscellaneous items approved by Bridge Inspection Program Manager

Chapter 2: Inspection Requirements

Assigning New Bridge Numbers

When you need a new bridge number, email Jake Norris or Dale Bittle with the following information, and they will put the bridge into InspectX for your use:

1) Bridge number, if assigned on a job. If not known, it will be assigned and provided to the Inspector.
2) Owner
3) District
4) County
5) Latitude (decimal)
6) Longitude (decimal)
7) Route carried
8) Planned inspection date
9) Inspection frequency
10) Bridge No. replaced
11) Construction Job No. (If applicable)

New Structure

For a new structure on a new alignment and open to public traffic, an NBIS inspection is to be completed, and SI&A data is to be inputted into the inventory as soon as possible. At a minimum, it should be completed within 90 days of the work (open to public travel) for state bridges or 180 days for local bridges. Completed new structures not open to traffic are not subject to the NBIS since they are technically closed. However, once a new structure is open to traffic, it is subject to the NBIS, and the inventory is to be updated with the new SI&A data within the 90/180-day timeframe. Where possible, the initial inventory inspection should be completed before the structure is open to traffic. This inspection can also be used to assist in completing the final punch list for the new structure.

New Structure Under Stage Construction

Staged construction of a new structure presents additional variables in determining when to complete an NBIS inspection. For a new structure on a new alignment, the portion of the new structure open to public traffic is to be inspected regularly to ensure its safety. This safety "Special Inspection" is to be completed as much as possible following the NBIS, and there should be an explanation in the comment field explaining why it was performed. The initial Routine (NBI) inspection and recording of SI&A data are required once **all** of the staged construction is complete (not the contract) and the new structure carries full traffic. The new SI&A data is to be entered into the inventory within 90/180 days.

Existing Structure Being Replaced

For an existing structure to be replaced with a new structure on a new alignment, the existing structure must be inspected per the NBIS as long as it remains in service as a highway bridge open to public traffic. For an existing structure to be replaced with a new structure on the same alignment and under staged construction, the portion of the existing/new structure open to public traffic must be inspected per the

NBIS. A Routine NBIS inspection should be completed as close to the start of construction as possible to provide a 24 month period without the need for inspection. This is assuming the structure does not warrant more frequent monitoring with an Other Special Recurring inspection. Once the new structure is complete and carrying full traffic, the Routine (NBI) inspection is to be finished, and the new SI&A data is to be entered into the inventory within 90/180 days. The DCE or someone from the inspection team shall notify HBM's Bridge Asset Management Section and Bridge Design Rating Section that the existing structure is no longer in service and can be archived.

Suppose an NBIS inspection cannot be conducted due to reasonable circumstances such as a hazardous project site or conditions unfavorable to complete an inspection. In that case, those circumstances should be documented. See "Routine (NBI) Inspection" for additional guidance when circumstances interfere with an inspection.

Temporary Structure

For a temporary structure to carry public traffic while the permanent structure is closed, the temporary structure must be inspected per the NBIS. The temporary structure is not required to have its own individual SI&A data in the inventory. Generally, the structure rehabilitated or replaced remains in the inventory, and appropriate SI&A data, Items 10, 41, 47, 53, 54, 55, 56, 70, and 103, are to be coded for the temporary structure. The Bridge Inspector shall provide the Rating Section with the needed information to rate the bridge. The Bridge Inspector shall also email Bridge Rating notifying them of the temporary structure so that they can update Item 70. Once the permanent structure is complete and open to public traffic, an NBIS inspection is to be completed, and updated SI&A data is to be inputted into the inventory within 90/180 days. The Bridge Inspector shall provide the necessary sketches and bridge description to fully describe the temporary structure so that the temporary structure may be rated.

From the SI&A Coding Guide: The use or presence of a temporary bridge requires special consideration in coding. In such cases, since there is no permanent bridge, Items 64 and 66 should be coded as 000 even though the temporary structure is rated for as much as full legal load. Item 41 will be listed as "E" for temp structures.

Frequency

Please make a note: InspectX scheduling is different from Inspecttech. The frequencies discussed in this chapter relate to the frequencies in InspectX (in the inspection and schedule). The values in the chapter below must go into InspectX when an inspection is scheduled or the inspection is performed. The scheduled inspections can be more frequent than the actual frequency.

When the NBIS Oversight Program started evaluating our bridge inspection program using the 23 Metrics, the program had perceived compliance issues concerning the frequency of inspections. This issue stemmed from our program requiring a greater inspection frequency for poor and fracture critical bridges than is needed for the NBIS. We showed different inspection frequency in the NBIS schedule and InspectX schedule for poor and fracture critical bridges to address the issue. FHWA now says that the greater frequency will no longer raise any red flags, so the schedule for poor and fracture critical bridges will be the same in NBIS and InspectX schedules. These should be switched as they come up for inspection.

1. Bridges requiring weight limit postings will need a “Routine” inspection **frequency** (Item 91) of 12 months and **scheduled** for every 12 months;

2. Bridges with condition ratings (Items 58 thru 62) less than 5 will require an “Other Special Recurring” inspection frequency (Item 92C) of 24 months with a date following 12 months after the 24-month “Routine (NBI)” inspection. This “Other Special Recurring” will include only those elements on the bridge that precipitated the “Other Special Recurringl” inspection, such as the deck, superstructure, etc. If the bridge is already **scheduled** (for example, posted bridges) for a “Routine” at 12 month or less, then no “Other Special Recurring” needs to be set up. Note, the schedule here is referring to the date you set to do the inspection and not the frequency shown in NBI values or the Inspection Overview found in the InspectX Schedule;

3. Structures with a vertical clearance of 15’ or less above the route or 15’or less when a public highway is under the structure will require an “Under Record Clearance” inspection frequency of 24 months following 12 months after the 24-month “Routine (NBI)” inspection. If a Routine is completed every 12 months, then no Under Record Clearance inspection is required since the clearance is checked during a Routine;

4. Structures designated as fracture critical will require a “Fracture Critical” inspection **frequency** (Item 92A) of 12 months and **scheduled** for every 12 months;

5. Structures with known deficiency or a unique feature may utilize an “Other Special Recurring” inspection. When used because of a known deficiency the frequency, (Item 92C) should be set for 24 months with a date following 12 months after the 24-month “Routine (NBI)” inspection. The Other Special Recurring inspection may be scheduled as needed to monitor adequately;

6. Scour-prone bridges (NBI-Item 113) with a rating of less than 5 will require an “Underwater Type 2” inspection frequency (Item 92C) of 12 months and scheduled for every 12 months.

If a bridge requires a more frequent inspection in the opinion of the inspector, then the Inspector may reduce the frequency of **scheduling** as necessary.

<u>Inspection Types</u>

The ARDOT inspection program records nine different inspection types: Routine National Bridge Inventory (NBI), Fracture Critical, Underwater (Dive/Multi-Beam Scan), Underwater Type 2 (wading/probing), Under Record Clearance, Other Special Recurring, Accident, Scour POA, and Special. Each of these inspections has a particular purpose and is described on the next page.

Summary Table of Frequency & Inspection Types

Type of Inspection	NBIS Schedule/ InspectX listed Frequency	InspectX Schedule
Regular Bridge Routine - Item 91	24	24 month Routine
Predetermined Culvert Routine - Item 91	48	48 month Routine
Posted Bridge	12	12 month Routine - Change Item 90 inspection date at each inspection
Poor Bridge Routine - Item 91 Other Special - Item 92C	24	A Routine and Other Special Recurring should be set to 24 month and the inspection dates Items 90 and 93C should be offset by 12 months
Fracture Critical - Item 92A	12	12 month
Under water (Dive) - Item 92B	Varies	Normally 60 month - Filled in by HBM
Other Special - Item 92C If needed	The Inspector should schedule an Other Special Recurring as often as needed.	If Item 92C is needed for a deficiency other than poor, the Inspector should schedule an Other Special Recurring in InspectX as often as needed.
Underwater Type 2	NA[1]	Varies - 60 month max
Under Clearance Record	NA	12 month For Clearance less than 15’ Non-NBI Bridge
		24 month For Clearance less than 15’ NBI Bridge (Alternate w/Routine)
Other Special Recurring If needed	The Inspector should schedule as often as needed to adequately monitor the deficiency.	The Inspector should schedule in InspectX as often as needed to adequately monitor the deficiency.
Accident	NA	Once - As Needed
Scour POA	NA	Once - As Needed
Special	NA	Once - As Needed

[1]An underwater Type 2 can also be coded as Other Special (Item 92C) when a bent is scour prone or scour critical. Item 92C would be scheduled as needed to monitor.

Minimum Information Needed on Drawings Created by Inspection Teams

Superstructure Cross Section

- Curb to curb and out to out of deck dimensions
- Slab/deck thickness
    - If thickness varies, please show
    - If stay-in-place forms are present, include the form dimensions and thickness.
- When present, curb/parapet/railing details – Dimensions and sizes. For rail, shapes define or give sizes.
- For girder type bridges
    - Type, number, and the dimension of girder spacing (if all are not the same, show individual spaces)
        - If steel girder designation isn't known, show flange(s) width and thickness, web thickness, and overall depth; If a cover plate is present, show the length, width and thickness, and distance of the beginning referencing the beginning of the girder or nearest bent.
        - For steel plate girders, show each flange's width, thickness, length, and the web. Sometimes there's a change in plate size on the girder length.
        - For steel girders, note if shear connectors exist, if possible.
    - Timber and RC – depth and width
    - Channel beams – unit width and depth, leg width and depth below the slab, slab thickness; grout keyway dimensions
- When wearing surface or cover is present, show type and thickness

Substructure

- Cap length, width, and depth dimensions
- Piling/columns
    - Cross-section dimensions
    - Spacing, including the distance from the end of the cap
- Footings, if present and visible
    - Length, width, and depth
    - If foundation piling is present and visible, size and spacing (Likely won't be visible)
- Main member bearing locations on the bent cap, including the distance from ends of the cap (for analyzing cap)

Bridge Profile

- Bridge length and individual span lengths
- Channel Profile
    - On the initial drawing, include the channel profile.
    - If a bridge is or might be scour susceptible, more frequent channel profiles would be needed.

RC Culverts

- Overall length, back face of wall at beginning to back face of wall at end.
- Thickness of end and intermediate walls; top and bottom slab, if possible;
- For multi-boxes: Show span lengths, center of wall to center of wall. Box sizes can be different.
- Barrel lengths
- Amount and type of cover
- Type of culvert – precast or cast-in-place

RC, Metal, or Other Pipe Culverts (round, arch, etc…)

- Diameter (round); Height and depth (arch)
- Wall thickness
- Barrel lengths
- Layout of pipes – distance between them, number of pipes, etc.
- Amount and type of cover

Truss

- Profile
    - Truss length
    - Panel lengths
    - Panel heights, center of floor-beam to pin at top of panel
    - Panel members configuration
- Cross section
    - Width, center to center of trusses
    - Roadway dimensions carried by truss (similar to a span cross section)
    - Floor-beam data
    - Stringer data and location, if present

Arch (varies with type and size)

- Profile
    - Arch length
    - Spacing of columns/vertical members
    - Vertical members heights, center of floor-beam to arch member
- Cross section
    - Width, center to center of arch
    - Roadway dimensions carried by arch (similar to a span cross section)
    - Floor-beam data
    - Stringer data and location, if present
    - Dimensions/size for all members

RR Car

- Profile
    - Overall length
    - Length of center sill sections (deep, shallow, and transitions), and distance of the beginning referencing the beginning of the girder or nearest bent.
    - Location of struts and floor beams
- Cross Section
    - Lateral spacing of members
    - Member size data
    - Decking type and size data

Routine (NBI) Inspection

This recurring inspection is made to assess the overall bridge condition and record any inventory changes from a previously recorded inspection. They are normally performed on a 24-month frequency (NBI Item 91). However, they may be scheduled differently, as directed in this document. This inspection is made to access all bridge elements with a visible observation to ascertain any deficiencies' existence and extent fully. It also includes clearances for the bridge, so there is no reason to have a Routine and Under Clearance Inspection schedule for the same date. Pictures shall accompany the Routine inspection showing:

- Bridge looking down the roadway
- Elevation view of the bridge
- Posting and clearance signs (if applicable)
- Maintenance item(s) that warrants a “CF” (critical finding), an “A” or “B” priority
- Conditions that rate 4 or lower on the NBI scale
- Repaired bridge elements
- Typical deck for state bridges showing both top and bottom of the deck
- Elements in condition state 3 or 4.

Any bridge without plans shall have micro-station drawings depicting span lengths, a cross-section of superstructure types, and views of the substructure. Pictures of hand drawings and scanned into micro-station are not acceptable. The drawings shall be of such detail so that the Rating Section may ascertain the needed details to determine any posting needs. Drawings shall be updated as necessary to reflect changes that may affect the bridge rating. At a minimum, the drawings shall be checked every ten years for accuracy and the review dated added to the drawing.

The Initial Inspection is included in Routine (NBI) inspections. This is the first inspection of a new or reconstructed bridge added to the inventory. The District Bridge Inspector should collect as much of the NBI and ARDOT data as possible. Contact the Central Office for data that is not available. District personnel should coordinate with the District Bridge Inspector when these bridge jobs are nearing completion so that plans can be made to inspect the bridge before it is opened to traffic and promptly submit the new bridge data to the Central Office as required by the NBIS. The District Construction Engineer is charged with ensuring that the Inspector is made aware of those bridge jobs. The inspection should be completed before the final inspection of the job.

When it is necessary to fully ascertain the existence of or the extent of any serious deficiencies, In-Depth Inspection procedures will be used as part of the Routine (NBI). In-Depth inspection procedures are used to identify any serious deficiencies not readily detectable using routine inspection procedures. This may include nondestructive field tests or other material tests. For example, pins of Pin/Hanger bridges and Pinned Truss Bridges shall receive an Ultra Sonic Inspection scheduled every 24-months.

Routine inspections (NBI Item 91) that will fall 1 month late should have a reason documented in the drop-down box for Late Reason found on the ARDOT Agency Form when the inspection is completed. Routine inspections (If Item 91 = 24 month) that will fall more than 1 month late need first to receive approval from the FHWA Bridge Engineer. Bridge Inspectors/Local Program Managers should submit late reasons for approval directly to Pritesh.Mehta@dot.gov, and the Heavy Bridge Maintenance Engineer should be included in the submittal. The late reason should also be documented in the drop-down box found on the ARDOT Agency Form.

No 24 month Routine NBI Inspection should exceed 3 months late (27 months). If a Routine NBI Inspection cannot be performed for some reason, the cause should be noted in the General Observation note. A modified Routine NBI Inspection, still coded as a Routine (NBI), should then be conducted as thoroughly as possible and followed by a Special Inspection to address those items not covered in the modified Routine NBI Inspection.

<u>Element Inspections at Routine Inspection</u>

For all state bridges and local bridges on the NHS system, a Routine Inspection will also include an element inspection as described in the "Manual for Bridge Element Inspection" with current interims and Chapter 10 of this Manual. Element inspections are required no more than once every two years. The following local bridges will require element inspections:

Bridge #	District		Bridge #	District
01694	4		06600	6
04259	6		19727	4
04260	6		20877	6
06599	6		22044	1

The inspection types of Fracture Critical and Underwater Type 2 may be performed simultaneously as a Routine (NBI) inspection.

<u>Fracture Critical Inspection</u>

This is a recurring inspection with Item 92A set for 12 months and also **scheduled** for 12 months. This is a close-up, hands-on inspection performed on bridges with fracture critical details. Fracture Critical inspections shall be limited to the bridge components in question, with a full Routine (NBI) inspection not being necessary unless it is scheduled. For example, on fracture critical bridges, inspections would be limited to only those tension-steel members that are fracture prone and whose failure might result in a partial or complete collapse of the bridge.

In addition, no Fracture Critical Inspection should exceed 3 months late (15 months). If a typical Fracture Critical Inspection cannot be performed for some reason, the cause should be noted in the late reason drop-down box found on the ARDOT Agency Form. A modified Fracture Critical Inspection, still coded as a Fracture Critical, should then be conducted as thoroughly as possible, followed by a Special Inspection when it becomes possible to address those items not covered in the modified Fracture Critical Inspection.

The objective of Fracture Critical Bridge Inspection is to evaluate, using fracture critical techniques, the condition of those portions of a bridge that are considered Fracture Critical (FC).

By definition, Fracture Critical Bridges are defined as non-redundant steel bridges such that failure of a single steel tension member or tension component could be expected to result in a collapse of the structure. On most FC Bridges, only the FC elements will require inspection every year, while the other bridge elements can be inspected on the regular cycle as deemed applicable for the particular bridge.

Types of bridges considered FC will be but not limited to all trusses, one or two girders per span bridges, pin, and hangers on two girder bridges, steel-framed bent cap bridges, suspension bridges, railroad car bridges, and steel tied-arch bridges

All bridges with FC elements on the public roads shall be inspected using FC inspection techniques. ARDOT policy will require that FC bridge elements be inspected one or more times per year as deemed necessary by the Inspector, District Bridge Inspection Engineer, or Central office.

Underwater (Dive/Acoustical Imaging) Inspection

Overview and Clarification: The Federal Register proposes the following definition of Underwater inspection: Underwater inspection - Inspection of the underwater portion of a bridge substructure and the surrounding channel, which cannot be inspected visually at low water or by wading or probing, and generally requiring diving or other appropriate techniques. ARDOT employs the term Underwater Type II inspection to signify inspecting visually/tactilely at low water by wading or probing. ARDOT uses in house and consultant dive underwater inspections levels 1-3 as well as underwater imaging technology to satisfy the National Bridge Inspection Standards. This section outlines the details of these efforts.

This is a recurring inspection with a frequency of 60 months or less. Consultants or HBM shall perform underwater (Dive/Acoustical Imaging) Inspections, and HBM or their representative shall input the information into InspectX. This is an evaluation of those portions of a bridge below the water line and cannot be inspected visually or probed during periods of low flow or examined by feel for condition, integrity, and safe load capacity. Generally, when the water depth is less than five feet, an underwater inspection will not be required unless the inspector cannot properly examine the substructure or channel components.

There are three methods used to evaluate underwater elements and channels during bridge inspections:

1. Underwater Type 2 - Wading and probing inspections
2. NBIS Underwater Inspection - Dive (In-House or Consultant)
    a. Level 1
    b. Level 2
    c. Level 3
3. NBIS Underwater Inspection - Imaging Technology (In-House Only)

In accordance with the FHWA/ARDOT Plan of Corrective Action for Metric 17 dated 12/2021: ARDOT has identified all bridges in the inventory that require a UWI. This was done by use of GIS and SQL to filter down to a list of 1789 structures that intersect a USGS body of water or stream. Each of these structures were researched (via imagery, photos, cross sections, inspection reports) to determine need for UWI. The list was narrowed to 268 bridges that were marked by an HBM engineer by first review to need an UWI. This list was sent out to the District inspectors to confirm add/delete. From this a list of 202 structures were confirmed to require an UWI by end of 2022.

An Inspector shall submit any bridge they feel warrants a dive to the HBM section to be evaluated for an Underwater (Dive/Acoustical Imaging) Inspection. HBM section will determine if the bridge can be inspected with the in house Dive Inspection Teams or not. If needed, the bridge will be combined with other bridges in that geographical area, and an Engineer Consultant selected for a dive inspection. A current list of dive or acoustical imaging bridges can be found in Appendix B. This list will be expanded as district inspectors make recommendations.

When a Consultant is used, they will provide the following services and use the inspectX inspection software for input of data:

- A Level I inspection (visual, tactile inspection) for all bridges indicated by the project manager requiring underwater inspections (bridges continuously in water deeper than 4 feet), any deficiencies may be further evaluated by a Level II inspection at the authorization of the project manager.

- A Level II inspection (detailed inspection with partial cleaning) will be performed on all steel elements indicated by the project manager, any deficiencies identified during a Level II inspection may be further evaluated by a Level III inspection at the authorization of the project manager.

- A Level III inspection (highly detailed inspection with non-destructive testing (NDT) or partially destructive testing (PDT)) will be conducted when the project manager authorizes the work.

The ARDOT Underwater Inspection Teams report to the State Heavy Bridge Maintenance Engineer, who is responsible for overseeing the inspection and recommending repair for bridges on a statewide basis. The Underwater Inspection Team is responsible for scheduling and coordinating diving activities with their regular duties and obligations. One on-site dive team will consist of at least one team leader, and two of the following: assistant inspector, inspector, engineer, safety assistant.

Diver Qualifications for in House Dive Teams:

All members of ARDOT's Underwater Inspection Team shall receive initial scuba training and NBIS bridge inspection training. To qualify as a diver an individual must meet the following requirements:

1. Candidates must receive approval from their current supervisor to participate in the dive program
2. Be medically eligible to dive. (Evaluated by medical professional)
3. Be employed by the Department in a bridge inspection role
4. Complete and pass the PADI Open Water Dive Certification or equivalent
5. Complete an FHWA approved comprehensive bridge inspection training course such as the NHI Safety Inspection of In-Service bridges training
6. Complete an FHWA approved underwater bridge inspection training course such as the NHI Underwater Bridge Inspection Course
7. Be certified in CPR (2 members of team on site minimum – not required of all divers)

All underwater bridge inspectors are required to receive bridge inspection refresher training at a minimum of five-year intervals.

Diver Safety Practices

Divers may be exposed to hazards that include circulatory risk, respiratory risk, low visibility, hypothermia, and possible injury from falls or submerged debris. Safety of all Underwater Inspection Team members is pinnacle to daily activities, which warrants the following safety practices:

- Follow all OSHA Scuba Requirements
- Follow all Padi Scuba Requirements

ARDOT Bridge Inspection divers will abide by the following at minimum:

- Dive no deeper than 25 ft
- Not dive currents faster than one knot
- Not dive in heavy debris areas, areas with hazardous material in the water near the bridge, in areas with active construction, or in confined spaces
- Not be working on submerged bridge components, only inspecting
- Not complete a dive if feeling uncomfortable or unsafe
- Have 2 members of team certified in CPR
- Have a dive team consisting of at least 3 members; 4 is reccomended
- Consist of a team leader, assistant inspector and a safety assistant
- Be PADI Open Water Certified or equivalent
- Pass the NHI Underwater Bridge Inspection Course

For further details regarding the In House Dive Operations, contact the Heavy Bridge Maintenance Section.

Underwater Dive inspections that will fall one month late should have a reason documented in the late reason drop-down box found on the ARDOT Agency Form. Underwater inspections that will fall more than one month late need first to receive approval from the local FHWA Bridge Engineer. The HBM Section should submit late reasons for approval directly to Pritesh.Mehta@dot.gov. The reason should also be documented in the late reason drop-down box found on the ARDOT Agency Form. An Underwater Dive Inspection **will** be coded under the (NBI) 92B as an Underwater Inspection.

When a dive UWI indicates no substructure element deficiencies require a Level 2-3 evaluation to determine structural stability, multibeam sonar may be used for the subsequent two UWIs before another dive UWI is to be performed. Also, multibeam sonar technology may be considered when water depth, high flow, turbidity, or other conditions could affect a diver's ability to safely determine localized conditions and scour effects. The Bridge Inspection Program Manager will designate these bridges with approval from the local FHWA representative. This in accordance with guidance in the AASHTO Bridge Evaluation Manual that states "inspections in deep water will generally require diving or other appropriate techniques to determine underwater conditions."

Underwater Imaging Technology Inspection

ARDOT acquired a state-of-the-art multibeam sonar in 2021. This is to collect better data and better monitor substructure/channel elevations over time. Multibeam sonar has many inspection benefits that a typical dive inspector simply cannot provide. RTK multibeam sonar allows for real time channel and substructure detection of elevation and position. This allows for 2 cm accurate determination of substructure and channel elevations.

ARDOT's Heavy Bridge Inspection Team will conduct underwater imaging technology inspections on all bridges that require dive inspections that are accessible by boat to document the best change over time via 3D models. This data will be processed and published to ArcGIS Online. Once published, the inspector will use measurement tools and bridge plans to identify defects observed in the 3D surface. A channel profile will be drawn in MicroStation utilizing point elevations found from the 3D surface.

Acceptable Technologies

The underwater imaging technologies acceptable for ARDOT bathymetric survey must include the following at minimum:

- Real time survey corrections via Wi-Fi
- Bottom resolution of 0.5 - 0.9 degrees
- Collection rate of approximately 1024 beams 40 times per second
- Capable of up to 180-degree swath width
- Range resolution of 0.01 m
- Frequency range of 250 – 650 kHZ
- Integral Sound Velocity Profiler
- Ping rate capability of up to 50 Hz
- Multi-detect capable
- Operating Temperature of 0 – 30 degrees C
- Capable of targeting and filtering weak returns by amplitude
- Integral Inertial Measurement Unit
- Auto switch to internal positioning if GPS signal is lost
- Position Accuracy of 0.02 m with RTK
- Heading Accuracy of 0.02 degrees with RTK
- Pitch/Roll Accuracy of 0.02 degrees
- Heave Accuracy of 0.05 m in real time
- Must be supported by RTK and include Survey Base Station if RTK correctional data is not available
- Capable of communication with the Trimble R8 RTK system (Currently utilized by the Department)
- GNSS Satellite Visibility: GPS, GLONASS, Galileo, BeiDou

Training Requirements

ARDOT's Underwater Imaging Team will consist of at minimum three people: boat pilot, navigator/sonar technician, and equipment assistant. For structures in rural areas, additional personnel may be required. Boat pilots should hold a valid Arkansas Drivers' License and have adequate experience with piloting a boat while following the sonar software project, watching multiple monitors. Navigator/sonar technicians must be trained in all parts of the sonar setup, including equipment management, best practices for setup, breakdown, and maintenance, planning the bathymetric inspection, and helping the boat pilot navigate around structures to ensure the highest quality imaging. The equipment assistant must be trained in proper setup practices, as well as, looking out for potential hazards to the sonar and being ready to assist if something makes contact. For structures in poor signal areas, that do not allow for proper NTRIP connection, additional personnel may be required monitor the base station site to ensure it is continuously functioning properly. All Underwater Imaging operations will be under the direct supervision of an NBIS Certified Team Leader.

All team members will be trained in the post processing software. Processing the data is a time-consuming task that requires a lot of judgment and experience. New employees must spend an ample amount of time with an experienced processor to ensure data is of the highest quality and accuracy. Additional training will be completed as necessary with software advancements.

Limitations of Underwater Imaging Technology

The Underwater Imaging Technology setup system is limited by accessibility, navigability, and adverse conditions. Some bridges are in areas that are not accessible by any of the three designated Heavy Bridge boats. There exist channels that are not suitable for navigation such as waterways with heavy debris, very shallow areas, spur dikes, sand wedges, and low elevation bridges. Waterways will be deemed unsuitable if there is a high risk of debris collision or channel bottom material. Other adverse conditions may exist at a bridge location such as active construction/maintenance and inclement weather. In these cases, underwater imaging can be rescheduled for a later date or consulted out for dive inspections by commercial divers as they are trained for such dive conditions.

Reporting Requirements of the Deliverables Produced by the Imaging Technology

Each bathymetric survey inspection raw data will be processed using Qimera. After data processing, two export files consisting of LAS line data designated as Sonar and Lidar will be exported to the bridge's project folder. This line data will be imported to ArcGIS Pro to create an LAS dataset. The dataset will be shared as a web layer to an ArcGIS Online Web Scene. This web scene is accessible by reviewers. The finished, processed project will be stored on ARDOT servers. Substructure elevations will be compared to bridge construction or reconstruction plans to find pier and contraction scour, channel migration or any other notable defects. Inspectors will review each bridge point cloud and document and compare as-built elevations to current elevations to ensure the substructure is sound. Areas of scour will be noted with corresponding elevations. Screenshots of elevations should be provided for each pier/column/pile group in the water as well as overall review of channel. A current channel profile should be included in the report, also. This report will be saved under the bridge underwater inspection files. The report template includes at minimum the following:

- Description of work.
- Date of work performed
- Inspection crew personel
- A description of scour and channel conditions.
- Pier scour holes will be documented by location, dimension, severity, and notable changes since last inspection or repair job such as, "scour hole at Pier 4, 3ft wide, 6 ft long, and 8 ft deep, with full footing exposure, piles visible on all faces down to 4 ft, riprap placed in 2017 is no longer present."
- For each pier/bent the report will also include information on:
    - Material type
    - Type/design of foundation
    - Protective coating present and material type
    - Inspection comments
    - Photos and measurements of that location
- A channel profile of that bridge.

<u>Underwater Type 2 Inspection</u>

Ideally, this recurring inspection would be scheduled along with the Routine Inspection and during low water conditions if possible. Bridges requiring Underwater Type 2 inspections will include bridge length structures on the public highway system crossing water and having a minimum of 3 tons load limit. Culverts with an (Item 113) greater than “4” will be excluded.

A channel profile shall be provided for bridges where the channel and/or overbank material is erodible. This profile would include bridges where water is present only periodically.

All bridges requiring Underwater Type 2 Inspection will be inspected every 60 months or more frequently if judged necessary due to eroding water or detrimental conditions. The Inspector may also consider scheduling every 48 months to better align with the two-year inspection cycle. Steel pile bridges in a corrosive environment will have a high priority for inspection and frequency of inspection. Following emergencies - such as flooding, accident damage, or substructure settlement – an Underwater Type 2 inspection will be performed. Use this type of inspection when underwater evaluation is made for:

- Channel depth or profile employing soundings using an electronic depth finder, measuring probe, or measured line with weight.
- Conditions of submerged substructure elements while wading, using a close visual or tactile (hands-on) examination and/or probing of the elements and adjacent streambed. Refer to the inspection levels described in the FHWA “Underwater Inspection of Bridges” report.

Soundings around piers and bents should be made on all bridges subject to scour from swift running water or where the previous flooding has occurred. If, in the estimation of the District Bridge Inspection Engineer, scour could be a problem for a specific bridge during a flood, he should call for soundings from the bridge side, cat-walk, or the bridge inspection unit. These soundings should then be compared with those from the normal river stages for any problems and should become a permanent part of the inspection file for that bridge.

Results of soundings should be plotted in Microstation or in an automated drawing in an Excel form showing the channel bottom in relation to footings or pile tip elevations, if available. Water surface elevation must be recorded and labeled on the drawing. Other presentation methods may be used, provided each bridge element is cataloged with condition number and type inspection used. Where it is necessary or useful, drawings should be presented to describe the condition accurately. Notes should be recorded under Item (61) Channel/Channel Protection. Underwater type 2 drawings should be combined and placed under the asset files to identify a trend. The latest drawing should be placed under the inspection report files.

A simple method of taking a stream profile would be to measure the distance to the ground or bottom from the bridge deck at 10' intervals along the side of the bridge. Where deemed necessary by the District Bridge Inspection Engineer, a stream bed profile should be taken from 500' upstream to 500' downstream of the bridge.

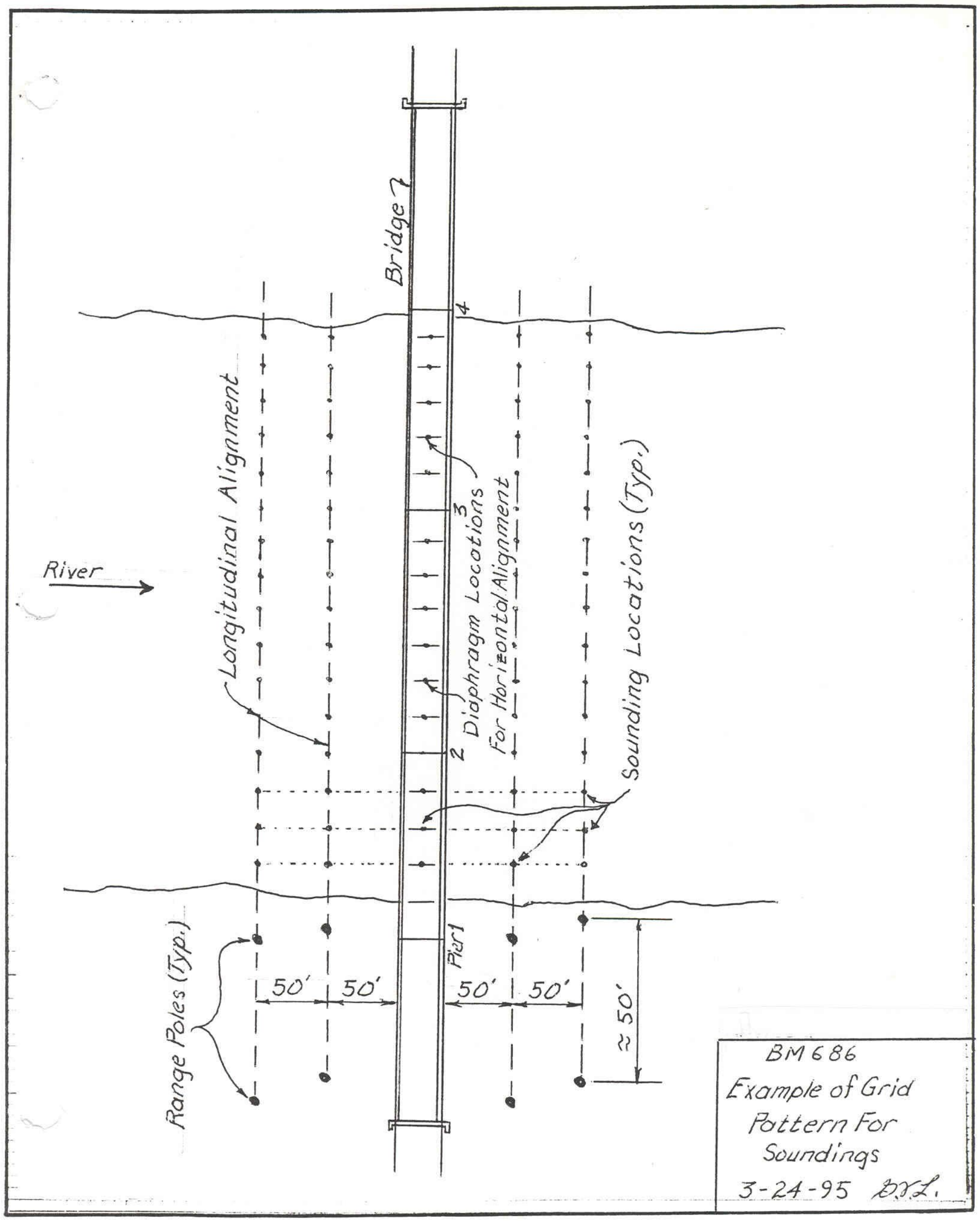
One method that will aid in documenting soundings is to establish a grid pattern (see the example on the next page). To establish longitudinal alignment (parallel to bridge), place two range poles set on the bank 50' from the side of the bridge 50' apart. Establish longitudinal alignment on both the upstream and downstream sides of the bridge. To establish the grid pattern for transverse alignment, use the bridge diaphragms and piers. Soundings should be made with reference to some point of known elevation on the bridge, such as the top of the cap. The actual depth at each reference point of the grid may be determined using an electronic depth finder, measuring probe, or line with weight. The electronic depth finder is more practical in swift water.

Structural components submerged in water generally of a shallow nature can easily be reached by probing rod or other tools (rod of approx. 12 ft. length). The probe will be one of the most useful tools available for an Underwater Type 2 Inspection in shallow water. A 12 to 15-foot long aluminum, 3/4" diameter, telescoping pole with a pointed end is recommended. The inspector can "feel" along the side of piles and columns for weak spots and deterioration. Where areas are found to be suspect, other methods of inspection may have to be used for supplemental investigation.

Scour POA Inspections may use underwater inspection methods (probe/profile/wade), but they are for a specific purpose. If the inspection is documented as a Scour POA Inspection, then there is no need to document it as an Underwater Type 2 inspection.

An Underwater Type 2 Inspection **will not** be coded under the (NBI) 92B as an Underwater Inspection. Neither will an Underwater Type 2 Inspection be coded under the Other Special Inspection (NBI) 92C unless it is to monitor a known or suspected deficiency. For example, if it is a scour critical bridge, and you are doing an Underwater Type 2 Inspection, that is a known (or suspected) deficiency. Its date will be coded as Other Special Inspection (NBI) 92C.

SUPPLEMENTAL BRIDGE INSPECTION – FORM 3A AHD Form Br.Me. 3A



DISTRICT____ COUNTY____ ROUTE____ SECTION_____ LOG_____ BRIDGE NO.______

Under Clearance Record Inspection

This is a recurring inspection that is performed to monitor the clearance of a bridge. This could be for an NBI bridge or a Non-NBI bridge such as a pedestrian bridge, railroad bridge, or other structure. Refer to FHWA Recording and Coding Guide. A picture of the clearance posting sign should be included in the report. A under clearance drawing should be used to detail the vertical and horizontal clearance as a highway or railroad passes under the bridge. These values will be used to code Items 54, 55, 56, and 69.

By Arkansas State Law 27-35-207, the maximum height of any vehicle on state highways is 13’-6”, unless a greater height is authorized by a special permit.

According to Maintenance Memorandum 95-10, “It shall be Department policy to post the actual clearance of all bridges that have a vertical roadway clearance of 15’-0” or less.” … “In addition, changes in vertical clearance due to maintenance activities should be measured by the District Bridge Inspector and reported to the Bridge Rating Section and the Permits Section as soon as possible. Bridges whose vertical clearance has been reduced to 15’ or less shall be posted.”

All structures over public roads and railroads shall have their vertical clearance checked every two years at a minimum and recorded as part of a Routine (NBI) inspection. A separate Under Clearance Record Inspection is not required when a Routine (NBI) Inspection is done. When the vertical clearance is 15’ or less, the vertical clearance shall be checked yearly at a minimum.

If a Routine (NBI) is not scheduled when a clearance check is required, the clearance should be recorded as an Under Clearance Record Inspection. If the under clearance is 15’ or less, and you are not doing a Routine (NBI), then an Under Clearance Record Inspection should be done.

Other Special Recurring Inspection

This is a recurring inspection for a known or suspected deficiency that does not fall under another category. This is an inspection that will be performed between the Routine (NBI) inspections. In general, only those elements on the bridges that precipitated the inspection will be assessed (i.e., a full inspection is not required at this time).

Other Special Recurring Inspections should not fall on the same date as a Routine (NBI) if it is something you would typically look at in a Routine (NBI) inspection. For example, you want to look at a finger joint every year and have a 24 month Routine (NBI) schedule. You should look at the finger joint during the Routine (NBI), so you don’t need the Other Special Recurring for that inspection. Set your Other Special Recurring for 24 month and start it 12 month after your Routine (NBI). That way, you look at the finger joint each year.

An Other Special Recurring Inspection will be coded under the (NBI) 92C as an Other Special Inspection only when it is for a known deficiency (i.e. scour critical, structurally deficient, etc.). Item 92C will be set at 24 months frequency but the date scheduled as often as needed. When scheduling an Other Special Recurring Inspection, add a comment in the comment box explaining why you are doing the Other Special Recurring.

Accident Inspection

An accident inspection is a one-time non-recurring inspection that will be performed as necessary whenever a bridge is damaged or suspected of being damaged by vehicular or water traffic. If the event has not changed the condition of the structure, the inspection schedule should not change. The Inspector should include documentation in the report that the bridge was inspected and record any damage found. A particular awareness of the potential for litigation must be exercised in the documentation of damage inspections. Since an Accident Inspection is not recurring, it **will not** be coded under the (NBI) 92C as an Other Special Inspection.

For an over-height bridge strike, photos along the beam are required to show any displacement. If beam displacement exists, document by the use of a string line along the beam. A hands-on inspection is required. Up-close images of the flange, web, and any other damage shall be taken to discern if there are any cracks or tears.

Also, if the damage was extreme enough to cause a load restriction on the bridge, a follow-up Special Inspection should be performed after the repairs have been completed. After this, the Rating Section should be notified that a special inspection noting the repairs has been completed.

Scour POA Inspection

The Plan Of Action (POA) for a scour critical bridge should be attached in Asset Details/Asset Files/Scour tab.

If the POA calls for an inspection at a regular interval, that inspection should be coded as an Underwater Type 2 Inspection rather than a Scour POA Inspection. The Scour POA Inspection is a one-time unscheduled inspection (or documentation) that will be performed as necessary whenever directed by the scour plan of action after a triggering event. Requirements for the inspection can be found in the Scour Plan of Action.

The Scour POA Inspection was created to track when an action is taken based on the scour plan of action. The Event Monitoring Form that must be filled out to satisfy the scour POA should be scanned and attached to the **inspection report** in the Scour Tab located in the Pictures/Files. If it is a Local Bridge, then the form will be the only thing in the report, and a note should be made in the "Comments" section when creating the report. It should read "Documenting local action only."

If the inspection is documented as a Scour POA Inspection, then there is no need also to document it as an Underwater Type 2 inspection. A Scour POA Inspection **will not** be coded under the (NBI) 92C as an Other Special Inspection.

Bridge Scour Plan of Action(SPOA) - Event Monitoring Form

ARDOT Bridge No.: ______________________ **Route carried:** ______________________

Waterway crossed: ____

Description of data entered for the Scour Monitoring Event Report items below:
Inspected by: *(name of person who performed the action(s) identified in the POA)*
Date: *(date of bridge monitoring to perform actions identified in POA)*
Triggering event description: *(Significant rainfall that raises water elevation to "Q25" or "Bank full" level)*
High water: *(Q25 or approximate "Bank full" water surface elevation, reference mark)*
Action taken: *(description of actions performed at bridge; if accessible, for example: soundings taken, closed bridge, notified owner of action need, verified bridge stability…)*
Length of time out of service: *(if any…)*
Damage: *(approach washout, abutment or pier settlement, wing wall damage, if any …)*
Repairs: *(if any…)*
Repair cost(s): *(if any…)*
Opened to traffic: *(full, partial-one lane, load restrictions, emergency only …)*
Date opened: *(if closed…)* **Approved by:**

IMPORTANT: Place a copy of the completed/updated monitoring history document in the bridge file after each triggering event

Scour Monitoring Event Report

Inspected by:______________________________ **Date:**__________________________

Triggering event description:____

High water:____

Action taken:____

Length of time out of service:____

Damage:____

Repairs:____

Repair cost(s):____

Opened to traffic:____

Date opened:______________________ **Approved by:**___________________________

Special Inspection

This is a one-time unscheduled inspection that does not fit into one of the other inspection categories. It will be performed as necessary. The requirements for this inspection vary depending on the need for the inspection. This inspection **will not** be coded under the (NBI) 92C as an Other Special Inspection. When a special inspection is scheduled, there should be an explanation in the comment field explaining why it was performed.

Late Inspection Justification Requirements

Routine (NBI) 24 Month Frequency	<= 24[1]	25	26[2]
Extended Routine (NBI) 48 Month Frequency	<= 48	49	50
Fracture Critical	<= 24[1]	25	26[2]
Underwater (Dive)	<= 60	61	62
Note: A month is defined as a calendar month, not by days or weeks.	Inspection is completed before or in the month that it is due.	The late reason is approved by the Local Program Manager and documented in the late reason drop-down box of the ARDOT Agency Form.	The late reason is sent to FHWA for validation at least 10 days before the end of the 1st month past its due date. Approval from FHWA may be granted before the end of the 1st month past its due date and documented in the late reason drop-down box found on the ARDOT Agency Form.

[1] The 12 month **scheduled** frequency is Department policy and not required by NBIS; therefore, approval from FHWA is based on the NBIS requirement of 24 months.

[2] The Department policy is that no Routine (NBI) or Fracture Critical Inspection should exceed 27 months except those approved for an Extended Routine (NBI). If one of these inspections cannot be performed in this time frame due to construction, weather, equipment problems, etc., a modified Routine (NBI) or Fracture Critical Inspection should be conducted as thoroughly as possible, followed by a Special Inspection when possible to address those items not covered in the modified Routine (NBI) or Fracture Critical Inspection.

Extended Routine (NBI) Inspection Interval

Paragraph 650.305(c) of the NBIS states, "The maximum inspection interval may be increased for certain types or groups of bridges where past inspection reports and favorable experience and analysis justifies the increased interval of inspection. If a State proposes to inspect some bridges at greater than a two year interval, the State shall submit a detailed proposal and supporting data to the Federal Highway Administrator for approval." FHWA Technical Advisory T 5140.21 states that submissions to the FHWA requesting longer inspection intervals must contain the following information as a minimum:

(A) Structure type and description, age, load rating, condition and appraisal rating, the volume of traffic carried, ADTT, major maintenance or structural repairs performed within the last two years, and an assessment of the frequency and degree of overload that is anticipated on the structure.
(B) A discussion of failure experience, maintenance history, and latest inspection findings for the group of structures.
(C) The proposed inspection interval.

The approved extended NBI inspection interval meet the following criteria:

- Reinforced concrete box culverts built with contract design plans
- Inventory rating of 15 tons or greater
- ADT less than 50,000 vehicles per day
- Field condition rating factor (NBIS – Items 61 and 62) of 7 or greater (Indicating very minimal maintenance need)

The Routine (NBI) inspection frequency of 48 months can be maintained as long as the conditions conform to the listed criteria. Central Office maintains the list of approved bridges and periodically verifies that the bridges meet the listed criteria. No additional bridges can be added to the group without approval.

Numbering Bents, Spans, Beams, etc.

If plans are available, the bents and spans shall be numbered as on the plans. When plans are not available, bents and spans shall be numbered in the report in the direction of the log mile. Beams shall be numbered as on the plans. If no plans are available, beams shall be numbered left to right looking in the direction of the log mile.

Mechanically Stabilized Earth (MSE) Walls

Mechanically Stabilized Earth (MSE) walls that function as a bridge abutment shall be inspected by the bridge inspector. The inspection will include the first 50 feet of an MSE wall perpendicular to the end of the bridge and the transverse portion under the bridge. Material leaching through the joints in the wall, vegetation growing through joints in the wall, and any differential settlement should be noted in the report.

Replacement of Bridges by Non-Bridge Length Structures

When a bridge length structure currently on the bridge inventory is replaced by a non-bridge length structure or is removed and not replaced, send an email or memo to the Bridge Inventory section with a copy to the Heavy Bridge Maintenance Section requesting it be removed with an explanation of the situation.

Chapter 3: InspectX Software

Inventory

Dashboard **-** Dashboards on each tab provide a general visual overview of the tabular data found in the list sections of each module in inspectX.

List – use the list to show bridges in excel format. To add or delete columns – click on the three dots on the column headers and select columns to add or delete. To export the list to excel, click the excel icon in the upper right-hand corner. Sort the list by clicking on the column headers.

Map – the map displays the x/y coordinates in NBI 16 and 17 of the bridges that meet the filter's criteria. All will show if no filter is applied. To export results to the map, click the google earth icon in the upper right-hand corner. This will download a .kml file which can be used within google earth, google maps, or maps. Maps.me is a very good app for offline navigation. It will let you add as many points to the map as you want. Unlike google maps, maps.me app will show all the points even if you don't have data.
Filters – are the inspectX version of a Query. Saved filters can be set to visible by individuals or by the public. Saved filter criteria can't currently be viewed.

Elements **-** The elements section shows the elements on the bridges for whatever filter is applied. The quantities and corresponding percentages are displayed for each element. These elements can be exported to Excel for further analysis. HBM has database queries set up to look for certain defects. For information pertaining to specific defects, contact HBM.

Schedule

The Schedule tab at the top next to the inventory tab is being worked on. After HBM finishes cleaning up inspection data, this tab will be handy. This tab will show which bridges are overdue in terms of NBI overdue. The summary for the schedule tab shows the scheduled dates for Routine, Underwater, F.C., and Special inspections.

Inspection

<u>Asset Files – attach files under “Files”</u>

<u>Asset Fracture Critical:</u>

- Fracture Critical Procedure (word)
- Fracture Critical Drawing (pdf and dgn)
- Fracture Reference Photo (any photo file)
- Blank Fracture Critical Inspection Report (word)
- Blank Pin Document (If Fracture Critical Member) (word)

<u>Asset Plans:</u>

- Combine all layout and cross-section drawings as a single PDF in accordance with the File Naming Convention section.
- Insp_Sketch_[structnum]_[date] (this is for inspector produced drawings when plans are not available. They shall be saved in the same dgn and pdf files).

<u>Asset Sketch:</u>

- Underwater Type 2 (dgn)
    - Combine to show multiple profiles (from separate inspections)
- Underclearance (dgn and pdf)
    - Most current
- Most updated grid deck drawing

<u>Asset Other Files:</u>

- Lanes Log Lane Closure
- Pin Document (If Not Fracture Critical Member)
- AHP Request form

<u>Report Files – attach files under “Report Files”</u>

<u>Fracture Critical Report:</u>

- Fracture Critical Inspection Report (PDF)
    - Combine current procedure, drawings, and pin document into the the pdf.

<u>Report Sketch:</u>

- Underclearance Drawing (pdf)
- Most updated grid deck drawing
- Underwater Type 2 (PDF)

<u>Report Other Files:</u>

- Pin Document (If Not Fracture Critical) (PDF)

Note: Underwater type 2 drawings should be combined and placed under the asset files to identify a trend. The latest drawing should be placed under the inspection report files. Blank documents should be saved in word; completed documents should be saved in pdf format.

File Naming Convention

File Common Name	**Description**	**Bridge Inspection Naming Convention Template**	**File Type Required**
Fracture Critical Procedure	Detailed document involving all FC details of inspection	FC_Proc_[structnum]_[date]	.doc or .pdf
Fracture Critical Drawing	MicroStation drawing of all FC members depicted in RED	FC_Plans_[structnum]_[date]	.dgn
Fracture Critical Reference Photo	Photos of FC members for reference	FC_Ref_Img_[structnum]_[date]	.jpg or .png
Blank Fracture Critical Inspection Report	Document template prepared for next inspection	FC_Insp_[structnum]_BLANK	.doc
Completed Pin Document	Completed Pin Document from inspection	Pin_Doc_[structnum]_[date]	.doc
Blank Pin Document	Blank Pin Document prepared for next inspection	Pin_Doc_[structnum]_BLANK	.doc
Design Plans/Drawings	Combine all plans as 1 .pdf	Struct_Plans_[structnum]_[date]	.pdf
Reconstruction Plans	Combine all reconstruction plans as 1 pdf.	Recon_Plans_[structnum]_[date]	.pdf
Inspector's Bridge Sketch	Drawing when plans not available	Insp_Sketch_[structnum]_[date]	.dgn
Channel profile drawing/sketch	MicroStation drawing of channel cross sections and substructure elements	Chan_Prof_[structnum]_[date]	.dgn
Under clearance drawings/sketch	MicroStation drawing of vertical and horizontal clearances	URC_Sketch_[structnum]_[date]	.dgn
Grid Deck Drawing	If applicable: MicroStation drawing depicting grid deck layout.	GridDeck_[structnum]_[date]	.dgn
Saved email coorespondance	Saved email coorespondance related to bridge inspection or asset	Email_[structnum]_[date]	.eml
Underwater Inspection Procedure	NBI Underwater Inspection Procedure document	UWI_Pro_[structnum]_[date]	.pdf
Repair Drawing/Detail	Documentation of drawings of repair done.	Repair_[Type]_[structnum]_[date]	.pdf or .dgn

Other	Description of other in inspectX	Description_[structnum]_[date]	Any

- Free pdf combiner: https://www.adobe.com/acrobat/online/merge-pdf.html
- Date format - use NBI format: YYYYMMDD
- Example: the fracture critical procedure for bridge 05050 done March 18th 2022 could be: FC_Proc_05050_20220318.pdf

Photo Assignments

Type of Photo	**Where to Attach In InspectX**
Inventory (roadway)	Inspection Direction
Elevation	General Observation – assign photo to "cover photo" in inspectX camera role.
Load Posting Signs	NBI 41 Posting
Typical Deck	NBI 58 Deck
Typical soffit/under the surface	NBI 58 Deck
Fracture Critical photos	Put in fracture critical procedure and attach to the asset. Attach photos to their relative location. Photos of two girder system – attach to super.
All others	Assign to the same item that you normally do. All photos will have to have a photo assignment to be included in the report. If you have a photo that does not fit as an NBI, Element, Defect, or Maintenance, assign the photo to the General Observation.

Maintenance

- To view maintenance items, do one of two things:
  - Jump to structure, then click on maintenance, click the eye.
  - Click on the large maintenance title at the top – filter for maintenance items and view from this page.
- A maintenance item cannot be assigned to particular user.

Maintenance Items Operation

i. The Construction Engineer (local program manager) needs to be the Engineer that looks at all "open" maintenance items.
   a. Go to maintenance
   b. Filter status for "open"
   c. This is the entire list that the construction engineer needs to look at and change the status.

ii. Construction Engineer – within this list, click on the structure number to go to the asset, click on the asset maintenance tab, click the eye, click edit. Construction Engineer needs to be involved with Maintenance Items on bridges.

   a. Change status to forward state
   b. Change priority if needed
   c. Add comments if needed

iii. Maintenance Engineer – Filter for the status of "forward State"

   a. Change status to either "monitor" or "assign"
   b. Change priority if needed
   c. Add comments if needed
   d. Most items would be monitor. Assign only if you plan to do the work.

iv. DCE or DME or others can change status from monitor and assign to repair documented

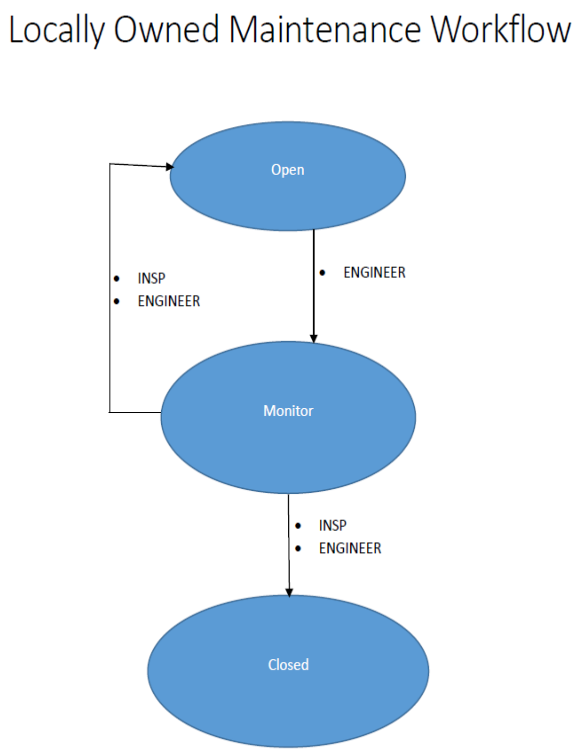
   a. Add comments and photos
   b. Enter date completed.

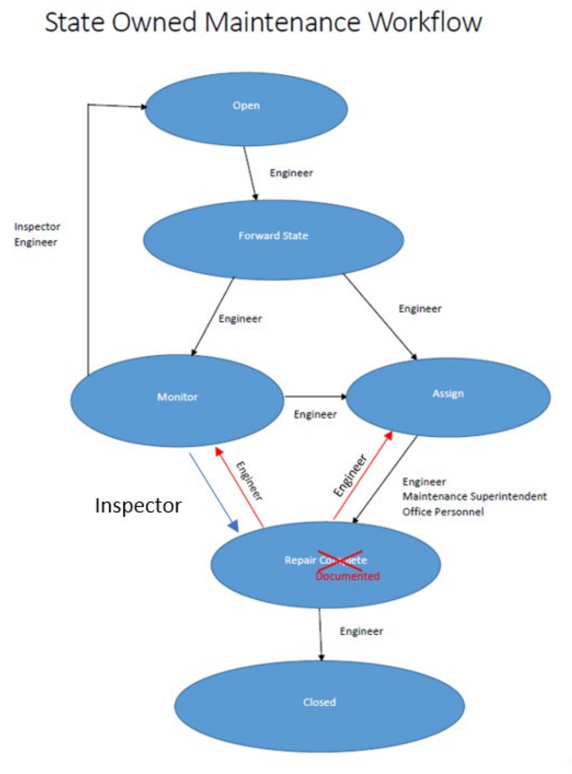
v. DCE/DME can change status from repair documented to closed or back to open.

Notes

- Locally owned bridges just have the status of open, monitor, and closed.
- "forward state" does not mean it is forwarding like an email
- Refer to the attached images for complete workflow capabilities.
- While DCE and DME have specific intended roles, they have the same permissions so that they have a backup (in case one is on vacation, switches job, or needs assistance)
- New Funcitonality of 2022: inspectors can choose drop down to request load rating to review the structure.
    - This generates an automatic email the next business day to load rating.

Maintenance WorkFlows





Draw

The draw feature in both the desktop and iPad application can be used to draw and annotate on a picture and save it as a picture or a file on a bridge or an inspection.

<u>Inspection in the Field with inspectX:</u>

- Put under water type II notes in the NBI 61 notes.
- For new structures – open up an inspection -> go to inventory tab at the top -> scroll to the very bottom category -> enter each of the fields you are responsible for.
- For Inspection Direction: enter "S to N," "N to S," "E to W," or "W to E."
- Values that do not change do not need to be entered in again.
    - Previous values will carry over
- NBI items 90, 91, 92/93 A,B,C
    - The values are automatic within InspectX
    - NBI 92 frequencies are based on the frequency that is in the schedule.
        - Make sure to list Routine and Fracture Critical inspections are set to the actual scheduled frequencies of ARDOT inspections.
        - For Other Special Recurring: refer to frequencies of inspections for information on which frequency to set.
- Under Records: All information in the InspectX under records pertains to the Under Route (U).
    - There is not information stored here any longer for the On Structure (O).
    - Please verify item 5A for each under record is correct. They should be lettered in order they appear (top down) in inspectX. If only 1 under record is present, code as "2".

- Scheduling a bridge:
  - List the team's inspector as the Team Leader
  - List the team's inspector and assistant inspector as the "Inspector"
  - List the team's inspector and assistant inspector as the "Reviewer"
  - This might not be how it is when it is carried over from InspectTech
  - You will have to add other names to the inspection roles
  - Pay attention and choose the correct frequency
  - Pay attention and choose the correct inspection type and element/NBI only
- To make any changes to an approved inspection:
  - Schedule an asset for a "Record Change" inspection
  - Perform necessary changes and approve.
  - Just need the person making the changes as the team lead, inspector, reviewer listed.
- Deck Width Vs. Out-to-Out:
  - These are the same thing. Item 52 is Deck Width, Out to out
- Maintenance:
  - When you create a maintenance item, write the comments in the deficiencies.
    - When changes are made to the status – put comments in the comments box
  - Assign all maintenance items to a component on the bridge
    - Posting problems – type of work: posting issue – component: approach
- Passwords:
  - For the initial use of inspectX, the password/login information will not be the same as your ArDOT login.
  - Use the one you have set up with it right now.
    - Default is "Password@123"
  - I will send out info when this changes to the ArDOT login.

Chapter 4: Restrictions

<u>Serviceability</u>

When it is apparent that a critical aspect of a bridge is not functioning as designed or jeopardizes the structural capacity and has an appraisal of “Poor” and the basic condition factor guidelines do not adequately cover the situation, the District Bridge Inspection Engineer (District Construction Engineer), or an Engineer from Heavy Bridge Maintenance, or an Engineer from the Bridge Inventory and Rating Section should be consulted. If the assessment warrants a condition rating other than that reflected by the condition guidelines, this should be explained in the comments area using the Engineer’s name.

When the appraisal for a critical aspect of a bridge is “Poor,” the condition rating for Item 58, 59, or 60 should be “4” or less. Element conditions should also be changed to coincide with Item 58, 59, or 60.

Examples for this situation would be:

A reinforced concrete slab bridge on pile bents is in basically good condition, but the spans are sliding off the caps (losing bearing area), and the bents have a definite lean.

A continuous steel girder bridge is in good condition, but the steel bearings are sliding off the end bent cap.

Concrete pile bents are in good condition but are leaning or greatly out of plumb.

<u>Bridge Closures</u>

Any structure that cannot carry a minimum live load of 3 tons is recommended for closure. The following procedures will be used for notification immediately after the structure has been determined to be recommended for closure.

<u>Bridge Closure for Non-State Owned Bridges</u>

A. If the inspection reveals a dangerous situation that the inspector is sure that it requires immediate closing, he should:

   1. As able, restrict access to the bridge and inform the traveling public of the danger.
   2. <u>Immediately</u> notify the owner and local law enforcement that the bridge should be closed and notify the District Construction Engineer (DCE).
   3. The DCE will:
      a. <u>Immediately</u> investigate the need to close the bridge.
      b. <u>Promptly</u> notify the owner and the local law enforcement of his findings and whether the bridge should remain closed.
      c. <u>Promptly</u> provide the inspection report and other appropriate information to the Bridge Division.
   4. Bridge Division will <u>promptly</u> send by certified mail official notification letters to the owner.

B. If an inspection reveals a dangerous situation, but the inspector is not sure immediate closing is required, he should:

1. Immediately notify the District Construction Engineer (DCE).
2. The DCE will:
    a. Immediately investigate the need to close the bridge.
    b. If bridge closing is required, immediately as able, restrict access to the bridge and notify the owner and the local law enforcement of the need to close the bridge.
    c. Promptly provide the inspection report and other appropriate information to the Bridge Division.
3. Bridge Division will promptly send by certified mail official notification letters to the owner.

C. If the Rating Section of Bridge Division determines by load analysis that a bridge should be closed, the following steps should be taken:

1. Bridge Division will:
    a. Send by certified mail official notification letters to the owner.
    b. Inform the DCE by telephone.
2. The DCE will make prompt, verbal notification to the owner.

If the local owner has not closed the bridge within two business days of being notified of the need for closure, an Administration Official (Assistant Chief or higher) of the ARDOT will directly contact the local owner to persuade the owner to comply with the bridge closure immediately.

Bridge Closure for State-Owned Bridges

A. If an inspection reveals a dangerous situation that the inspector is sure requires immediate closing, he should:

1. As able, restrict access to the bridge. Inform the traveling public of the danger.
2. Request assistance from the local maintenance yard to properly close the bridge.
3. Immediately inform the District Engineer (DE) or the DCE.

B. If an inspection reveals a dangerous situation that the inspector is not sure requires closing, he should immediately inform the DE or the DCE.

C. If the Rating Section of Bridge Division determines by load analysis that a bridge should be closed, the Rating Section should immediately inform the Bridge Engineer and the DE or the DCE that immediate closure is required.

Abandonment of Bridges by Local Governments

According to 23 U.S.C. 101(a) (21), The term public road means "any road or street under the jurisdiction of and maintained by a public authority and open to public travel." As such, the public authority has a responsibility to maintain any bridge that the public can traverse. To remove a bridge from the local inventory, the public authority must provide certification to the District Construction Engineer of one of the following:

- The ownership and responsibility have been transferred to another public authority.
- The owner must maintain restricted access to the structure so that the public may not traverse the structure.
- The road is not open to public access.

Posting for State-Owned Bridges

The District Maintenance Engineer shall see that all posting issues for state-owned bridges in their respective Districts are addressed within 30 days of notification.

A report of current load posting requirements for all State-owned bridges by the District will be generated by the Bridge Rating Section for quarterly documentation. This list will include all of the bridges that require posting and their current posting status. The bridges requiring attention will be highlighted. This report will be sent to the District Construction Engineers via email and posted on the ARDOT drive: \\csd4\Room 901(DRB)\StateQtrBIWLReports.

This information will also be used to update the Bridge Restrictions Map located on the ARDOT web page by the Staff Structures Engineer or his designate.

The District Area Maintenance Supervisors are responsible for verifying that all signs are in place as shown on the quarterly load posting report. The Area Maintenance Supervisor will submit a Monthly Verification of Bridge Weight Limit Signs form to the District Maintenance Engineer by the 15th of each month. The District will submit the completed forms to the Bridge Rating Section as documentation of compliance regarding posting. The Bridge Rating Section will review the monthly forms received from each District and confirm that the InspectX database has been updated as required.

Between quarterly reports, if the recommended posting for a bridge decreases or the structure requires posting for the first time as a result of a load rating analysis, the Bridge Rating Section will notify the State Program Manager, Staff Structures Engineer, District Maintenance Engineer, District Construction Engineer, and Bridge Inspectors via email. The email shall convey the reason for the posting change. The Construction Engineer will see that a maintenance item in InspectX is updated or created as needed.

Posting for Non-State Owned Bridges

The Bridge Rating Section will send a Weight Limit Posting Certification document to the Local Owners for the posting requirements by October 1st. This document serves as yearly documentation of posting status. The document will provide a list of all bridges specific to the local Owner and the posting requirements for those bridges according to current information in the InspectX database. The Weight Limit Posting Certification document is described further in the current issue of "Local Government Procedures for Compliance with the National Bridge Inspection Standards," prepared and distributed by the ARDOT.

Verification of posting and requisition of materials for posting are detailed in the publication "Local Government Procedures for Compliance with the National Bridge Inspection Standards." The yearly documentation of verification and posting of locally owned bridges shall be submitted by the Local Owners to the respective District by December 31 and forwarded to the Bridge Rating Section. The Bridge Rating Section will use this annual verification from the Local Owners to update the Asset on the InspectX database, and the Districts will update the corresponding Maintenance Items.

A local bridge that should be posted for 15 tons or less and is missing posting numbers or is posted too high should be addressed within one month of notification. Posting issues that are over 15 tons should be addressed within two months of notification. The bridge owner will be promptly notified verbally and with an official notification by either certified mail or email marked delivery receipt. In addition, the local owner will receive an automated email notice on the 15th of each month of this posting issue from the inspection software until the owner has verified completion and it has been documented completed in the corresponding Maintenance Item. The District Construction Engineer, State Program Manager, Staff Structures Engineer, and the FHWA Bridge Engineer will also receive an email of all posting issues. The email shall convey the reason for the posting change. The Chief Legal Counsel of the Association of Arkansas Counties (AAC) will receive an email report of county posting issues when help is required for compliance.

The District Construction Engineer shall review the email notifications for local bridges. If any posting issue has passed the required timeframe to be addressed, the District Construction Engineer shall contact the Local Owner by phone to discuss the safety concern, and a resolution plan shall be worked out. If a posting issue has passed its required timeframe of action by two months or more, the State Program Manager will confer with the Assistant Chief of Operations for assistance in resolving the posting issue. The Chief Legal Counsel of the AAC shall be included in consultation for those issues involving counties.

When a bridge is found to have a weight posting safety issue during a bridge inspection, the District Bridge Inspection staff will send a Maintenance Needs Report to inform the Owner of the deficiency within one week of the inspection. The District Inspection Staff shall instruct the Owner to submit a Form VIII as documentation that the posting has been corrected. The Owner shall also be encouraged to include dated photographs showing legal signs at both ends of the bridge. The Department will accept verbal, a returned Form VIII or email notification from the Owner as documentation of completed posting. The date and means of notification shall be recorded in the bridge inspection software.

Upon written notification (Form VIII or other) by the Owner of a structural change or the addition or the removal of a bridge from their inventory, ARDOT will inspect the bridge if deemed necessary for an inventory update.

Between annual certifications, if the inspection frequency of a bridge changes or the recommended posting for a bridge decreases or the structure requires posting for the first time as a result of a load rating analysis, the Bridge Rating Section will notify the District Construction Engineer and the District Bridge Inspectors via electronic mail. The District Construction Engineer will notify the Owner by telephone and by letter. Someone from the inspection team will add it to the Maintenance items and adjust schedule frequency as needed for that bridge. If a posting change requires a change in the current posting, the District Construction Engineer shall notify the Local Owner by letter and include the required posting numerals and a filled out Form IX to be signed and returned. In addition to the annual certifications, all weight-posted bridges will be required to be inspected at least annually, and photographs taken to verify the posting status. The Public shall be kept aware of the posting status of locally owned bridges. This will be accomplished by the Department maintaining an up-to-date map showing all locally owned posted bridges. This will be made available to the public through the web portal www.idrivearkansas.com.

Tracking of Bridge Weight Posting Issues

The HBM Section shall track all bridge weight posting issues. This tracking will be used to ensure that follow-up with the Owner is completed and documented for those issues more than 2 months past the required timeframe of action.

Weight Limit Signs General Information

ARKANSAS HIGHWAY & TRANSPORTATION DEPT.

BRIDGE DIVISION

VERIFICATIONS OF BRIDGE WEIGHT LIMIT SIGNS

Inspected By J.P. Jones

Date of Inspection 6-15-04

Sheet 1 of 3

County Little River

Dist. No. 3

LOCATION RT.-SEC.-LOG	BRIDGE NO.	TYPE OF SIGN—WT. IN TONS: I (TRUCK CODE; WEIGHT LIMIT 4 — 11T, 9 — 17T, 5 — 21T) 4	I 9	I 5	II (WEIGHT LIMIT 4 TONS)	NO. SIGNS IN PLACE	REPLACEMENT MADE BY & DATE	COMMENTS
233-1-2.22	M3426	13	18	21	—	2		
233-1-4.22	M3542	—	29	33	—	2		
233-2-8.62	4210	—	—	34	—	2		
249-0-2.42	M2110	—	—	—	4	1	JPJ 6-22-04	3 signs in 2 months

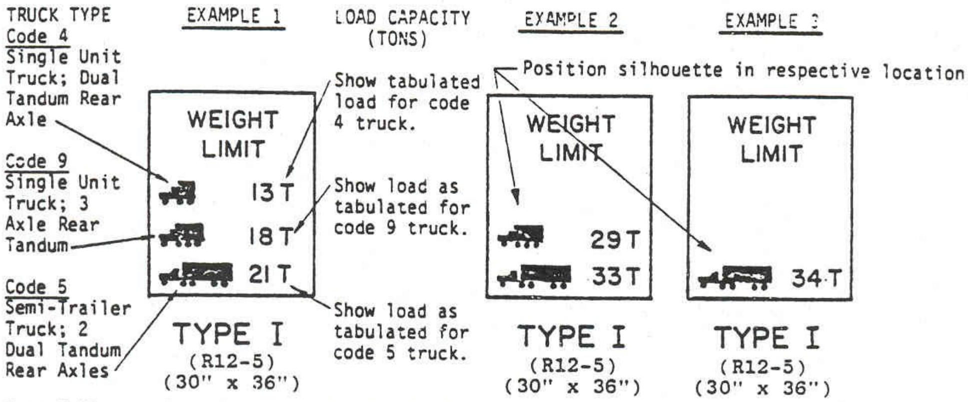
EXAMPLE

NOTE: VERIFY WEIGHT LIMIT SIGNS IN PLACE. REPORT TO BE SUBMITTED BY AREA FOREMAN TO THE MAINTENANCE SUPERINTENDENT BY THE 15 th OF EACH MONTH.

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

STANDARD WEIGHT LIMIT SIGNS FOR BRIDGE POSTING

TYPES AND EXAMPLES OF WEIGHT LIMIT SIGNS



Type I Sign - To be used for bridges when load carrying capacity is less than legal limit for one or more truck types.

*Note: Minimum posting for any bridge shall be 3 tons. Bridge warrants closing if the weight limit is less than 3 tons.

EXAMPLES SHOWING APPLICATION OF TABULATED LOAD CAPACITY

EXAMPLE	STATUS OF TRUCKS RESTRICTED ON BRIDGE	SAFE LOAD CAPACITY CODE	TABULATED LOAD CAPACITY*	POST BRIDGE FOR	SIGN TYPE
No. 1	All less than legal limit	3	413,918,521	413,918,521	I
No. 2	One single unit & semi-trailer	4	424,929,533	929,533	I
No. 3	One semi-trailer truck	4	425,931,534	534	I

Note: If safe load capacity code is 4 or less, bridge will not carry legal loaded truck(s) and is to be posted for the respective truck(s). See page 1.48 for maximum legal load operating vehicles governing load rating of bridge structures.

*EXPLANATION OF TABULATED LOAD CAPACITY

	CODE	TONS	
Code 4 Truck 4=Dual Tandem Axle Truck	4	13	13=Gross Load of 13 Tons Allowed on Bridge
Code 9 Truck 9=Triaxle Rear Tandum Tr'k.	9	18	18=Gross Load of 18 Tons Allowed on Bridge
Code 5 Truck 5=Semi-Trailer Truck	5	21	21=Gross Load of 21 Tons Allowed on Bridge

MAXIMUM LEGAL LIMITS

TRUCK CODE		TONS
4		22
9		31
5		40

GENERAL APPLICATION OF WEIGHT LIMIT SIGNS
MAINTENANCE DIVISION
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

DRAWING NO. BM 420

Chapter 5: Maintenance Needs

Maintenance Module

The Maintenance Module is a component of InspectX that functions outside of the Collector Module so that repair work and/or comments concerning a maintenance need can be documented after the inspection report has been approved and locked from editing. The maintenance needs stored in the Maintenance Module are required to describe the condition of a bridge adequately and may be included whenever a printed inspection report is required.

Please note: InspectX maintenance needs will not update the bridge page until the inspection that contains the maintenance need has been approved.

Inspector Workflow for Maintenance Needs

When adding a new maintenance item on the IPad, set the required fields: Date, Priority, and Description, and attach any photos you may have taken. The item(s) will be uploaded when you upload the inspection report.

An old maintenance item that is not completed will be downloaded to the IPad when the asset is downloaded. Each maintenance item should be checked to see if the condition has changed. If changes are observed, the Description, Date, and Priority should be updated, and any needed photos taken. If the item's priority has increased, the workflow must be changed to "Open" after the inspection report is uploaded so that the DCE can "Review" the item again. Do not change the workflow unless the priority has increased or there is no longer a maintenance need for the item or unless you would like the DCE/DME to review the maintenance item again.

If you observe an item on a state bridge that has been completed, note it in the Maintenance Comments box and set the Date Repairs Completed box. Use the date you inspected or were notified if the actual date is unknown. The program is set up so that Inspectors cannot set State items to complete because an Engineer is required to sign off on the repair work for state bridges. This item will show up in the "State – Repair Complete Approval Required" filter that the DME should periodically check.

If the Bridge Inspector observes or is notified that an item on a local bridge has been completed, note the work done in the Work Description box and set the Date Repairs Completed box. Use the date you inspected or were notified if the actual date is unknown. Note in the Maintenance Comments box how the determination was made the repairs were completed (observation, the notification from the owner, etc.). Set the Workflow Stage to "Completed." Either the Inspection Team or Engineer may set a local bridge to "Completed."

To view all the pictures for a Maintenance Item, you will need to look in the Rollup View, located at the bottom of the Maintenance Item as the edit icon.

The following headings make up the main Maintenance Item form:

- Date Reported – The date the Maintenance Item was created or changed.
- Priority – The ranking of the significance of the Maintenance Item.

- Type of work – Used to identify Posting safety issues and tracking of preservation activities by Central Office.
- Component – part of the bridge that the maintenance need is associated with.
- Deficiency Description – Describe the location of deficiency and a description of it.
- Work Description – Describe how the deficiency was repaired.
- Date Repairs Completed – The date the repairs were completed or, if not known, the date when repairs were observed or District was notified.
- Maintenance Comments – Any additional comments that do not fit other note areas.

Priority Codes

CF = Critical Finding; action goal of 2 weeks
A = Safety Deficiency; requires prompt action
B = Pressing; within 6 months
C = Important; within 12 months
D = Routine; within 24 months
G = General/Preventive Maintenance

Critical Findings

All critical findings should have an updated picture(s) at each inspection. Conditions that constitute a critical finding include, but are not limited to the following:

Condition of Critical Finding	**Typically found by**
A partial or complete collapse of the bridge	Inspection
Structural or other defects that pose a definite and immediate public safety hazard	Inspection
A load rating of less than 3 Tons	Load Rating
Bridge not completely closed, but closure is required	Inspection
A scour analysis results in a Scour Critical Item 113 of $\leq$ 2	Scour Assessment
The bridge is open and a condition rating of 2 or less for any of the following Items: • Deck, Item 58 • Superstructure, Item 59 • Substructure, Item 60 • Culvert, Item 62 • Channel and Channel Protection, Item 61	Inspection

To record a critical finding, the Inspector would enter it into the Maintenance Needs describing both the critical finding and its location. It would be assigned a "CF" priority which should normally be addressed in some way within two weeks. This does not mean that the repair must be completed in that time frame, but some action such as scheduling a repair action or requiring additional monitoring is required. The District

Construction Engineer may adjust the “CF” timeframe as necessary depending on the severity of the critical finding.

When the critical finding has been entered into the database, it is subject to review by the District Construction Engineer. Once the District Construction Engineer agrees with the Bridge Inspector’s recommendation, it is marked reviewed in the software and becomes “active.” If the “CF” priority could warrant a change in the load posting, the District Construction Engineer shall immediately send an email to Bridge Division, Rating Section, for further analysis. If the finding necessitates a reduced load rating, the Rating Section will immediately notify the District, who will then address it if it is a state bridge or forward on to the local bridge owner. A critical finding should be looked at intervals not exceeding 12 months. This can be achieved with a special inspection.

It shall be the responsibility of the District Maintenance Engineer to see that all “CF” priorities on state bridges are assigned, and the assignment noted in the inspection software. The District Maintenance Engineer will follow the progress of the State “CF” priority to its completion and see that corrective actions are entered into the inspection software. For bridges inspected by the state-wide Bridge Inspector, the District Maintenance Engineer's duties shall be fulfilled by the Staff Heavy Bridge Maintenance Engineer.

If a “CF” priority involves a locally owned bridge, the bridge owner will be promptly notified verbally and with an official notification letter by certified mail or email marked delivery receipt. In addition, the local owner shall receive an email Maintenance Needs report generated from the inspection software every month until recorded complete in the inspection software. For that reason, the Bridge Inspector shall verify that an owner email has been entered into the inspection software under the ARDOT Agency Form.

After taking action on City/County bridges, local governments shall complete the Maintenance Needs report (or Form VIII) and submit it to the District. The District Construction Engineer shall see to it that returned information is entered into the database. The Form VIII will be scanned and attached to one of the Maintenance Items that were completed. If the local owner reports the critical finding completed, the complete date should be filled in, and the Maintenance Item should be marked completed in the software. Any action the owner reported should also be included in the note for the Maintenance Item**. If a posting issue is reported complete, Item 41 needs to be updated with a record change inspection.** Attachments notes for Maintenance Needs and completion date must be entered before the workflow is marked complete. Once a Maintenance Need is marked complete, you cannot perform any other action to the Maintenance Need.

All critical findings (State and Local) shall have remarks in the “Maintenance Comments” within two weeks of becoming active. This could include an assignment of a crew or noting where the local owner has been informed.

All critical findings shall be monitored and tracked by the Heavy Bridge Maintenance Section. An Engineer shall review each critical finding and document the review in the Maintenance Comments field of the Maintenance Need. If the item is not deemed an actual critical finding, it shall be reclassified as another priority.

Priority Code A
Safety deficiency; requires prompt action.

This priority code is for deficiencies that should be prioritized and scheduled for prompt action. Examples would be joint steel broken and projecting into traffic; navigational lighting out or damaged; the failure of one interior timber beam in a system of 6 beams; one failed interior pile in a four pile system; and missing posting sign. The inspector should notify the owner as soon as possible. Pictures of "A" priorities should always be taken and attached to the Maintenance Need.

Priority Code B
Important; 6-month completion goal.

This priority code is for deficiencies that should be prioritized and scheduled for a 6-month completion goal. Examples would be: potholes developing in the bridge deck; posting signs that need improvement but are still legible; bracing members that require replacing, or a crack developing at the end of a steel cover plate in a multi-beam system. If a deficiency could transition to a safety deficiency if unattended beyond 6 months, then the deficiency should be completed within 6 months. Pictures of "B" priorities should always be taken and attached to the Maintenance Need.

Priority Code C
Routine; within 12 months.

This priority code is for deficiencies that should be prioritized and scheduled within the next 12 months. Examples would be damaged bridge railing, removing drift build-up from piers, minor bolts missing in a primary member, and a timber deck with a few deteriorated timbers.

Priority Code D
Routine; within 24 months.

This priority code is for deficiencies that can be scheduled for repairs within the next 24 months. Examples would be minor potholes, bridge railing that needs reattachment, beam-ends rusted through at non-critical locations, repairing leaking joints, cleaning out drains, and vegetation removal from channel.

Priority Code G
General/Preventive maintenance.

This priority code is for general maintenance that can be scheduled as the workload permits. Examples of this type of work would be: cleaning bridge decks, washing down bent caps, and painting steel beams.

The examples above and below are not meant to cover all situations and be all-inclusive but are only meant to be illustrations. The inspector should use his best judgment to set priority.

Maintenance Needs for Bridge Weight Postings

Bridge weight postings that do not convey the needed safety warning to the traveling public shall receive an "A" priority code. An "A" priority would include missing posting signs, unreadable posting signs, and postings that reflect a weight limit above the recommended posting. Other posting issues such as obscured but readable numerals or postings shall receive a "B" priority code. Postings that reflect a weight limit below the recommended postings may receive a “G” priority at the Inspector’s discretion since it is not considered a safety issue.

Vandalism of weight posting signs shall be documented in the Maintenance Items under the Work Code using the drop-down selection “Vandalism Problem.” Other weight posting issues that are a priority “A” or “B” shall use the drop-down selection “Other Posting Problem.” All weight limit posting issues of a safety nature shall have one of these two codes to satisfy FHWA requirements for tracking posting safety issues.

Additional Examples of Bridge Maintenance Needs and Associated Priority Codes

The following list is intended to provide typical examples of when bridge maintenance needs should be reported on the Bridge Maintenance Needs. The priority codes associated with each maintenance need item are for typical conditions; however, the bridge inspector may revise the priority as necessary to accommodate unusual situations. **The list is not intended as inclusive** but does serve as a guide for general classes of maintenance needs to be reported.

Priority	Approach Roadway
B-D	Approach Slab
C	Pavement Relief Jts.
C	Shoulders
D	Drainage - Off Bridge
B-C	Guide Rail
A-B	Safety Issues for Load Limit Signs
B	Missing Clearance ≥ 13’-6”
A	Missing Clearance < 13’-6”
B	Cut Brush To Clear Signs

Priority	Railing
B-D	Bridge/Parapet
B-D	Pedestrian
B-D	Median Barrier

Priority	Clean/Flush
G	Deck
D	Pedestrian
B-D	Bearing/Bearing Seat
B-D	Steel Horizontal Surfaces

Priority	Deck
B-D	Asphalt Wear Surface
CF-C	Timber Deck
CF-C	Concrete Deck
B-D	Concrete Sidewalk
B-D	Concrete Curb/Parapet

Priority	Painting
G	Superstructure - Spot
G	Substructure - Spot
D	Superstructure - Full
D	Substructure - Full

Priority	Deck Joints
A-D	Sliding Plate
A-D	Finger Joint
C-D	Compression Seal
C-D	Joint Sealant
A-D	Steel Extrusion
C-D	Other Types

Priority	Steel Superstructure
CF-C	Stringer
CF-C	Floorbeam
CF-C	Girder
C-D	Diaph/Lat Bracing
CF-C	Pin/Hanger

Priority	Timber Superstructure

Priority	Substructure

CF-C	Stringer
B-C	Other Members

Priority	Truss
CF-C	Member
C	Portal
CF-C	Member

Priority	Reinf Conc/Prestress
CF-D	Stringer
C-D	Diaphragm
B-D	Other Members

Priority	Bearings
B-D	Steel
B-D	Steel
B-D	Expansion
B-D	Pedestal/Seat
C-D	Lubricate

B-D	Abutments
B-D	Abutment Slopewall
C-D	Backwall
C-D	Wing
CF-B	Temporary Bent
CF-C	Piers
CF-C	Pile
C-D	Masonry
CF-C	Footing

Priority	Erosion Control
B-D	Vegetation/Debris
CF-C	Scour Hole
B-D	Deposition
B-D	Rock Protection
C-D	Stream Deflector

Priority	Culvert
C-D	Headwall/Wings
C-D	Apron/Cutoff Wall
B-C	Barrel

NBIS Form VIII Guidelines

After repairs have been performed on City/County bridges, local governments shall complete Form VIII and submit it to the District to update the Maintenance Item(s). The Form VIII should be linked to one of the completed items before being marked Completed and locked from changes. If the returned Form VIII indicates that major structural repairs have been performed, a new "Special" inspection will be required.

Rev., 9/2017
NBIS-Form VIII

ARKANSAS' BRIDGE INSPECTION PROGRAM
FOR LOCAL GOVERNMENTS

Bridge Revisions Affecting Inventory Data

*** NOT FOR USE IN BRIDGE WEIGHT LIMIT SIGN REQUISITION OR CERTIFICATION ***

County or City Name: ______________________________ Official's Signature: ____

* Bridge Number	* Route Number or Name and Feature Under Bridge	Description of Work Performed	Date Work Performed	** Recommended Action (ARDOT Use Only)

* Refer to current "Bridge Inventory/Posting Certification" Report or other ARDOT notification (Maintenance Needs report, letter, etc...)

** Recommended Actions by ARDOT District Office:

1 = Schedule Bridge Inspection and update database with revised inspection data
2 = Work performed does not necessitate reinspection (No Further Action Taken)

PLEASE SUBMIT THE COMPLETED FORM PROMPTLY TO YOUR ARDOT DISTRICT CONSTRUCTION ENGINEER

Chapter 6: Steel Inspections

Steel Terminology

Fracture Critical Member – A fracture critical member (FCM) is a steel member in tension or with a tension element, whose failure would probably cause a portion of the entire bridge to collapse. Bridges that contain fracture critical members are fracture critical bridges.

Fatigue – Fatigue is the tendency of a member to fail at a stress level below its yield stress when subject to cyclical loading. Fatigue is the primary cause of failure in fracture critical members. Describing the process by which a member fails when subjected to fatigue is called failure mechanics.

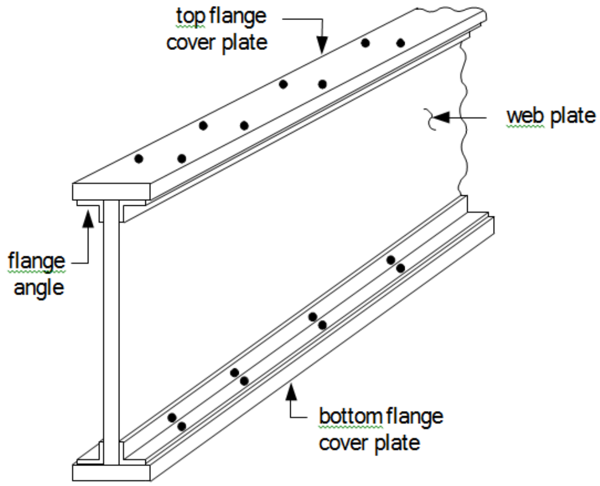
Redundancy – Redundancy is defined as a structural condition where there are more elements of support than are necessary for stability. Redundancy means that should a member or element fail, the load previously carried by the failed member will be redistributed to other members or elements. These other members have the capacity to carry additional load temporarily, and collapse of the structure may be avoided. On non-redundant structures, the redistribution of load may cause additional members also to fail, resulting in a partial or total collapse of the structure. There are three basic types of redundancy in bridge design:

- Load Path Redundancy
- Structural Redundancy
- Internal Redundancy

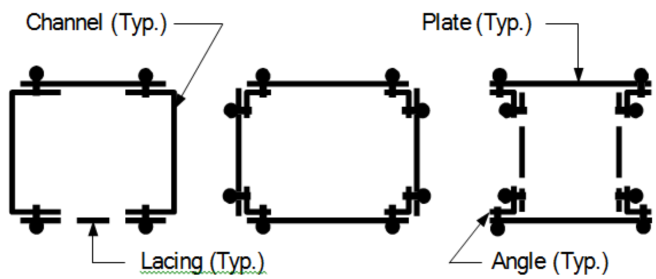
Load Path Redundancy – Bridge designs that have three or more main load-carrying members or load paths between supports are considered load path redundant. If one member were to fail, the bridge load would likely be redistributed to the other members, and bridge failure may not occur. An example of load path redundancy is a multi-girder bridge.

Structural Redundancy – Bridge designs that provide continuity of load path from span to span are referred to as structurally redundant. Continuous span arrangements consisting of three or more spans are considered structurally redundant. In the event of an interior member failure, loading from that span can be redistributed to the adjacent spans, and bridge failure may not occur. Continuous spans are structurally redundant except for the end spans, where the development of a fracture would effectively cause two hinges, one at the abutment and one at the fracture itself. This situation would lead to structural instability.

Internal Redundancy – Internal or member redundancy exists when a bridge member contains three or more elements that are mechanically fastened together so that multiple independent load paths are formed. Failure of one member element might not cause total failure of the member. Examples of internally redundant members are shown in the following figures.



Internally Redundant Riveted I-Beam



Internally Redundant Riveted Box Shapes

Internal redundancy of a member can be decreased or eliminated by repairs that involve welding. The welds provide paths for cracks to travel from one element to another

Bridge inspectors should be concerned primarily with **load path redundancy**. The inspector should neglect structural and internal redundancy and classify all bridges with less than three load paths as non-redundant. Non-redundant bridge configurations in tension contain fracture critical members.

Fracture Critical Procedure

A Fracture Critical Procedure is required for any bridge with a fracture critical member. It will be developed for each fracture critical bridge and attached in Asset Details/Asset Files. The Word document will include the following:

- A description of the fracture critical aspects of the structure
- Equipment and procedures required to access each fracture critical member
- Tools necessary for inspection, including any special equipment such as non-destructive testing devices.

Also, reference photos and a micro-station framing plan drawing or schematic labeling each fracture critical location shall be linked at the same location. An elevation view shall be included for trusses.

Upon completion of the Fracture Critical Inspection Procedure, the Inspector shall inform the Heavy Bridge Maintenance Section the procedure is available for review. An Engineer from the Heavy Bridge Maintenance Section shall verify that all fracture critical members have been identified and properly labeled. Once the procedure has been approved, the Engineer shall record the approval.

The Form III shall continue to be used to list all fracture critical elements, the inspection method used and the current condition factor at the time of inspection. The Form III shall be linked in the InspectX database under Picture/Files and Fracture Critical tab.

A complete list of all FC bridges will be maintained by the Central Office; this list will contain but not be limited to:

1. The bridge number, District, county, route, section, and logmile;
2. The method of inspection for each element.

All elements of FC bridges will be inspected by one or more of the methods of inspection listed below.

Visual Inspection

The most useful method of inspection is Hands-On Visual Inspection, where the inspector makes an up-close examination of each FC element. In most cases, this will require a mechanical lift system or ladder to get up close to examine the detail. A borescope can be used in examining obscured members, and a Lever Pit Gauge can be useful in estimating section loss. A keen eye is often the best tool for finding cracks. When cracks cycle open and close, the crack surfaces rub against each other, creating a fine steel powder that easily oxidizes when exposed to the environment. This often leads to rust staining, or discoloration, as the oxidized material bleeds from the cracks. This can offer quick visual detection of problem areas but should not be used as the sole means of detection. Experience has shown that cracks have generally propagated to a depth between one-fourth and one-half the plate thickness before the paint film is broken, permitting the oxide to form. This occurs because the paint is more flexible than the underlying steel.

Dye Penetrant Inspection

Dye Penetrant Inspection (DPI) effectively finds cracks that are open to the surface of steel elements. DPI method of examination should be used where it is suspected that a crack is present in an FC or Fracture Prone Element. DPI testing requires training in the use of the materials and surface preparation; its use is limited to suspicious areas.

A location where DPI will be useful is in examining ends of cover plates where rust stains are coming through the paint, or the paint is cracked, and a crack in the weld is suspect.

Dye penetrant is a three-part system applied to an area where a crack is suspected. Each component is usually contained in small, pressurized cans that can be easily transported in the field. The first step is cleaning/degreasing the area to remove surface contaminants; use a wire brush to remove heavy corrosion, but avoid grinding as it tends to smear out the crack. Then a liquid dye (commonly red in color) is sprayed onto the surface, and this dye seeps into the cracks. After a specified time (~60-90 seconds), the excess dye is wiped away from the surface. A white developer is then sprayed in the same area the dye was applied. The white developer then draws out the dye within the crack, clearly showing the crack.

Magnetic Particle Inspection

Magnetic Particle Inspection (MPI) effectively finds cracks that are open to the surface or below the surface of steel elements. MPI method of examination should be used where it is suspected that a crack is present in an FC or Fracture Prone Element. MPI testing requires training in the materials, equipment, and surface preparation; it also requires a considerable amount of time to take the test. Contact Heavy Bridge Maintenance if this test needs to be used.

A location where MPI will be useful is in examining ends of stiffener plates where rust stains are coming through the paint, or the paint is cracked, and a crack in the weld is suspect.

Ultra Sonic Inspection

This examination method requires the use of Ultrasonic Inspection (UT) test equipment to examine for cracks that cannot be seen with the eye. This examination method should be used where it is suspected that a crack is present in an FC element.

UT for flaw detection is a nondestructive method in which high-frequency acoustic waves are introduced into a material by a transducer placed on the surface. The acoustic wave propagates through the material and is reflected by discontinuities in the material. The transducer detects the reflected acoustic waves. The resulting waveform is analyzed to identify reflections that discontinuities in the material may cause. The technology can be used to detect weld flaws such as cracks, inclusions, weld porosity, or lack of fusion.

UT technology can be applied to truss members, steel girders, or other steel bridge components with a plate-like geometry (i.e., parallel surfaces). UT is often used for determining the thickness of a test member. Thickness gauges are commonly used for the detection of section loss resulting from corrosion in steel bridge members. UT technology can also be applied to in-service bridges to detect and monitor the following:

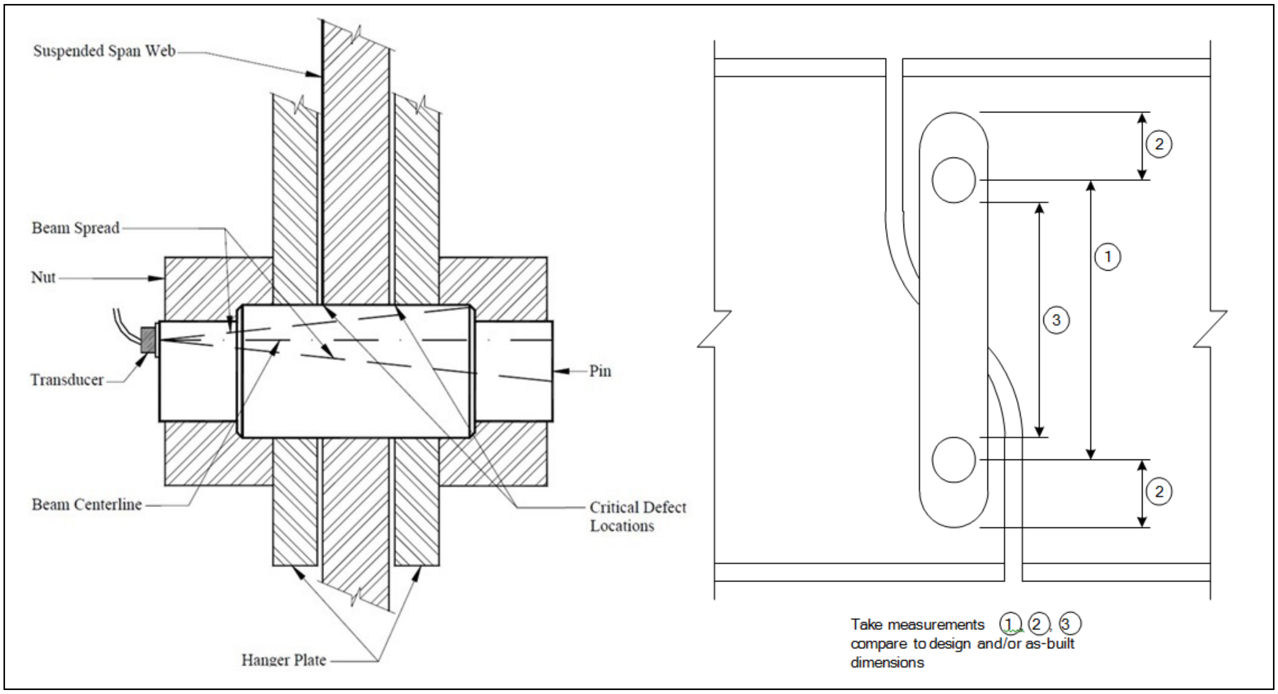
- Cracks in steel bridge members.
- Weld flaws such as cracks, slag inclusions, weld porosity, or lack of fusion in steel bridge members.
- Cracks in steel bridge components such as pins, hangers, and eyebars.
- Fractured anchor bolts.
- The thickness of a steel plate.
- Length of a bridge pin or anchor bolt.

Pins of Pin/Hanger bridges and Pinned Truss bridges will be inspected using UT equipment because most of the pin is hidden from view. Visual inspection practice doesn't reveal the potential cracks in the pins {Do not strike pins with a hammer to check soundness}. Since sound pins are so critical to bridges, the time and expense are well justified. It will be ARDOT practice to inspect pins using UT every 24 months or less as deemed necessary by the inspector.

When truss gusset plate section loss cannot be detected or adequately quantified by traditional measurement devices (calipers, depth probe, tape-measure, etc.), UT equipment will be used to document the corrosion adequately. The thickness measurements and their locations will be thoroughly documented. This information will be included in the inspection report for reference in conducting future inspections and monitoring corrosion progress. It will be ARDOT practice to inspect gusset plates requiring UT inspection every 24 months or less as deemed necessary by the inspector. Additional information on Nondestructive Evaluation (NDE) can be found at
https://fhwaapps.fhwa.dot.gov/ndep/Default.aspx

Pin and Hanger Assemblies

We currently have 3 methods to evaluate our pin and hanger assemblies. The first is a simple visual inspection of a pin and hangers, including joints and wind locks if present. The second is UT which is useful in determining whether or not you have a crack. The third is measuring the actual dimensions between the pins and the distance from each pin to the end of the hanger assembly and comparing these values to the planned dimensions. This is useful in documenting wear in the assembly. See the following drawings as an example of UT inspection and documentation inspection.



Try to determine if movement is taking place. Corrosion can cause fixity at pin and hanger connections. This changes the structural behavior of the connection and is a source of cracking. Powdery red or black rust where surfaces rub indicates movement. It may or may not indicate appreciable section loss. An unbroken paint film across a surface where relative movement should occur indicates the pin is frozen.

Some movement due to traffic vibration may be observable. If this movement is excessive or has significant vertical movement with live load passage, the pins or pinholes may be excessively worn. Contact the HBM section as this may warrant a pin/hanger replacement.

The expansion dam, beam ends, and any other structural components in the hinge area should be studied to see if any unusual displacements have taken place.

Examine the hanger plates for cracks due to bending of the plate from a frozen pin connection. Observe the amount of corrosion buildup between the webs of the girders and the back faces of the plates. Inspect the hanger plate for bowing or out-of-plane distortion from the webs of the girders. Any welds should be investigated for cracks. If the plate is bowed, check carefully at the point of maximum bow for cracks that a broken paint film and corrosion might indicate.

Measure the distance between the back of the hanger and the face of the web at several locations. Compare these measurements from location to location and hanger to hanger. Variations greater than 1/8 inch could indicate twisting of the hanger bars or lateral movement due to rust packing. These measurements should be carefully described and recorded in permanent notes to compare measurements taken at the next inspection.

Steel Failure Mechanics

Steel failure mechanics involves describing the process by which a member fails when subjected to fatigue. The fatigue failure process of a member consists of three stages:

- Crack Initiation
- Crack Propagation
- Fracture

Crack Initiation - Cracks most commonly initiate from points of stress concentrations in structural details. The most critical conditions for crack initiation at structural details are those combining high-stress concentrations due to: flaws, connections, and out-of-plane distortions.

Crack Propagation - Once a fatigue crack has initiated, applied cyclic stresses cause propagation, or growth, of a crack across the member's section until it reaches a critical size. At this time, the member may fracture.

Fracture - Once a crack has initiated and propagated to a critical size, the member fractures. Fracture of a member is the separation of the member into two parts. The fracture of a critical member may cause a total or partial bridge collapse.

Fatigue Cracking

Most critical conditions for fatigue cracking are those which involve a combination of flaws and stress concentrations. Girders, stringers, floorbeams, diaphragms, bracing, truss members, hangers, and other members must be structurally connected. Bridge structures, particularly those that are welded, cannot be fabricated without details that cause some level of stress concentrations.

Welds

Welds are the connections of metal parts formed by heating the surfaces to a plastic (or fluid) state and allowing the parts to flow together and join with or without the addition of filler metal. The term base metal refers to the metal parts that are to be joined. Filler metal, or weld metal, is the additional molten metal generally used in the formation of welds. The complete assembly is referred to as a weldment. Conditions of stress concentration are often found in weldments and can be prone to crack initiation.

The four common types of welds found on bridges are groove welds, fillet welds, plug welds, and tack welds.

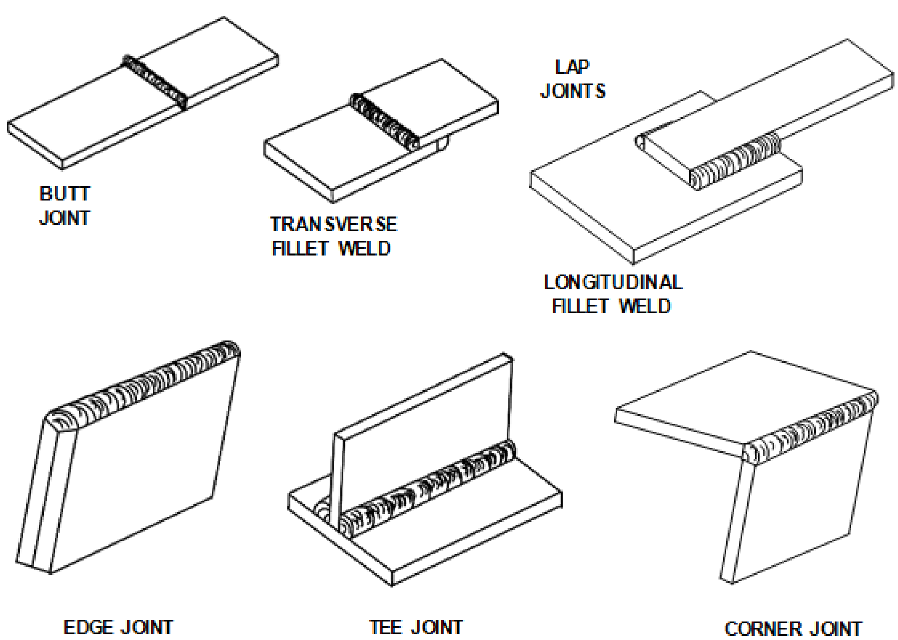
Groove Welds **–** Groove welds, sometimes referred to as butt welds, are used when the members to be connected are lined up edge to edge or are in the same plane. Full penetration groove welds extend through the entire thickness of the joined piece, while partial penetration groove welds do not. Weld reinforcement is the added filler metal that causes the throat dimension to be greater than the thickness of the base metal. This reinforcement is sometimes ground flush with the base metal to qualify the joint for a better fatigue strength category.

Fillet welds – Fillet welds connect members that overlap each other or are joined edge to face of the plate, as in plate girder assembly of web and flange plates. Fillet welds are the most common type of weld because large tolerances in fabrication are allowable when members are lapped over each other instead of fitted together as in groove welds.

Plug welds - Plug and slot welds pass through holes in one member to another, with weld metal filling the holes and joining the members together. Plug welds have sometimes been used to fill misplaced holes. These repairs are very likely to contain flaws and micro-cracks that can initiate fatigue cracking. AASHTO no longer permits plug welds for bridge construction.

Tack welds **-** Tack welds are small welds commonly used to hold pieces in position during fabrication or construction temporarily. They are often made carelessly, without proper procedures or preheating, and can be a fatigue-prone detail.

Both plug and tack welds are smaller than fillet and groove welds, but they can be the source of serious problems to bridges and should be investigated closely.



Types of Welded Joints

All welding processes result in high built-in residual tension stresses at or near the yield point in the weldment and the base metal adjacent to it. Load-induced stress concentrations also often occur at welded bridge connections, where these residual tensile stresses are high. This combination of stress concentration and high residual tensile stress is conducive to fatigue crack initiation. Such cracks typically begin at the weld periphery, such as at the toe of a fillet weld, where there typically can be sharp discontinuities, or at an internal discontinuity such as a slag inclusion or porosity. In the initial stages of fatigue crack growth, much of the fatigue life is expended when a crack has propagated out of the high residual tensile stress zone.

Welded details tend to be less forgiving of small weld discontinuities than riveted details because welds are more sensitive to repeated stresses. Once cracking starts to develop, it can destroy the member base metal due to the continuous path provided by the welded connections. Cracking has developed more frequently in welded bridges because of flaws that escape detection, the use of details less fatigue resistant than assumed in the design, and secondary and displacement induced stresses.

Crack Areas

The Inspector must realize that cracks are only readily detectable visually as a through crack after most of the fatigue life cycle is gone. The following areas have a higher possibility of cracking and should receive close scrutiny:

- Plug welds
- Tack welds
- Out-of-Plane bending
- Nicks, notches, and indentations (Truck Impacts)
- Flange/web coping without proper radius
- Flame cuts
- Toe of a transverse stiffener that is welded to the web
- Poor quality welds
- Intersecting welds

Any web cracks discovered in a tension zone should be brought to the immediate attention of an Engineer in the HBM Section or the Rating Section.

Fatigue cracks can also develop at welded details in the compression regions of steel bridge members. However, when a crack propagates out of the weld tensile- residual-stress zone and into the adjacent compression region, the crack growth usually stops. Because of this, the inspection of welded details in regions of nominal compressive stress is of lower priority than in tension regions.

Riveted and Bolted Details

Fatigue cracking can occur at riveted or bolted details, particularly as the result of secondary or displacement-induced stresses or from assembly tack welds that have not been removed. Framing connections intended to provide only simple support, but by their function, tend to resist bending moment, are suspect locations. Fortunately, crack growth is often inhibited by multiple element members, i.e., internal redundancy.

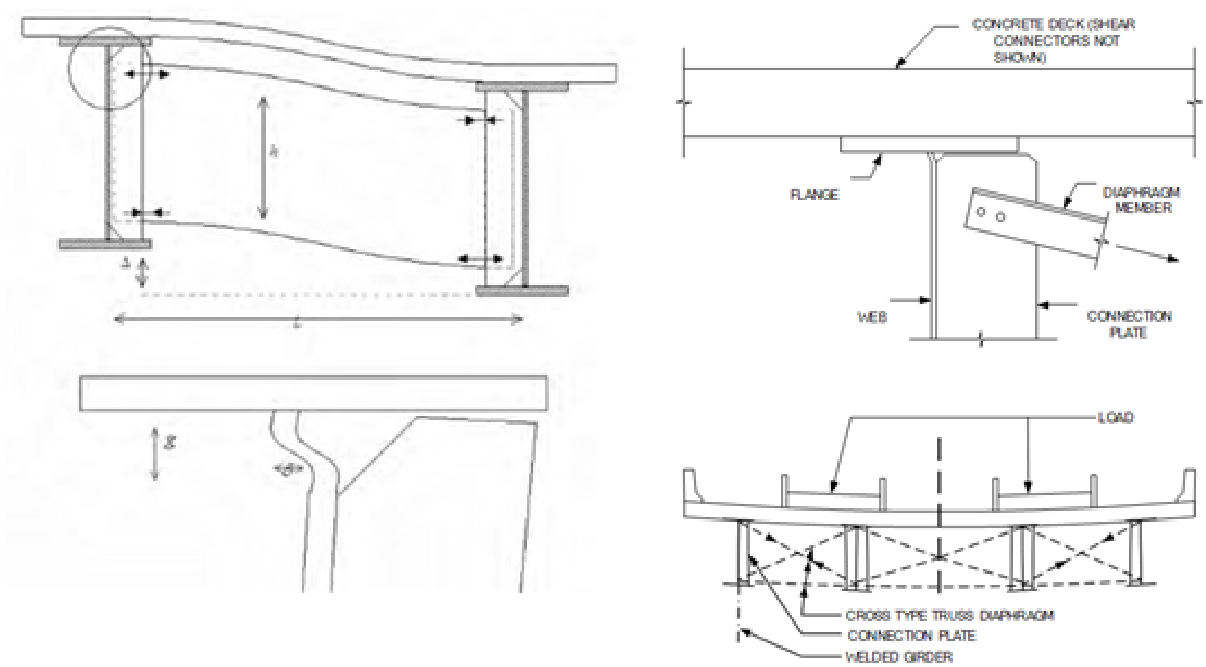
Most riveted bridges were constructed before the 1960's when bolted connections became common. Because of their age and the number of stress cycles already experienced, the close inspection of riveted members and connections in bridges with high truck traffic volume is necessary. In general, the locations where fatigue cracks develop in riveted bridges are similar to those in welded bridges.

Out-of-Plane Distortion

Deflection of floorbeams or diaphragms can cause out-of-plane distortion in the girder webs. You will see this more when you have skewed bridges where the diaphragms are not skewed and are subjected to large differential vertical deflections. If the girder flange is relatively thick and stiff against lateral displacement, most of the deflection is accommodated by bending of the web plate across a small web gap between the flanges and end of vertical connection plates.

When cracks form in planes parallel to the stresses between the flanges and end of vertical connection plates, they are not typically detrimental to the structure's performance. Even though distortion-induced cracks are usually parallel to the primary stress direction, they can turn perpendicular. Retrofits such as drilled holes are often used when cracks turn perpendicular to the primary stresses.

Once an out-of-plane bending crack is identified, it is imperative that all similar locations on the structure also be carefully inspected to search for similar damage.



Out-Of-Plane Distortion in Web Gap at End of Transverse Connection Plate

Two very common instances are in the web gap at unconnected cross-frame connection plates, that is, connection plates that are not attached to the beam or girder flanges, and at similar web gaps at floorbeam connections to main girders.
When distortion-induced cracking develops in a bridge, large numbers of cracks usually form before corrective action is taken because the cyclic stresses are often very high. As a result, many cracks form simultaneously in the structural system.

Corrosion

Corrosion is the most common form of defect found on steel bridges. More section loss results from corrosion than from any other cause. However, few bridge failures can be attributed solely to corrosion. Shallow surface corrosion is generally not serious but is quite common when the paint system has failed. Measurable section loss is significant as it may reduce the structural capacity of the member. Accurately measuring and documenting the extent and location of section loss is one of the primary responsibilities of the Bridge Inspector and is essential in evaluating the load-carrying capacity of a steel bridge.

The bridge inspection report should accurately describe the location and extent of any significant section loss - section loss is typically expressed as a percentage of the original cross-sectional area.

- On members subjected to axial loading (such as truss members), section loss is typically expressed as a percentage of the entire member cross-section. *For example: "truss bottom chord member L2-L3 has 15% section loss at the L2 connection".*

- On members subjected to bending moment (such as girders or beams), section loss is typically expressed as a percentage of the bottom flange, top flange, or web cross-section. *For example: "the bottom flange of the girder 5 has 10% section loss at the 1st deck drain east of Pier 2".*

When describing section loss in an inspection report, it is essential that the extent of section loss not be misrepresented. For example, the bottom flange of a girder has a 1" diameter hole which constitutes 15% of the total bottom flange cross-section. While the flange has rusted entirely through at the hole, this **should not** be described as "the bottom flange has 100% section loss", but rather as "the bottom flange has 15% section loss" (or "the bottom flange of a girder has a 1" diameter hole").

If the original cross-section has not yet been determined, it may be better to describe the location and dimensions of the area with section loss. For example, Girder 3 has a 4" wide by 2" high area of pitting (up to $^{1}/_{8}$" deep) at Abutment 1 bearing".

When Measurements Are Needed

As it is not generally practical to accurately measure and document every area of section loss on a bridge, some judgment must be used by the inspector in prioritizing the locations where section loss measurements are taken. Generally, section loss measurements should be taken if the approximate section loss on a primary structural steel member exceeds 5% of the total member cross-section (or 5% of the flange or web cross-section). The structure's highly stressed portions (such as the bottom flange near the center of a span) should be prioritized for section loss measurements. If section loss is present at similar details throughout a bridge, measurements should be taken at locations that appear to have the most severe or extensive section loss.

Corrosion Likely Locations

The locations where corrosion (and section loss) will occur on a bridge are typically predictable - steel members exposed to salt spray or covered by debris will typically have section loss. The exact locations will vary depending upon the structural configuration and features present on the bridge - locations where corrosion (and section loss) is likely to occur include the following:

- Structural members located below deck joints
- Bearing areas
- Areas below deck drain or adjacent to downspouts
- Areas located directly above traffic (exposed to salt spray)
- Horizontal surfaces, field splices, or other details that tend to accumulate debris
- Fascia girders, beams, or stringers will typically have more corrosion and section loss than interior members, particularly the exterior bottom flange.
- On bridges with concrete decks, corrosion will tend to be localized (below deck joints or leaching cracks) - on bridges with timber decks. Corrosion may be widespread.
- Through truss and pony truss bridges will typically have section loss along the bottom chord, particularly at the panel point connections - section loss may be present on the truss members or gusset plates. Truss diagonal and vertical members will typically have corrosion at the railing connections, at the curb level, and the bottom chord connections.
- Steel box girders (or other box sections) will develop internal corrosion if moisture accumulates within the box section.
- Steel piling will typically have corrosion at the waterline or ground line.

Cleaning Before Inspection

To properly inspect a steel member and determine the extent of section loss, the steel must first be cleaned of any dirt, debris, or excess flaking rust. A significant build-up of debris on a steel member indicates inadequate maintenance and inadequate inspection. A bridge inspector should have ready access to cleaning tools such as a shovel, spade, whisk broom, wire brush, pick hammer, or scraper. Inspection during (or immediately after) re-painting contracts will often allow for more precise section loss measurements.

Methods of Measurement

During a bridge inspection, initial section loss is often estimated (often aided by a straight edge or ruler) - as section loss advances, more precise measurements may be necessary. Calipers are an inexpensive and straightforward method of measuring the thickness of the remaining steel, but they may not be able to reach some locations (such as a girder web). An ultrasonic thickness gauge or a pit gauge is effective in obtaining thickness measurements - these can be used in confined areas or locations where only one side of the member is accessible.

Field Notes and Cross-Section Diagrams

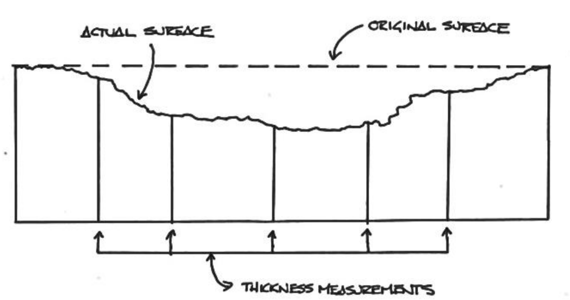
In areas of severe section loss, field notes may be required. Field notes should be thorough, concise, and readable - they should include the thickness measurements and the exact location where those measurements were taken. The original cross-section area must be known to determine the extent of section loss on a structural member. If no plans are available, measurements and thickness readings should be taken in areas without section loss to establish a basis for the section loss calculations. Plan dimensions and thicknesses should be verified.

Cross-section diagrams help document field measurements and perform section loss calculations. If possible, blank forms (with cross-section diagrams) should be prepared before taking field measurements. To facilitate section loss calculations, the exact location of all thickness readings should be recorded - areas with section loss should be indicated.

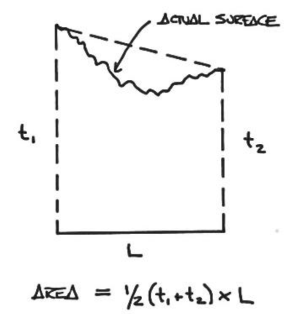
All cross-sections should be recorded in a micro-station drawing and attached under Report Info/Picture Files/Sketch.

Section Loss Calculations

When performing section loss calculations, the level of accuracy will generally depend on how many thickness measurements are taken - the more measurements are taken, the greater the accuracy. One common method of calculating section loss is simply taking the average of several thickness measurements over a portion of the member cross-section. A slightly more accurate method is to divide the cross-section into trapezoidal sub-areas based upon the exact locations of the thickness measurements. These areas are then calculated separately and added up. Whatever method is used should be done clearly and consistently, so the calculations can be easily checked and verified.



Cross-section showing the location of thickness measurements



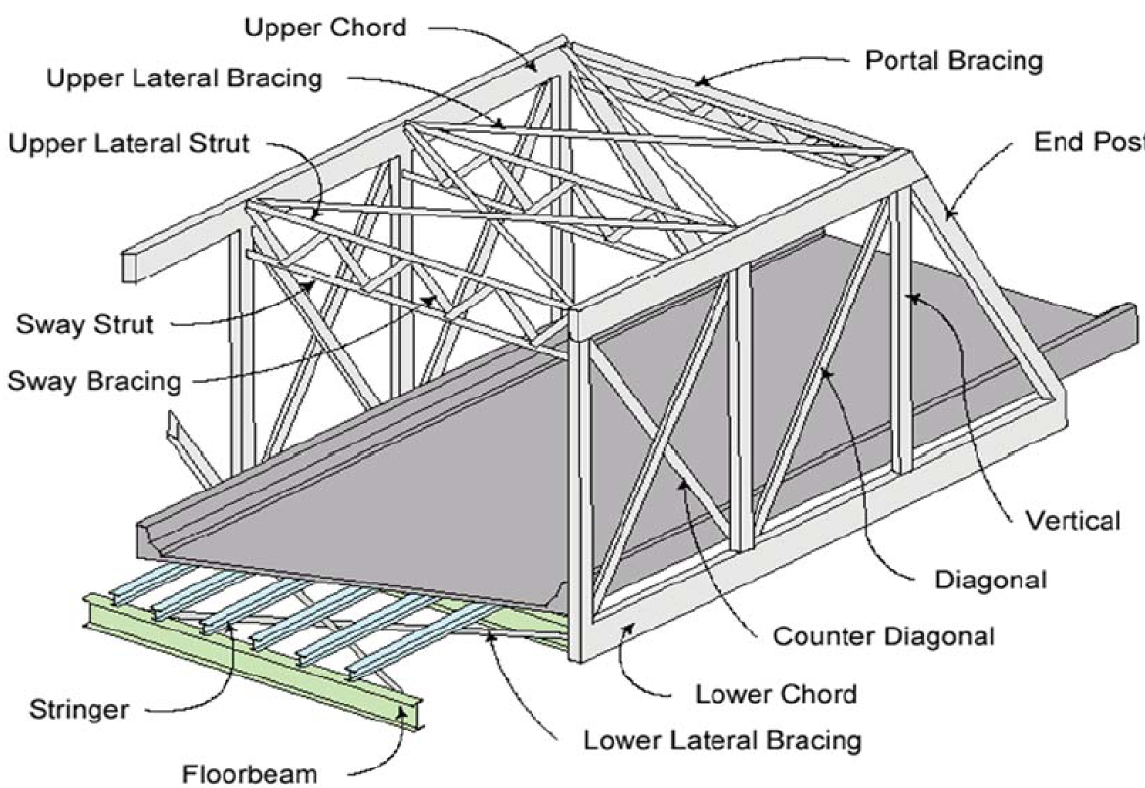
Trapezoidal sub-area

Truss Bridge

A truss bridge is two parallel trusses tied together by the floor beams and lower lateral bracing at the lower chords and the struts, portals, and upper lateral bracing at the upper chords. The trusses themselves are composed of the upper chord, the topmost member of the truss, the lower chord, the bottom member of the truss, and vertical and diagonal members that connect the upper and lower chords. Floor beams, with and without stringers, support the deck. The upper and lower lateral bracing provide lateral stability to the trusses and hold them parallel to each other.

The following drawing is a breakdown of the typical elements of a truss bridge.

Elements of a Truss



Chapter 7: Concrete Inspections

Delamination

Delamination in concrete can be a serious problem and often are "heard" before they are seen. The most common NDE method for concrete structures is by sounding. Sounding is used to determine the presence of delamination within a concrete element and is typically performed using a hammer on the surface of concrete substructure units and using a chain drag when evaluating the condition of a concrete deck. Delamination typically results from corrosion of the reinforcement bars or de-bonding in the case of a concrete overlay.

The test procedure involves delineating sound and unsound concrete by the sound produced when struck by a metal object such as a hammer or chain. With little experience, an Inspector can begin to delineate the different sounds produced. However, it does take a trained ear to differentiate defects located further below the surface and identify the actual limits of defects. Many delaminations are visible on the surface due to the general deterioration of the concrete, but others show no visual signs and require another NDE method to locate.

Chain Drag

The chain drag is a method of sounding concrete and is typically used to evaluate the condition of a concrete bridge deck. The chain drag allows inspectors to cover a large area of deck surface quickly with a reasonable amount of accuracy. The chain drag survey is also a low-cost alternative to other NDE methods. Due to its low cost, many agencies use this method as an initial evaluation to determine the need for further investigation. Like hammer-sounding methods, the chain drag test is subjective and requires an experienced inspector to perform the survey with a high degree of accuracy. Also, localized areas are harder to detect with a chain drag and may need hammer sounding to provide accurate limits of the delamination. Due to the nature of the test, localized areas of delamination are more challenging to detect.

The chain drag survey entails dragging a chain over the concrete surface and listening for the sound difference between sound and unsound areas of concrete. The device typically consists of four or five sections of chain mounted to an 18" (+/-) long tube. The chain sections are 12" to 18" long, and the tube is connected to a handle that can be fabricated to any length for operator comfort. The test is performed by dragging the chain sections across the surface of the concrete and marking areas that produce a dull sound. Care must be taken to differentiate and mark the unsound areas accurately. This usually involves going over a suspect area several times to identify the locations of unsound concrete. A grid system should be constructed on the deck's surface so that delaminated areas can be plotted easily. This test usually involves two people: one to drag the chain and one to do the marking.

Reinforced Concrete

Reinforced concrete is designed to carry the required compression while the embedded steel carries the tension. Cracking in the concrete may indicate that the steel is insufficient to carry the tension loads, so special attention is given to cracks.

The following concrete elements are considered Primary Members:

- Rigid frames (Cast-in-place and precast)
- Filled arches
- Arch ribs, spandrel columns, and spandrel walls
- Cast-in-place slabs
- Precast reinforced concrete slabs
- Cast-in-place through girders
- T-Beams (stem portion if cast-in-place, entire unit if precast)
- Channel Beams

When inspecting these types of structures, the following should be visually checked:

- Deterioration at the end of the beam can lead to loss of bearing area and local crushing of the remaining concrete.
- Near bearing areas at the ends of slabs, girders, T-beams, channel beams, etc., for spalling and cracked concrete. Any diagonal cracking in spandrel columns or at the ends of beams, girders, etc., is serious.
- Areas near supports for diagonal (shear) cracks occurring on exposed vertical surfaces and projecting diagonally toward the top of the girder, beam, etc.
- Tension areas at mid-span of simple spans for flexural cracks extending transversely across the underside of the primary member. Longitudinal flexural cracks in the deck when the primary rebars are transverse. Transverse flexural cracks in tops of beams (slab portions) at or near piers on continuous spans.
- Areas with efflorescence indicating contaminated concrete and with rust stains indicating rebar corrosion. Spalling, delaminations, and pop-outs are commonly associated with deterioration. In severe cases, rebars will be exposed; determine the section loss of any exposed rebars.
- Longitudinal cracks between adjacent channel or T-beams indicating possible broken shear keys, differential deflections under the passage of live loads, leakage, etc.
- Shear or torsional cracks at open-spandrel arch floor systems, bent cap interfaces, or in spandrel bent caps or columns. Cracks in tension areas of spandrel bent caps (i.e., mid-span at the bottom and ends at the tops).
- Deterioration of closed- spandrel arches and spandrel walls includes cracks, discoloration, spalling, exposed rebars, etc. Differential movement, change of alignment/profile, or loss of fill.
- Shear cracks in rigid frame beams (beginning at the frame legs and propagating toward the adjacent span), in the frame legs (starting at the top and propagating downward), and in the ends of frame beams at end spans.

- Flexural cracks in tension areas of rigid frames at the bottom of the frame beam at mid-span, inside faces of frame legs at mid-height, the base of each frame leg, and the outside corners of a simple-span slab frame.
- Areas at, near, or under drainage features such as scuppers, weeps, curb lines, etc., for the loss of fill or concrete deterioration.
- Areas of previous repairs, impact damage, honeycombing, scaling, and any other conditions indicating potential deterioration of concrete or rebars.

Reinforced Concrete Slab Spans Lengthening

Many long reinforced concrete (R.C.) slab span bridges have joint incompressibility problems and should be monitored closely. Over time, the ½" compressible joints in R.C. slab span bridges deteriorate, allowing incompressible material to enter the joints. As the bridge contracts due to cooler weather, additional material will enter the joints. The additional material in the joint will "hold" the joint wider during the expansion that comes with warmer weather, and the bridge will "grow," resulting in increased bridge length. It has been documented that R.C. slab span bridges, with a length of 1000', have "grown" as much as 20". This increase in bridge length can cause several problems:

- Intermediate bents may be pushed out of plumb, causing a rotating cap.
- The span on one side of the intermediate bent may be higher than the other due to the rotating cap.
- A pushed-over bent along with the bridge length growth may cause a loss of bearing area for the slab end, necessitating a helper bent to "catch" the slab span end.
- At bridge ends, you may have approach slabs pushed up, end posts broken, and guard rails damaged

Since this problem "grows" over time, it is imperative to record the ongoing movement so that precautions or remediation actions may be taken before severe consequences. The documentation may include measurements of joint widths and corresponding temperatures, remaining bearing areas at slab ends, and measurements of how much bents are out of plumb.

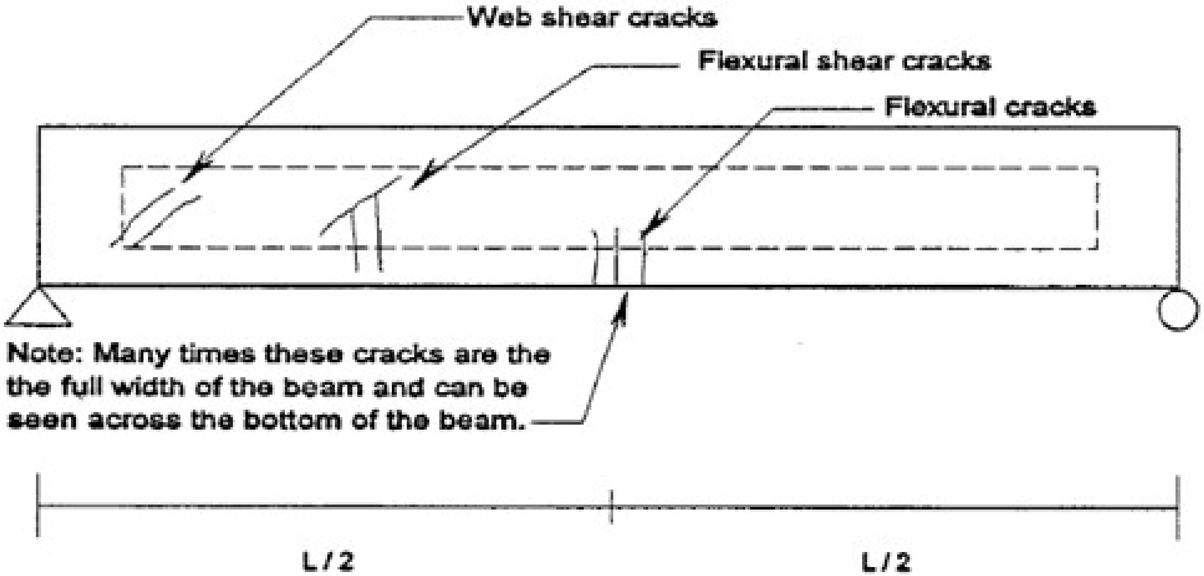
Prestressed Concrete

Most cracks in prestressed beams are potentially serious since tensile forces exist that the design might not have accounted for. Vertical or diagonal tension cracks in prestressed members are signs that the prestressing steel (tendon) has failed or is failing, and adjoining beams are carrying the loads. This is a serious condition, and steps should be taken to ensure the bridge's stability as soon as possible.

Generally, there are three main types of structural cracks (see figure below):

- Web Shear Cracks - Diagonal tension causes a crack at or near the support. These cracks typically extend up and away from the support at an approximately 30° angle (45° if not prestressed).
- Flexural Shear Cracks - Found between the support and maximum moment area. These cracks consist of both vertical and diagonal cracks occurring together.
- Flexural Cracks - Usually found in the vicinity of the maximum moment. These cracks are normal to the longitudinal axis and extend vertically through the tendon locations.

Additionally, cracks occur in the ends of prestressed members due to de-tensioning forces. These cracks generally can be seen across the beam end or along the sides and bottom at the end.



When inspecting these types of structures, the following should be visually checked:

- Any sagging by individual members could indicate overloading or loss of prestress.
- Support area for diagonal cracking (shear).
- Deterioration at the end of the beam can lead to loss of bearing area and local crushing of the remaining concrete.
- Mid-span area (maximum moment) for flexural cracks.
- Between mid-span and bearing for flexural shear cracks.
- Longitudinal cracking at prestressing steel tendon levels.
- Horizontal deflections (sweep) may indicate asymmetric loading from either non-uniform prestressing forces or tendon failure.
- Spalled areas for exposed tendons.
- Shear keys for grout displacement and evidence of leakage.

In addition to the visual check, the following activities should be performed:

- Sound the beams at the support area and mid-span location and any other areas showing deterioration.
- Evaluate and estimate or, if possible, measure any loss to exposed tendons and note the location.
- Quantify de-bonded tendons and fully or partially broken tendons. Note these locations.
- Investigate previously repaired areas.
- Document findings with notes, photographs, and drawings, including full crack and deterioration documentation.

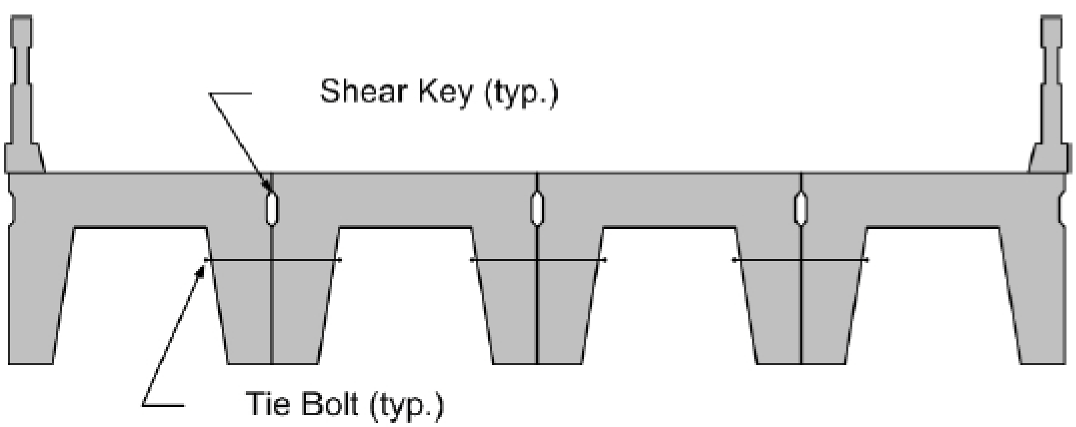
The two most common causes of losing prestressing forces are impact and corrosion. Generally, deterioration occurring in prestressed concrete members is evident to the Inspector. Still, in some cases, severe but latent corrosion of the prestressing strands may exist without many outward signs of problems. Be sure to check for:

- Concrete delamination, hairline cracks, efflorescence, or rust stains at the level of the prestressing strands, which can indicate strand corrosion.
- Longitudinal cracks in the beam may be the result of expansion forces caused by prestressing steel corrosion.
- Efflorescence, leakage, and staining indicate the likelihood of prestressing steel corrosion and a diminished load-carrying capacity.
- Concrete delamination or spalling is the more definitive sign of prestressing steel corrosion and diminished capacity.
- Check for tendon damage if any of the beams have been impacted. Cracks spreading from the damaged area indicate the extent of prestress loss.
- Longitudinal cracks in the wearing surface may indicate that the shear keys of the primaries have failed or are not working as designed.

Recent research has suggested that once outward signs of prestressing steel corrosion are visible, deterioration occurs very rapidly. The Inspector should pay particular attention to areas where the concrete is patched.

Concrete Channel Beams

Concrete channel beams are usually precast and consist of a conventionally reinforced deck cast monolithically with two stems. Precast channel beam stems may be conventionally reinforced or prestressed, but in Arkansas, you would typically look at conventionally reinforced. Stem tie bolts and shear keys are used to achieve monolithic action between precast channel beams.



While both the tie bolts and grouted shear keys are mechanisms for the units to work together to carry the traffic load, the main feature needed to transfer load is that grout is placed in the shear key between the units. The notes on the superstructure should state whether the tie bolts are in place and whether or not the shear key is grouted. If you can't see the shear key because of an overlay, you should note if there are longitudinal cracks in the asphalt over the shear keys and if the units are spalling. You may notice the units appear to act or not act together while traffic is traveling on the span. Your observations should also be recorded to help the Rating Section in their load rating.

Concrete channel beams are an extremely robust unit. They can lose much of the cover over the reinforcing in their stems in the center of the span before they have a reduction in their capacity. As long as the reinforcing has good embedment at the ends of the units, there is little concern for a load reduction due to bending. Suppose you have deteriorated concrete at the ends of the units where you could have a loss of embedment of the reinforcement. In that case, you should immediately notify Bridge Rating, for this is a severe condition.

The units will almost always fail in shear before bending. Shear cracking will typically occur about 15 inches from the face of the bearing and run at a 45-degree angle from the bottom of the stem and move away from the support. Before 1974 there was no shear reinforcement in the units, so shear cracks in these older units could be a serious concern, and the Rating Section should be made aware of problems.

Chapter 8: Timber Inspections

Timber Bridge Overview

Wood is an organic material rather than a manufactured material such as concrete, steel, or masonry. It tends to be less homogeneous and more susceptible to various recurring random defects. Lumber is generally classified according to its species, size, and natural variations.

Wood is a natural engineering material prone to deterioration caused by decay fungi, insect attack, fire, and mechanical damage. Typically, areas of high moisture content in decking, girders, abutment caps, and pilings create conditions suitable for biological damage. Types of biological damage include decay and insect damage caused by various species of fungi and insects such as ants or termites. Mechanical damage might consist of damaged members or mechanical fasteners. The application of preservative treatment by pressure methods enhances the durability of timber bridge components, but regular inspections are vital for the identification of damage and implementation of timely repairs and proactive maintenance programs.

Visual Signs of Deterioration

The simplest method for locating external deterioration is a visual inspection. An inspector observes bridge elements for signs of actual or potential deterioration. Visual inspection requires intense light and is useful for detecting intermediate or advanced surface decay, water damage, mechanical damage, or failed members. Visual inspection cannot detect early-stage decay when remedial treatment is most effective. A visual inspection should focus on identifying the extent of the following signs of deterioration.

Fruiting Bodies

Although they do not indicate the amount or extent of decay, fruiting bodies positively indicate a fungal attack. Some fungi produce fruiting bodies after small amounts of decay have occurred, while others develop only after extensive decay. When fruiting bodies are present, they indicate the possibility of a severe decay problem. The presence of decay fungi and fruiting bodies suggests that the member has a high moisture content, usually above 28% dry weight. Plant or moss growth in splits and cracks, or soil accumulation on the structure, indicates that adjacent wood has been at a relatively high moisture content for a sustained period and may sustain the growth of decay fungi. It is vital to include maintenance activities that remove dirt accumulation and plant growth from timber elements.

Sunken Faces or Localized Collapse

Sunken faces or localized surface depressions can indicate underlying decay. Decay voids or pockets may develop close to the surface of the member, leaving a relatively thin, depressed layer of intact or partially intact wood at the surface.

Staining or Discoloration

Staining or discoloration of wood indicates that it has been subjected to water and potentially has a high moisture content, making it susceptible to decay. Rust stains from connection hardware are also an indication of wetting.

Insect or Animal Activity

Insect activity is often identified by the presence of holes, frass, and powder posting. For wood-boring insects like carpenter ants, frass is defined as the mix of insect excrement and excavated wood material from timber members where they are active. The presence of insects may also indicate the presence of decay, as carpenter ants often create tunnels and nests in decay cavities. Carpenter ants deposit sawdust in gallery openings, trapping moisture and increasing an element's decay rate. In addition to insects, birds often nest under bridge decks. The nests may trap moisture against a timber element, potentially increasing the moisture content resulting in localized decay.

Checks and Splits

Timber members are susceptible to drying and weathering, resulting in surface and deep surface checks, ring shake, end checks, and through splits. Checks and splits in members can indicate a weakened member and create an entry for moisture to enter the element. If a check or split develops sufficiently, the untreated inner wood is susceptible to moisture and decay fungi. This will create conditions that can result in severe decay and premature deterioration of a timber bridge element. Railing posts and abutment cap ends are typically the most common location to observe lumber checking or splitting. In rail posts, overtightening of bolts during construction can contribute to their occurrence. Severe splits in timber abutment caps often lead to substantial decay. They should be thoroughly evaluated, especially when multiple spans are butted together over the support or when the wood deck does not shelter the cap beam effectively.

Weathering or Impact Damage

Frequently, weathering and aging of bridge elements impact the performance and durability of timber bridges. This occurs with both timber and non-timber materials like bituminous or other wear layers. Further natural weathering damage occurs to timber piles exposed to water and materials flowing down the river or stream. Members in the mud zone (+/- 2 ft. of normal water level) have ideal conditions (oxygen, moisture) to promote decay. This can affect the structural performance both through loss of cross-section and the removal of the preservative treatment.

Additional damage to timber bridge components can be caused by impact from vehicle traffic. Snowplows can damage timber curbs and railings during winter months, as the curb is hidden by snow. Floating objects, such as trees and logs, can damage timber substructures during high flow rates associated with heavy rain events or seasons.

Miscellaneous Conditions

During visual inspections of timber bridge components, other significant conditions need to be further explored using the full combination of inspection and assessment techniques. These conditions can include the rotation of timber piers and abutments caused by the loss of fill behind the backwall or some other mechanism. Misalignment of caps and piles will not effectively transfer vehicle loads to the ground, causing piles to be overstressed in bending and compression. A second significant condition is the build-up of road materials like gravel or sand that hold moisture in contact with structural timber elements.

Sounding and Probing Techniques

One of the most commonly used techniques for detecting deterioration is hitting a member's surface with a hammer or other object. An inspector can identify areas of concern for further investigation using advanced tools like a stress wave timer or resistance micro-drill based on the sound quality or surface condition. Deteriorated areas typically have a hollow or dull sound that may indicate internal decay. Care must be taken not to confuse the sound associated with high moisture content pile with decay. A pick hammer commonly used by geologists is recommended for timber bridges because it allows inspectors to combine sound and the pick end to probe the element.

Probing with a moderately pointed tool, such as an awl or knife, locates decay near the wood surface as indicated by excessive softness or a lack of resistance to probe penetration and the breakage pattern of the splinters. A brash break means decayed wood. A splintered break reveals sound wood. Although probing is a simple inspection method, experience is required to interpret results. Care must be taken to differentiate between decay and water-softened wood that may be sound but somewhat softer than dry wood. Probes can also be used to assess the depth of splits and checks. Flat-bladed probes like pocket knives or calibrated feeler gauges are recommended for use in this process.

Drilling and Coring Techniques

Drilling and coring are the most common methods used to detect internal deterioration in wood members. Both techniques are used to detect voids' presence and determine the thickness of the residual shell when voids are present. Drilling is usually done with an electrical power drill or hand-crank drill equipped with a 3/8 to 3/4-in—diameter bit. Power drilling is faster, but hand drilling allows the inspector to monitor drilling resistance and may be more beneficial in detecting pockets of deterioration. In general, the inspector drills into the member in question, noting zones where drilling becomes easier and observing drill shavings for evidence of decay. The presence of common wood defects, such as knots, resin pockets, and abnormal grain, should be anticipated while drilling and should not be confused with decay. The inspection hole is probed with a bent wire or a thickness gauge to measure shell thickness. Since these holes are typically ¼ to ½ in. diameter, they should be plugged with a wood dowel section that has been soaked in a preservative.

HBM now has a micro-driller with a bit only 1/8” in width. This machine can take readings and graph both lateral and rotational resistance as it drills. The Inspector may request HBM to use the micro-driller when additional information is needed about a pile.

Coring with an increment borer (often used for determining the age of a tree) also provides information on the presence of decay pockets and other voids. The resultant solid wood core can be carefully examined for evidence of decay. In addition, the core can be used to obtain a measure of the depth of preservative penetration. Typically, coring should be conducted on a horizontal plane. To prevent moisture and insect entry, a bored-out core hole should be plugged with a wood dowel section that has been soaked in a preservative.

Chapter 9: NBI Inspection Guidance

Introduction

A bridge inspection includes examining the structure, evaluating the physical condition of the structure, and reporting the observations and evaluations on the bridge inspection report. ARDOT currently uses two separate condition rating systems for bridges and culverts - the NBI condition ratings and the structural element condition ratings. All state bridges and local bridges on the NHS shall be evaluated under both systems. Local bridges not on the NHS need only be evaluated under the NBI rating system.

NBI Condition Rating Summary

The NBI condition ratings describe the general overall condition of a bridge (or culvert). During each inspection, these ratings must be reviewed. 5 NBI condition ratings are rated on a numerical scale of 1 to 9 (with 9 beings "new" condition).

- NBI Deck Condition Rating (Item #58)
- NBI Superstructure Condition Rating (Item #59)
- NBI Substructure Condition Rating (Item #60)
- NBI Channel and Channel Protection Condition Rating (Item #61)
- NBI Culvert Condition Rating (Item #62)

Bridges are typically rated in three components - deck, superstructure, and substructure. The channel (FHWA Item #61) must also be rated if a bridge spans over a waterway. The NBI superstructure and substructure items should be rated for filled spandrel arch bridges, but the NBI deck rating may be entered as "N."

- FHWA Item #58 describes the general overall condition of the deck (or slab) - this includes the underside of the deck. The wearing surface, railings, curbs, sidewalks, expansion joints, and deck drains should typically not be considered in this rating.
- FHWA Item #59 describes the general overall condition of the superstructure - this includes all structural components (slabs, arches, trusses, girders, or beams) located above (and including) the bearings. This rating should consider any deterioration, misalignment, or collision damage.
- FHWA Item #60 describes the general overall condition of the substructure - this includes all structural components (piers, abutments, pilings, or footings) located below the bearings. This rating should consider any settlement, tipping, misalignment, undermining, or scour. Wingwalls or retaining walls (up to the first expansion or construction joint) may be considered in this rating.

Culverts are rated as a single component (FHWA Item #62) - if water flows through a culvert, the channel (FHWA Item #61) must also be rated. FHWA Item #62 describes the general overall condition of the culvert. This rating should consider the condition of the culvert barrel, joints, and seams, as well as any deflection, distortion, misalignment, settlement, scour, or voiding of backfill. Headwalls, wingwalls, or aprons (up to the first construction joint) should be included in this rating.

The following general guidelines apply to the NBI Condition Ratings:

- New bridges and culverts are initially assigned NBI ratings of “9” (excellent condition) unless there are flaws in its construction.
- Repaired bridge components should typically not be rated higher than “7” (good condition).
- An NBI rating of “5” (fair condition) or less generally implies that repairs are recommended - NBI ratings of condition “5” or less will also reduce the Bridge Sufficiency Rating.
- An NBI rating of “4” (poor condition) or less may impact the required inspection frequency.
- An NBI rating of “3” (serious condition) or less generally implies that immediate repairs, structural analysis, or a new load rating is necessary.
- An NBI rating of “2” (critical condition) indicates a critical deficiency. NBI ratings of “2” should be adjusted immediately after the deficiency is addressed.
- Temporary supports (shoring, bracing, or underpinning) should generally not improve the NBI rating. *One exception would be if a critical condition was corrected with temporary shoring (the NBI rating should be raised from condition 2 after the temporary repairs have been performed).*
- The load-carrying capacity should not be considered when determining the NBI condition ratings.

Use the tables below as general guidelines for rating NBI numbers 58-60 and 62.

<u>General Guidelines on Code Definitions</u>

Code	Condition	Description
9	Excellent	No defects.
8	Very Good	Insignificant defects.
7	Good	Isolated minor defects.
6	Satisfactory	Widespread minor or isolated moderate defects.
5	Fair	Some moderate defects, strength, and performance of the component are not affected.
4	Poor	Widespread moderate or isolated major defects; strength or performance of the component is affected.
3	Serious	Major defects; strength or performance of the component is seriously affected. Condition likely requires more frequent monitoring, corrective action, or load restrictions.
2	Critical	Major defects; component is severely compromised.
1	Imminent Failure	A bridge is closed to traffic due to the condition. Corrective action may return the bridge to service.
0	Failed	The bridge is closed and will not reopen.

Material Specific, Defect Severity Descriptions

Material	**Defect**	**Minor**	**Moderate**
Concrete	Delamination, Spall, Patched Area	Delamination. Patched Area. Spall less than 6” in diameter or less than 1” deep.	Unsound patched area. Larger/Deeper Spalls.
	Exposed Rebar	Present without measurable section loss.	Present with measurable section loss.
	Exposed Prestressing	NA	Present.
	Cracking*	Unsealed medium width cracks or unsealed medium map cracking.	Wide cracks or heavy map cracking.
	Abrasion, Wear	Exposed but secure coarse aggregate.	Aggregate is loose or has popped out.
	Efflorescence, Rust Staining	Surface white or leaching with little build-up.	Heavy build-up or rust staining (from reinforcing steel).
Steel	Corrosion	Present. Freckled rust.	Section loss is evident.
	Cracking	Effectively arrested.	Not arrested.
	Connection	Connection is functionalizing as intended but has loose fasteners or pack rut without distortion.	Missing fasteners, broken welds, or pack rust with distortion.
Timber	Cracking	Effectively arrested.	Not arrested.
	Decay, Section Loss	Affects up to 10% of the member section.	It affects more than 10% of the member's section
	Checks, Shakes	Penetrates 5%-50% of the thickness of the member, not in a high-stress zone.	Penetrates more than 50% of the member thickness and length equal to or greater than the member depth or penetrates more than 5% of the member thickness in a high-stress zone.
	Splits, Delamination	Length is less than the member depth, or it is effectively arrested.	Length equal to or greater than the member depth; not arrested
	Abrasion, Wear	Affects up to 10% of the member section.	Affects more than 10% of the member section.

*Concrete cracking:

- Insignificant - width less than 0.012” or 0.004” (prestressed) and medium cracks that have been sealed.
- Medium - width ranging from 0.012-0.05 or 0.004-0.009 (prestressed).
- Wide - width greater than 0.05” or 0.009” (prestressed).
- Medium Map Cracking – Spacing of 1’-3’.
- Heavy Map Cracking – Spacing less than 1’.

General Defect Severity Descriptions

Defect	Minor	Moderate
Distortion	The distortion has been mitigated or does not require mitigation.	A distortion that requires mitigation
Settlement*	It exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits
Scour**	It exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than critical limits determined by scour evaluation or design analysis.
Deterioration	Breakdown or deterioration has initiated.	Significant deterioration or breakdown.

Tolerable settlement can be considered uniform or minor to the extent that it is not causing other bridge defects or increased impact loads from traffic on the bridge.*Settlement defect applies only to substructure components. Superstructure or deck components may indirectly show the effects of settlement but should be evaluated by the resulting defects not the settlement itself.

**See the NBI Coding Guide (1995) pages 75-76 for guidance on tolerable and critical limits.

NBI Item Numbers

NBI condition codes are properly used when they provide an overall characterization of the general condition of the entire component being rated. Conversely, they are improperly used if they attempt to describe localized or nominally occurring instances of deterioration or disrepair. Therefore, the correct assignment of a condition code must consider both the severity of the deterioration of disrepair and the extent to which it is widespread throughout the rated component.

Although the FHWA Coding Guide states that it is improper to use the condition codes to describe localized instances of deterioration or disrepair, it also says that the Inspector must consider the severity and extent of the decline. With this in mind, there are occasions when a severe, localized condition affects the structural capacity of a component member.

While the NBI condition ratings describe the general overall condition of a bridge, additional NBI items need to be coded. The rating system was developed by the Federal Highway Administration (FHWA) and is outlined in the "FHWA Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges." Inspection teams should refer to this guide for guidance in how to code item numbers for bridges. Some additional guidance is given in this chapter for specific item numbers that may need further explanation. The following item numbers fall under the responsibility of the Inspector.

Inspector Responsibly (86 NBI Fields)	
NBI 001: State Code	NBI 047: Inventory Route, Total Horizontal Clearance
NBI 002: Highway Agency District	NBI 048: Length of Maximum Span
NBI 003: County (Parish) Code	NBI 049: Structure Length
NBI 004: Place Code	NBI 050A: Curb or Sidewalk Width: Left Side
NBI 005A: Inventory Route: Record Type	NBI 050B: Curb or Sidewalk Width: Right Side

NBI 005B: Inventory Route: Rt. Signing Prefix	NBI 051: Bridge Roadway Width, Curb-To-Curb
NBI 005C: Inventory Route: Level of Service	NBI 052: Deck Width, Out-To-Out
NBI 005D: Inventory Route: Route Number	NBI 053: Min. Vert. Clearance OVER Bridge Roadway
NBI 005E: Inventory Route: Direction Suffix	NBI 054A: Min. Vert. Under Clearance: Ref. Feature
NBI 006: Feature Intersected	NBI 054B: Minimum Vertical Under Clearance
NBI 007: Facility Carried by Structure	NBI 055A: Min. Lat. Under Clearance on Rt.: Ref. Feat.
NBI 008: Structure Number	NBI 055B: Min. Lat. Under Clr. on Rt.: Min. Lat. Under Clr.
NBI 009: Location	NBI 056: Minimum Lateral Under Clearance on Left
NBI 010: Minimum Vertical Clearance	NBI 058: Deck
NBI 011: Milepoint	NBI 059: Superstructure
NBI 016: Latitude	NBI 060: Substructure
NBI 017: Longitude	NBI 061: Channel and Channel Protection
NBI 019: Bypass Detour Length	NBI 062: Culverts
NBI 021: Maintenance Responsibility	NBI 071: Waterway Adequacy
NBI 022: Owner NBI 027: Year Built	NBI 072: Approach Roadway Alignment NBI 090: Inspection Date
NBI 028A: Lanes on the Structure	NBI 091: Designated Inspection Frequency
NBI 028B: Lanes Under the Structure	NBI 092A: Critical Features: Fracture Critical Details
NBI 032: Approach Roadway Width	NBI 092A: Critical Features: Fracture Critical Required
NBI 033: Bridge Median	NBI 092B: Critical Features: UW Inspection
NBI 034: Skew	NBI 092B: Critical Features: UW Inspection Required
NBI 035: Structure Flared	NBI 092C: Critical Features: Special Inspection
NBI 036A: Traffic Safety Feat.: BR. Railings	NBI 092C: Critical Features: Special Insp. Required
NBI 036B: Traffic Safety Features: Transitions	NBI 093A: Critical Feat. Insp. Date: Fract. Critical Details
NBI 036C: Traf. Safety Feat.: Appr. Guardrail	NBI 093B: Critical Feat. Insp. Date: Underwater Inspection
NBI 036D: Traf. Safety Feat.: Appr. Grail. Ends	NBI 093C: Critical Feat. Insp. Date: Special Inspection
NBI 038: Navigation Control	NBI 100: STRAHNET Highway Designation
NBI 039: Navigation Vertical Clearance	NBI 101: Parallel Structure Designation
NBI 040: Navigation Horizontal Clearance	NBI 102: Direction of Traffic
NBI 041: Struc. Open, Posted, Closed to Traf.	NBI 103: Temporary Structure Designation
NBI 042A: Type of Service: ON Bridge	NBI 106: Year Reconstructed
NBI 042B: Type of Service: UNDER Bridge	NBI 107: Deck Structure Type
NBI 043A: Struc. Type, Main: Kind Mat./Des.	NBI 108A: Type of Wearing Surface
NBI 043B: Struc. Type, Main: Type Des./Con.	NBI 108B: Type of Membrane
NBI 044A: Struc. Type, Appr. Spans: Mat./Des.	NBI 108C: Deck Protection
NBI 044B: Struc. Type, Appr. Spans: Type Des/Con.	NBI 111: Pier or Abutment Protection
NBI 045: Number of Spans in Main Unit	NBI 112: NBIS Bridge Length
NBI 046: Number of Approach Spans	NBI 116: Min. Nav. Vertical Clearance, Vertical Lift Bridge

Item 1 - State Code

This is always coded “05” and “Region 6”

Item 3 - County Code

Arkansas numbers the 75 counties by alphabetical order, placing St. Francis County just after Sharp County. FHWA spells out Saint Francis putting it just before Saline County. Also, the FHWA numbers the counties using the formula: (Arkansas County number x 2) – 1 Example: Randolph County is 61; FHWA number is (61 X 2) –1 = 121.

Item 4 - City/Town/Place Code

Select a city from the item’s pick list. Notify the Central Office if the name is not available for the bridge.

Item 5A - Record Type

There are two types of National Bridge Inventory records: “on” and “under.” Code the first digit (leftmost) using one of the following codes:

Code	Description
1	Route carried "on" the structure
2	Single route goes "under" the structure
A through Z	Multiple routes go "under" the structure

When determining the coding of Item 5A for multiple “under” records, use the following hierarchy of route types:

1. If the route is a STRAHNET (Item 100 = 1, 2, or 3), it has the highest priority. If several STRAHNET types exist, the route with Item 100 = “1” must be coded first, with others in descending order. Main lanes have precedence over ramps and frontage roads.
2. Non-STRAHNET U.S. highways have the next priority.
3. Non-STRAHNET state highways have the next priority.
4. Non-STRAHNET county routes or city streets have the lowest priority.

Example 1 - Interstate main lanes and frontage roads under a bridge.

Item 5A	On/Under	Route Description
A	1st Route under	The right-hand main lane in the direction of the log mile
B	2nd Route under	The left-hand main lane in the direction of the log mile
C	3rd Route under	The right hand frontage road in the direction of the log mile
D	4th Route under	The left-hand frontage road in the direction of the log mile

Example 2 - Interstate main lanes and ramp and STRAHNET U.S. highway under a bridge

Item 5A	On/Under	Route Description
A	1st Route under	The right hand interstate main lane in the direction of the log mile
B	2nd Route under	The left-hand interstate main lane in the direction of the log mile
C	3rd Route under	The interstate ramp
D	4th Route under	The STRAHNET U.S. highway

Example 3 - STRAHNET U.S. highway, Non-STRAHNET state and county highways under a bridge

Item 5A	On/Under	Route Description
A	1st Route under	The STRAHNET U.S. highway
B	2nd Route under	The Non-STRAHNET state highway
C	3rd Route under	The Non-STRAHNET county highway

Example 4 - Two Non-STRAHNET state highways and a county highway under a bridge

Item 5A	On/Under	Route Description
A	1st Route under	The Non-STRAHNET state highway that is most important, usually indicated by a smaller route number or higher ADT
B	2nd Route under	The other Non-STRAHNET state highway
C	3rd Route under	The Non-STRAHNET county highway

"Under" signifies that the inventor route goes "under" the structure. When this item is coded 2 or A through Z, only the following items must be coded for the under record: Items 1, 3-11, 16, 17, 19, 20, 26-30, 42, 43, 47-49, 100-104, 109 and 110. All other items may remain blank.

Item 5E - Directional Suffix:

Refer to the FHWA Recording and Coding Guide - Code "0" (i.e., not applicable) for bridges carrying two-way traffic. For bridges carrying one-directional traffic - such as parallel bridges on the Interstate where one bridge carries East-bound traffic and the other bridge carries West-bound traffic - code "1" through "4", as applicable.

Item 6B –Critical Facility Indicator

Will no longer be coded, and a blank space will be inserted in its place

Item 7 –Facility Carried By Structure:

Refer to the FHWA Recording and Coding Guide. Many counties have changed the road numbers over the years to accommodate 911 systems and have changed their road numbers. The Inspector shall update this road number as they become aware of it. The facility carried is printed on the Maintenance Needs and is useful for the local owners in bridge identification.

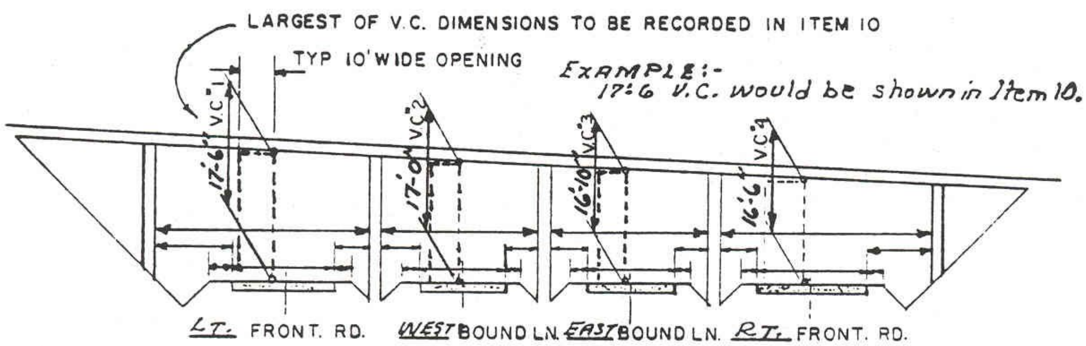
Item 10 - Inventory Route, Minimum Vertical Clearance

Code the minimum vertical clearance **over** the **inventory route** identified in Item 5, whether the route is "**on**" the structure or "**under**" the structure. The minimum clearance for a 3-meter width of the pavement or traveled part of the roadway where the clearance is the greatest shall be recorded and coded as a 4-digit number truncated to the hundredth of a meter (with an assumed decimal point). For structures having multiple openings, clearance for each opening shall be recorded, but only the greatest of the "minimum clearances" for the two or more openings shall be coded regardless of the direction of travel. This would be the **practical maximum clearance**. When no restriction exists or when the restriction is 30 meters or greater, code 9999. Coding of actual clearances between 30.0 and 99.99 meters to an exact measurement is optional.

* MULTIPLE ROADWAY OPENINGS:

Show least vertical dimension for the largest 10' wide opening of each opening on Form IIIB. (See sketch below)

Record the largest of these vertical dimensions in Item 10.



MULTI LANE WITH FRONTAGE RD.

Item 27 – Year Built

For a known date, this should be the date the structure is open to traffic. Do not use the date on the nameplate or date let to contract unless no better information is available. For a bridge that has been widened or otherwise reconstructed, this date is the date of the original construction - not the reconstruction date. For a structure that has been completely rebuilt, a new structure number should be requested. Do not show as reconstructed. Item 27B should be coded "K" if the year built is known or "E", if the year built is estimated.

Item 32 – Approach Roadway Width

If there is a step down at the shoulder or median greater than 1", do not include the shoulder or median width in the measurement unless it is a temporary construction condition that is clearly signed and will be remedied soon.

Items 36a, 36b, 36c, and 36d – Traffic Safety Features

Refer to the FHWA Recording and Coding Guide and the following FHWA website:
https://safety.fhwa.dot.gov/roadway_dept/countermeasures/faqs/qa_bttabr.cfm

If the as-built railing system does not meet safety requirements but is in good condition, the traffic safety features are noted under Item 36. Maintenance Needs should be noted only when the as-built railing is damaged or deteriorated, requiring maintenance. If a bridge was initially constructed without an approach guardrail, then Maintenance Needs notation would not be needed.

Item 43B – Main Span Design

Concrete T-beams should be coded 1/04. Concrete channel beams (precast units) should be coded 1/22.

Item 44B – Approach Span Design

Concrete T-beams should be coded 1/04. Concrete channel beams (precast units) should be coded 1/22.

Item 47 – Inventory Route, Total Horizontal Clearance

If the curb or other obstruction is less than 6" high, this dimension should be measured to the rail or other 6" or higher obstruction.

Item 53. Minimum Vertical Clearance Over Bridge Roadway

This is the clearance for the route of the "on" record.

Item 54b. Minimum Vertical Underclearance

Code the most restrictive clearance for any route under the bridge. Use Form IIIB to record dimensions. A revised Form IIIB should be completed and submitted to the Central Office whenever a change in under clearance (vertical or horizontal) occurs.

Item 58 - Deck

This item should describe the overall condition rating of the deck. The rating does not include the condition of the surface/protective systems, joints, expansion devices, curbs, sidewalks, parapets, fascias, bridge rail, and scuppers. Still, these conditions will be noted in the inspection. Decks that are integral with the superstructure will be rated as a deck only and not influence the superstructure rating. In addition to using the general condition guidelines on the next page and as contained in the FHWA Coding Guide, the following descriptive codes shall also be used to assist in evaluating the condition of various components.

__Codes Applicable to Decks of Different Materials__

CODE	GENERAL DESCRIPTION	GENERAL TERMS	CONCRETE	STEEL	TIMBER
N	**Not Applicable**		**Use N for Culverts**	**Use N for Culverts**	**Use N for Culverts**
9	**Excellent Condition**	**No Defects**	***No Defects***	***No Defects***	***No Defects***
8	**Very Good**	**Insignificant Defects.**	**Minor Transverse Cracks. No Spalling, Scaling, Delamination**	**Tightly Secured. No Rust.**	**Tightly Secured. No Crushing, Rotting, or Spalling.**
7	**Good**	**Isolated Minor Defects**	**Sealable Cracks, Light Scaling (less than ¼"), No Spalling but visible tire wear in wheel line**	**Loose at some connections, Few Cracked Welds /Broken grids, Minor Rust**	**Minor Cracking or Splitting. Few loose Planks.**
6	**Satisfactory**	**Widespread minor or isolated moderate defects.**	**Excessive Number of Open Cracks (5' spacing) Med. Scaling (1/4"-1/2" deep) Spalling 2% or Less Area: Delam. Area < 5%**	**Considerable Rust / Initial Sect. Loss, Loose at Many Locations—some Cracked Welds / Broken Grids.**	**Minor Number of Rotted or Crushed Planks. Many Cracked, Split or Loose. No Sect. Loss on Fire Damage.**
5	**Fair**	**Some moderate defects; strength, and performance of the component are not affected**	**2 – 5% Area Spalled, 5 – 15% Area Delam., Heavy scaling (1/2" to 1" depth), Partial / Full Failures, Considerable leaching through the deck**	**Heavy Rust with Areas of Sect. Loss, Loose at Numerous Locations, Numerous Cracked Welds / Broken Grids.**	**Numerous Planks Cracked, Split, Rotted, Or Crushed. Majority of Planks Loose. Minor Sect. Loss From Fire Damage.**
4	**Poor**	**Widespread moderate or isolate major defects; strength or performance of the component is affected.**	**> 5% Spalled Area, 15 – 20% Delam., This area includes any repaired areas or areas in need of corrective action; many full depth present or imminent, Leaching throughout**	**Heavy Rusting with Considerable Sect. Loss., Some Holes, Majority of Welds Cracked and/or Grids Broken.**	**Majority of Planks Rotted, Crushed, and/or Split. Significant Sect. Loss From Fire Damage Reducing Load Capacity of the Member**
3	**Serious**	**Major defects; strength or performance of the component is seriously affected. Condition typically necessitates more frequent**	**+ 20% Delam., Many Full Depth Failures**	**Critical Signs of Structural Distress**	**Critical Signs of Structural Distress. Major Fire Damage Substantially Reducing Load Capacity of the Member.**

		monitoring, corrective actions, or load restrictions.			
2	**Critical**	**Major Defects; component is severely compromised.**	**Full Depth Failures Over Much of Deck**	**Many Holes Through Deck.**	**Advanced Deterioration with Partial Deck Failure.**
1	**Imminent Failure**	Bridge Closed. Corrective Action Possible	**Bridge Closed. Corrective Action Possible.**	**Bridge Closed. Corrective Action Possible.**	**Bridge Closed. Corrective Action Possible.**
0	**Failed**	**Bridge Closed. Replacement Necessary.**	**Bridge Closed. Replacement Necessary.**	**Bridge Closed. Replacement Necessary.**	**Bridge Closed. Replacement Necessary.**

A deck rehabilitated by hydro-demolition and then overlaid will mainly be rated based on the condition of the top of the deck. The bottom of the deck may lower the rating by no more than one. This is to account for the poor concrete being removed during the rehabilitation. The Federal Coding Guide and the BIRM does not yet address decks that have been rehabilitated in this manner so this guidance supersedes their guidance for bridges rehabilitated by hydro-demolition.

Item 59 - Superstructure

Rate and code the conditions in accordance with the general condition ratings in the FHWA Coding Guide, pages 84-86, and the following descriptive codes, which shall be used as an additional guide in evaluating the superstructure condition.

Two sets of descriptive codes shall be used to evaluate this item: (1) the codes applicable to all superstructures not tied to a specific type of material, and (2) the codes applicable to concrete, steel, or timber superstructures. The lowest of the codes determined shall be reported.

Codes Applicable to all Superstructures

Code	Description
N	Use for all culverts.
9	No noticeable or noteworthy deficiencies which affect the condition of the superstructure.
8	Minor collision damage without misalignment or corrective action required.
7	Minor longitudinal or transverse movement of the superstructure.
6	Minor collision damage to nonstructural support elements.
5	Substantial but not critical, collision damage to structural support elements (through girders, trusses, etc.).
4	Critical collision damage sustained to structural support elements and precautionary measures may be needed, such as temporary shoring. Bearings may be frozen from corrosion, misaligned, and are causing problems to superstructure or substructure.
3	Damage or disintegration of a structural support element which requires shoring, auxiliary splices, or substitute members.
2	Permanent deformation of main support member or members.
1	Bridge closed. Corrective action may put back in light service.
0	Bridge closed. Replacement required.

__Codes Applicable to Superstructures of Different Materials__

CODE	GENERAL DESCRIPTION	GENERAL TERMS	CONCRETE	STEEL	TIMBER
N	Not Applicable		Use N for Culverts	Use N for Culverts	Use N for Culverts
9	Excellent Condition	No Defects	No Noteworthy Deficiencies	No Noteworthy Deficiencies	No Noteworthy Deficiencies
8	Very Good	Insignificant Defects	Negligible Scaling, Insignificant Accident Damage.	No Visible Rust.	Minor Cracking / Splitting of Beams / Stringers at Non-Critical Locations.
7	Good	Isolated Minor Defects	Non-Structural Hairline Cracks Without Disintegration	Some Rust but no Section Loss.	Insignificant Decay Cracking or Splitting of Beams / Stringers.
6	Satisfactory	Widespread minor or isolated moderate defects.	Minor Deterioration	Initial Section Loss (minor pitting, scaling, or flaking) in Non-Critical Areas.	Some Decay. Cracking or Splitting of Beams / Stringers. No Section Loss From Fire Damage.
5	Fair	Some moderate defects; strength, and performance of the component are not affected.	Substantial Deterioration. Hairline Structural Cracks / Spalls. Possible Reinf. Steel Section Loss (minor).	Initial Section Loss in Critical Areas, Fatigue or out-of-plane bending in non-critical areas,	Substantial Decay, Cracking, Splitting of Beams / Stringers. Fire Damage with Minor Measurable Section Loss.
4	Poor	Widespread moderate or isolate major defects; strength or performance of the component is affected.	Extensive Disintegration. Measurable Structural Cracks. Large Spall Areas. Reinf. Steel Exposed With Measurable Section Loss.	Measurable Section Loss in Critical Stress Area. Fatigue Bending Cracks Possible in Major Structural Elements, Hinges may be frozen from corrosion	Extensive Decay, Cracking, Splitting, or Crushing of Beams or Stringers. Significant Section Loss From Fire Damage Reducing Load Carrying Capacity.
3	Serious	Major defects; strength or performance of the component is seriously affected. Condition typically necessitates more frequent monitoring, corrective	Severe Disintegration. Large Structural Cracks. Advanced Corrosion in Exposed Reinf. Steel. Localized Loss of Bond.	Severe Section Loss in a Critical Stress Area.	Severe Decay, Cracking, Splitting or Crushing of Beams or Stringers. Major Fire Damage Substantially Reducing Load Carrying Capacity.

		actions, or load restrictions.			
2	Critical	Major Defects; component is severely compromised.	Concrete Disintegrated Around Reinf. Steel with Loss of Bond. Numerous Large Structural Cracks. Possible Local Bearing Failures.	Severe Section Loss in Many Areas With Holes at Numerous Locations.	Beam Ends Crushed or Split with Some Deck Settlement. Further Deterioration of Conditions Noted in Code 3.
1	Imminent Failure	Bridge Closed. Corrective Action Possible.	Bridge Closed. Corrective Action Possible.	Bridge Closed. Corrective Action Possible.	Bridge Closed. Corrective Action Possible.
0	Failed	Bridge Closed. Replacement Necessary. .	Bridge Closed. Replacement Necessary.	Bridge Closed. Replacement Necessary.	Bridge Closed. Replacement Necessary.

Item 60 - Substructure

Rate and code the condition in accordance with the previously described general condition ratings in the FHWA Recording and Coding Guide, pages 84-86, and the following additional descriptive codes, which shall be used as an additional guide in evaluating the substructure condition. The rating factor given to Item 60 should be consistent with the one given to Item 113 whenever a rating factor of 2 or below is determined for Item 113 – Scour Critical Bridges.

Two sets of descriptive codes shall be used to evaluate this item: (1) the codes applicable to all substructures not tied to a specific type of material, and (2) the codes applicable to concrete, steel, or timber superstructures. The lowest of the codes determined shall be reported.

Codes Applicable to all Substructures

Code	Description
N	Use for all culverts.
9	No noticeable or noteworthy deficiencies which affect the condition of the substructure. Insignificant scrape marks caused by drift or collision.
8	Shrinkage cracks, light scaling, or insignificant scaling that does not expose reinforcing steel. Insignificant damage caused by drift or collision with no misalignment and not requiring corrective action.
7	Deterioration or initial disintegration, cracking with some leaching, or spalls on concrete or masonry units with no effect on bearing area. Leakage of expansion devices have initiated minor cracking—some rusting of steel without measurable section loss. Insignificant decay, cracking or splitting of timber. Minor scouring may have occurred.
6	Moderate deterioration or disintegration, spalls, cracking, and leaching on concrete or masonry units with little or no loss of bearing area. Initial (measurable) loss of steel section. Some initial decay, cracking or splitting of timber. Fire damage limited to surface scorching of timber with no measurable section loss. Shallow, local scouring may have occurred near the foundation.
5	Concrete or masonry units show some section loss with exposed reinforcing steel possible—measurable section loss in steel members. Moderate decay, cracking, or splitting of timber, a few secondary members, may need replacement. Fire damage limited to surface charring of timber with minor, measurable section loss. Some exposure of timber piles as a result of erosion, reducing the penetration. Scour may be progressive and/or is becoming more prominent with a possibility of exposing the top of the footing, but no misalignment or settlement noted.
4	Structural cracks in concrete and masonry units. Substantial decay, cracking, splitting, or crushing of primary timber members, requiring some replacement. Fire damage with significant section loss of the member. Extensive exposure of timber piles as a result of erosion, reducing the penetration and affecting the stability of the unit. Additional cross bracing or backfilling is required—extensive scouring or undermining of footing affecting the stability of the unit and requiring corrective action.

3 Severe disintegration of concrete. Generally, reinforcing steel exposed with advanced stages of corrosion. Severe section loss in critical stress areas. Major fire damage to timber which will substantially reduce the load-carrying capacity of the member. Bearing areas seriously deteriorated with considerable loss of bearing—severe scouring or undermining of footings affecting the stability of the unit. Settlement of the substructure may have occurred. Blocking and shoring considered necessary (not just precautionary) to maintain the safety and alignment of the structure.

2 Concrete cap is soft and spalling with reinforcing steel exposed with no bond to the concrete. The top of the concrete cap is split, or the concrete column has undergone shear failure. Structural steel members have critical section loss with holes in the web and/or knife-edged flanges typical. Primary timber members crushed or split and ineffective. Scour is sufficient that substructure is near state of collapse. Pier has settled.

1 Bridge closed. Corrective action may put back in light service.

0 Bridge closed. Replacement necessary

__Codes Applicable to Substructures of Different Materials__

CODE	GENERAL DESCRIPTION	GENERAL TERMS	CONCRETE	STEEL	TIMBER
N	Not Applicable		Use N for Culverts	Use N for Culverts	Use N for Culverts
9	Excellent Condition	No Defects	No Noteworthy Deficiencies. Insignificant Scrape Marks.	No Noteworthy Deficiencies. Insignificant Scrape Marks.	No Noteworthy Deficiencies. Insignificant Scrape Marks.
8	Very Good	Insignificant Defects	Cracks, Light Scaling, or Insignificant Spalling Not Exposing Reinf. Steel. Insignificant Damage with no Misalignment Not Requiring Correction.	Insignificant Damage with no Misalignment Not Requiring Correction.	Insignificant Damage with no Misalignment Not Requiring Correction.
7	Good	Minor Defects	Deterioration or Initial Disintegration, Cracking with Some Leaching or Spalls. No Effect on Bearing Area. Minor Cracking Due to Leakage of Exp. Device.	Some Rust Without Measurable Section Loss. Minor Scour Possible.	Insignificant Decay Cracking or Splitting. Minor Scour Possible.
6	Satisfactory	Widespread minor or isolated moderate defects.	Moderate Deterioration, Disintegration, Spalls and Cracking with Leaching. Little Loss of Bearing Area Possible. Shallow Local Scour Near Foundation Possible.	Initial Measurable Section Loss. Shallow Local Scour Near Foundation Possible.	Initial Decay, Cracking or Splitting. Shallow Local Scour Near Foundation Possible. Fire Damage Limited to Surface Scorching. No Section Loss.
5	Fair	Some moderate defects; strength and performance of the component are not affected.	Some Section Loss with Exposed Reinf. Steel Possible. Scour More Prominent Possibly Exposing Footing but no Settlement or Misalignment.	Measurable Section Loss. Scour More Prominent Possibly Exposing Footing but no Settlement or Misalignment.	Moderate Decay, Cracking or Splitting. Fire Damage Resulting in Minor Measurable Section Loss. Some Exposure as a Result of Erosion Reducing Pile Penetration. No Settlement or Misalignment.
4	Poor	Widespread moderate or isolate major defects; strength or performance of the component is affected.	Structural Cracks. Extensive Erosion / Scour Reducing Penetration or Affecting Stability Requiring Correction.	Extensive Section Loss. Extensive Erosion / Scour Reducing Penetration or Affecting Stability Requiring Correction.	Substantial Decay, Cracking, Splitting or Crushing of Primary Members Requiring Some Replacement. Significant Section Loss Due to Fire Reducing Load Carrying

					Capacity. Extensive Erosion / Scour Reducing Penetration Affecting Stability Requiring Correction.
3	Serious	Major defects; strength or performance of the component is seriously affected. Condition typically necessitates more frequent monitoring, corrective actions, or load restrictions.	Severe Disintegration Exposing Reinf. Steel with Advanced Stages of Corrosion. Severe Section Loss in Critical Stress Areas. Bearing Area Loss. Severe Scour Affecting Stability. Settlement Possible. Shoring Necessary.	Severe Section Loss in Critical Stress Areas. Bearing Areas Seriously Deteriorated with Bearing Loss. Severe Scour Affecting Stability. Settlement Possible. Shoring Necessary.	Severe Section Loss in Critical Stress Areas. Major Fire Damage Substantially Reducing Load Capacity. Bearing Area Loss. Severe Scour Affecting Stability. Settlement Possible. Shoring Necessary.
2	Critical	Major Defects; component is severely compromised. s	Spalling Soft Concrete Exposing Reinf. Steel Without Bond. Failure Cracks in Caps and Columns. Scour Resulting in Near Collapse. Settlement.	Critical Section Loss. Holes in Web or Knife Edge Flanges. Scour Resulting in Near Collapse.	Ineffective Primary Members Due to Crushing or Splitting. Scour Resulting in Near Collapse.
1	Imminent Failure	Bridge Closed. Corrective Action Possible.	Bridge Closed. Corrective Action Possible.	Bridge Closed. Corrective Action Possible.	Bridge Closed. Corrective Action Possible.
0	Failed	Out of Service	Bridge Closed. Replacement Necessary.	Bridge Closed. Replacement Necessary.	Bridge Closed. Replacement Necessary.

Item 62 - Culvert

Rate and code the conditions in accordance with the general condition ratings in the FHWA Coding Guide and the following descriptive codes, which shall be used as an additional guide in evaluating the superstructure condition.

Codes Applicable to all Culverts

Code	Description
N	Not applicable.
9	No deficiencies.
8	No noticeable or noteworthy deficiencies which affect the condition of the culvert. Insignificant scrape marks caused by drift.
7	Shrinkage cracks, light scaling, and insignificant spalling which does not expose reinforcing steel. Insignificant damage caused by drift with no misalignment and not requiring corrective action. Some minor scouring has occurred near curtain walls, wingwalls, or pipes. Metal culverts have a smooth, symmetrical curvature with superficial corrosion and no pitting.
6	Deterioration or initial disintegration, minor chloride contamination, cracking with some leaching, or spalls on concrete or masonry walls and slabs. Local minor scouring at curtain walls, wingwalls, or pipes. Metal culverts have a smooth curvature, non-symmetrical shape, significant corrosion, or moderate pitting.
5	Moderate to major deterioration or disintegration, extensive cracking, and leaching, or spalls on concrete or masonry walls and slabs. Minor settlement or misalignment. Noticeable scouring or erosion at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection in one section, significant corrosion, or deep pitting.
4	Large spalls, heavy scaling, wide cracks, considerable efflorescence, or opened construction joint permitting loss of backfill. Considerable settlement or misalignment. Considerable scouring or erosion at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection throughout, extensive corrosion, or deep pitting.
3	Any condition described in Code 4 but which is excessive in scope. Severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe scour or erosion at curtain walls, wingwalls, or pipes. Metal culverts have extreme distortion and deflection in one section, extensive corrosion, or deep pitting with scattered perforations.
2	Integral wingwalls collapsed severe settlement of roadway due to loss of fill. Section of culvert may have failed and can no longer support an embankment. Complete undermining at curtain walls and pipes. Corrective action required to maintain traffic. Metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion.

1 Bridge closed. Corrective action may put the bridge back in light service.

0 Bridge closed. Replacement necessary.

<u>Item 71 – Waterway Adequacy</u>

The values given are based on the Functional Classification (Item 26) of the route and the description of waterway adequacy (i.e., for a structure on Interstate route, a code of "7" would not be a valid code).

The following table is a summary of the FHWA Recording and Coding Guide's discussion on Item 71 and can be used as an aid in coding that item.

Codes Applicable to Waterway Adequacy

Principal Arterials- Interstates, Freeways, or Expressways	Other Principal And Minor Arterials and Major Collectors	Minor Collectors, Locals	DESCRIPTION	OVERTOPPING FREQUENCY	TRAFFIC DELAY
Code					
N	N	N	Bridge Not Over a Waterway		
9	9	9	Bridge Deck and Roadway Approaches Above Flood Water Elevations (High Water). Chance of Overtopping is Remote.	> 100 yrs.	
8	8	8	Bridge Deck Above Roadway Approaches. Slight Chance of Overtopping Roadway Approaches.	11 to 100 yrs.	
6	6	7	Slight Chance of Overtopping Bridge Deck And Roadway Approaches.	11 to 100 yrs.	
4	5	6	Bridge Deck Above Roadway Approaches. Occasional Overtopping of Roadway Approaches With Insignificant Traffic Delays.	3 – 10 yrs.	Passable in Hours.
3	4	5	Bridge Deck Above Roadway Approaches. Occasional Overtopping of Roadway Approaches With Significant Traffic Delays.	3 – 10 yrs.	Passable in Several Days.
2	3	4	Occasional Overtopping of Bridge Deck and Roadway Approaches with Significant Traffic Delays.	3 – 10 yrs.	Passable in Several Days.
2	2	3	Frequent Overtopping of Bridge Deck and Roadway Approaches with Significant Traffic Delays.	< 3 yrs.	Passable in Several Days.
2	2	2	Occasional or Frequent Overtopping of Bridge Deck and Roadway Approaches with Severe Traffic Delays.	< 3 yrs.	Long Term.
0	0	0	Bridge Closed.		

Item 92C – Other Special

This is for monitoring a particular known or suspected deficiency. For our purposes, this would include our "Other Recurring Special Inspection" and could include an "Underwater Type 2 Inspection" if there is a known or suspected deficiency.

Item 103 – Temporary Structure Designation

Refer to the FHWA Recording and Coding Guide. Where detour bridges for contract jobs are encountered, this item should be coded "T," and only Items 10, 41, 47, 53, 54, 55, 56, and 70 are to be completed for the temporary structure. Items 91, 92A, 92C, and 107 should be completed based on the structure's condition without temporary measures. The structure number will be retained.

Item 106 – Year Reconstructed

This is the year in which extensive work was performed to reconstruct or rehabilitate the structure. Extensive work is defined as major work required to restore structural integrity and extend the useful life of a bridge. For a bridge that has been widened or otherwise reconstructed more than once, this date should be the most recent reconstruction date. Item 106B should be coded "K" if the reconstruction date is known or coded "E" if the reconstruction date is estimated.

Some examples of reconstruction or rehabilitation work are:

- Full-depth replacement or hydro-demolition and overlay of bridge deck where the deck's replaced portion(s) is 50% or more of the original bridge deck area.
- Bridge widening adds one or more traffic lanes or results in substructure widening.
- 50% or more of superstructure or substructure units replaced.

Refer to the FHWA Recording and Coding Guide for some types of work NOT to be considered reconstruction or rehabilitation.

Item 113 – Scour Critical Bridges

The inspector should not enter a value for Item 113 for new bridges. The inspector will inform the Staff Structures Engineer in the Bridge Division Rating Section for initial coding of Item 113 of a new bridge.

Suppose an inspector finds evidence of scour critical conditions. In that case, this should be documented in the inspection and reported to the Staff Structures Engineer in the Bridge Division Rating Section for reevaluation.

If an inspector finds evidence that scour countermeasures, such as riprap dumped next to a pier or bent, were placed at a bridge, this should be documented in the inspection and reported to an Engineer in the Bridge Division Rating Section for reevaluation.

Future changes to the initial coding of Item 113 are to be made only by an Engineer in the Bridge Division Rating Section.

The Plan Of Action (POA) for a scour-critical bridge is located under Files and the Scour tab in the bridge inspection software. Click on the drop-down box "Scour" to view the POA. Document any action taken related to the POA.

Chapter 10: Element Inspection Guidance

Introduction

Structural element condition ratings divide a bridge into separate components, which are then rated individually based upon the severity and extent of deterioration. This rating system was developed by the American Association of State Highway and Transportation Officials (AASHTO) and is outlined in the "Manual for Bridge Element Inspection" – First Edition, 2013 with current Interims. Structural element condition ratings will provide input data for a Bridge Management System (BMS), which can identify present maintenance needs and is intended to offer cost-effective options for long-range bridge maintenance and improvement programs (using computer projections of future deterioration).

This chapter is designed to answer questions that the Bridge Inspection Teams may have concerning coding the elements. The feedback from the Inspections Teams will be integral to developing this chapter into a helpful tool.

Element Level Condition States

The condition rating of a bridge component is coded with a rating of '4' (worst) through '1' (best). The bridge elements are rated in quantitative units or percentages for each condition state.

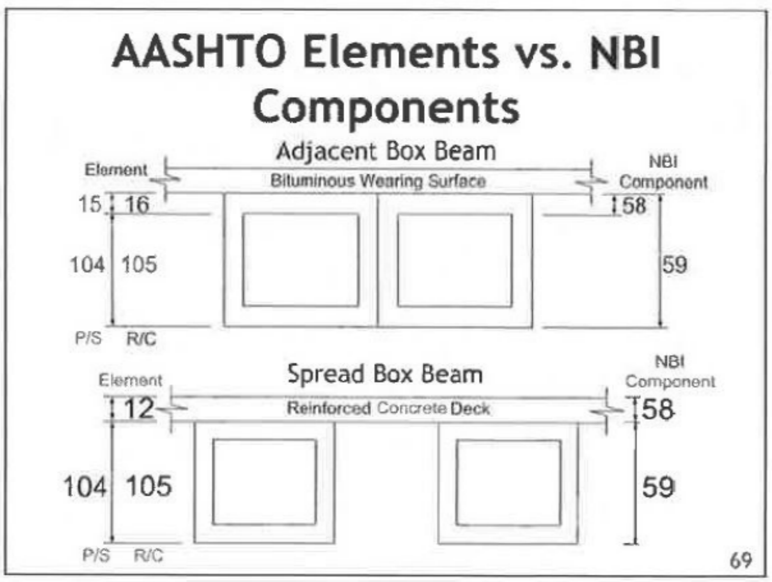
The condition of each element is determined by performing a field inspection and recording quantities of the element that have identified defects. The evaluation of the item is complete when the sum of all four condition states equals 100%. Ratings shall be rounded up to the nearest integer. The following chart provides a general guideline on how to collect and quantify the element.

Generic Item – Condition States (CS)				
Defect	*GOOD* *Condition State 1*	*FAIR* *Condition State 2*	*POOR* *Condition State 3*	*SEVERE* *Condition State 4*
Adjective	Quantity that is **Good**	Quantity that is **Fair**	Quantity that is **Poor**, does not warrant a structural review	**Warrants Structural Review** OR the defect impacts the strength or serviceability of the element
Maintenance Response -->	*Monitor* *Protect* *Repair* *Rehab* *Replace*	*Monitor* *Protect* *Repair* *Rehab* *Replace*	*Monitor* *Protect* *Repair* *Rehab* *Replace*	*Monitor* *Protect* *Repair* *Rehab* *Replace*

Condition State 4 Warrants a structural review or a structural review was performed, and the defect impacts strength or serviceability. This is reserved for critical conditions beyond the specific defects defined in the Condition States 1 through 3. Quantities in CS4 may often have implications that affect public safety OR reduction in load capacity. If the inspector determines an impact on the load capacity or a direct impact on safety, then the 4 is the appropriate rating. All Quantities in CS4 must be accounted for with quantitative descriptions and/or pictures.

<u>AASHTO Elements vs. NBI Components</u>

The following are examples of AASHTO Elements and how they compare to NBI Components:



Background Information: AASHTO *Manual for Bridge Element Inspection*, FHWA *Coding Guide*

Adjacent box beam

AASHTO elements:

- 15 - Prestressed concrete top flange
- 16 - Reinforced concrete top flange
- 104 - Prestressed concrete box beam
- 105 - Reinforced concrete box beam

NBI components:

- 58 - Deck
- 59 - Superstructure

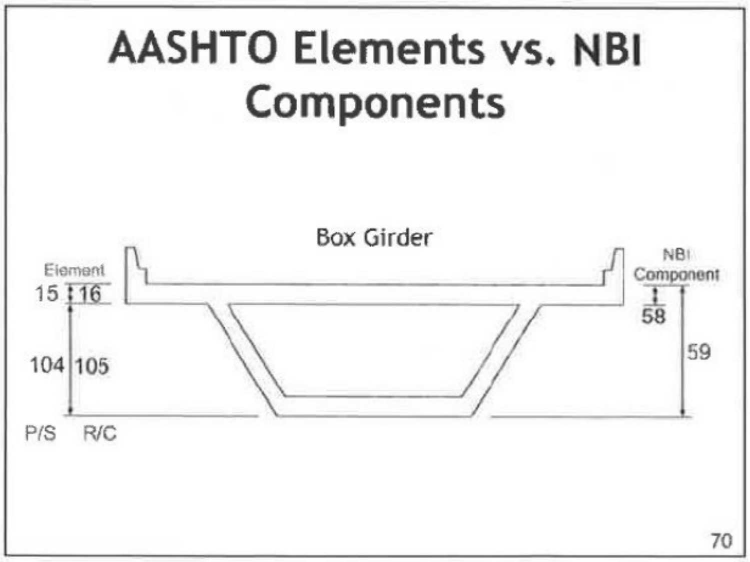
Spread box beam

AASHTO elements:

- 12 - Reinforced concrete deck
- 104 - Prestressed concrete box beam
- 105 - Reinforced concrete box beam

NBI components:

- 58 - Deck
- 59 - Superstructure



Background Information: AASHTO *Manual for Bridge Element Inspection*, FHWA *Coding Guide*

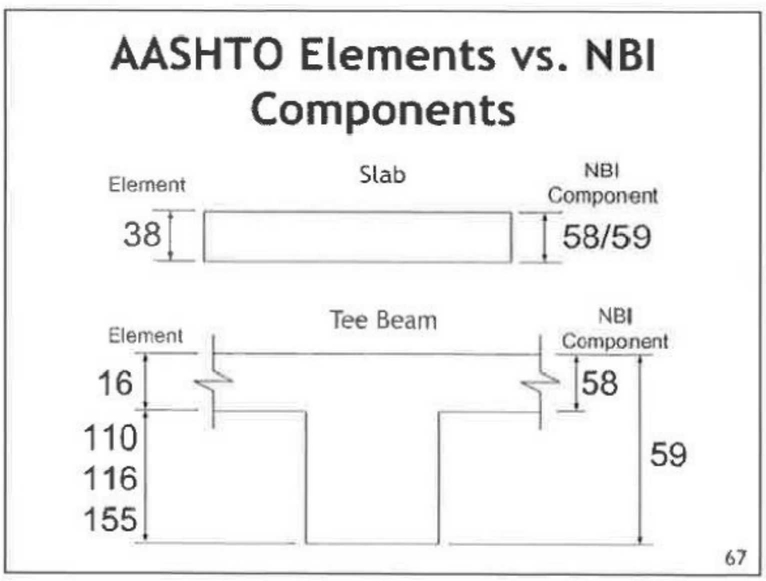
Box girder

AASHTO elements:

- 15 - Prestressed concrete top flange
- 16 - Reinforced concrete top flange
- 104 - Prestressed concrete box girder
- 105 - Reinforced concrete box girder

NBI components:

- 58 - Deck
- 59 - Superstructure



Background Information: AASHTO *Manual for Bridge Element Inspection*, FHWA *Coding Guide*

Slab

AASHTO elements:

- 38 - Reinforced concrete slab

NBI components:

- 58 - Deck
- 59 - Superstructure

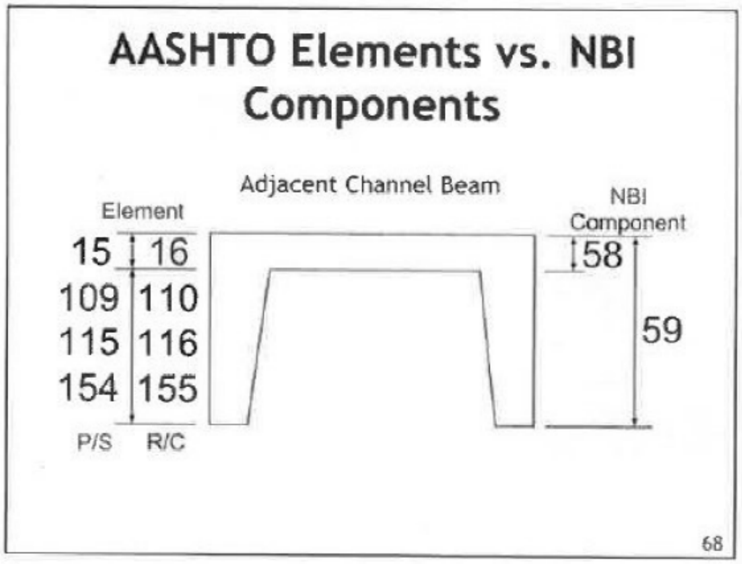
Tee beam

AASHTO elements:

- 16 - Reinforced concrete top flange
- 110 - Reinforced concrete girder
- 116 - Reinforced concrete stringer
- 155 - Reinforced concrete floorbeam

NBI components:

- 58 - Deck
- 59 - Superstructure



Background Information: AASHTO *Manual for Bridge Element Inspection*, FHWA *Coding Guide*

Adjacent Channel Beam

AASHTO elements:

- 15 - Prestressed concrete top flange
- 16 - Reinforced concrete top flange
- 110 - Reinforced concrete girder
- 116 - Reinforced concrete stringer
- 155 - Reinforced concrete floorbeam
- 109 - Prestressed concrete girder
- 115 - Prestressed concrete stringer
- 154 - Prestressed concrete floorbeam

NBI components:

- 58 - Deck
- 59 - Superstructure

Weathering Steel Protective Coating

The inspection of weathering steel bridges differs from that of a painted steel bridge. The entire surface area of weathering steel is covered in a patina or rust layer. The inspector must distinguish between a protective and non-protective oxide coating. Slight variations in color and texture are important indicators of non-protective coating requiring close inspection. Inspector shall note any section loss associated with coating failure in the appropriate item.

Visual Color Table for Weathering Steel

Color	Film Stage	Condition
Yellow-Orange	Initial stage of exposure	Acceptable
Light Brown	Early-stage of exposure	Acceptable
Chocolate brown to purple-brown	Development of protective oxide	Acceptable
Black	Non-protective oxide	**Failed**

The oxide film must be tested by tapping or vigorously wire brushing to determine whether the film is adhering to the substrate. Physical and visual means are used in conjunction to determine the condition of the oxide film accurately. The oxide film texture may debond in the form of granules, flakes, or laminar sheets. New weathering steel requires 3 to 5 years to stabilize. An inspector should keep in mind the year built when evaluating the oxide film. The interior surfaces are likely to exhibit the same color as the exterior beams but sheltered from the wind and rain, the initial dusty surface is not sweep clean, thus becoming embedded and leaving a coarse finish.

Texture Table for Weathering Steel

Texture	Surface Stage	Condition
Tightly adherent, capable of withstanding hammering or vigorous wire brushing	Protective oxide film	Acceptable
Dusty	Early stage of exposure	Acceptable
Granular	Possible development of non-protective oxide	Acceptable
Small flakes, 1/4” diameter	Non-protective oxide	**Failed**
Large flakes, ½” diameter	Non-protective oxide	**Failed**
Laminar sheets of nodules	Non-protective oxide, severe corrosion	**Failed**

Defect Hierarchy

The ASSHTO *Manual for Bridge Element Inspection* lists multiple defects to be used for specific bridge elements constructed of specific materials. A defect in a worse condition state (higher number on the 1-4 scale) controls over a separate defect for the same unit of quantity for the element. For example, if there is a spall of condition state 3 and exposed rebar of condition state 2 for the same square foot of deck, that square foot should be recorded as having a defect of spalling in condition state 3. To provide guidance in the situation that multiple defects of the same condition state are present at the same unit of quantity, the defects are listed below in a top first hierarchy format. The inspectors still should use their own judgment, for instance, a concrete girder with 20 feet of cracking in condition state two, but within those 20 feet, it contains 6” of efflorescence in condition state two it would be acceptable to record the 20 feet as condition state 2 for the defect cracking. Below is the hierarchy that may be used as a guide.

Reinforced Concrete (All Elements)

- 6000 - Scour (Substructure Only)
- 4000 - Settlement (Substructure Only)
- 1090 - Exposed Rebar
- 1080 - Delamination/Spall/Patched Area
- 1120 - Efflorescence/Rust Staining
- 1130 - Cracking
- 1190 - Abrasion/Wear

Prestressed Concrete (All Elements)

Same hierarchy as Reinforced Concrete given that: 1100 – Exposed Prestressing supersedes 1090 – Exposed Rebar for all elements.

Steel (All Elements)

- 6000 - Scour (Substructure Only)
- 4000 - Settlement (Substructure Only)
- 1010 - Cracking
- 1020 - Connection
- 1900 - Distortion
- 1000 - Corrosion

Timber (All Elements)

- 6000 - Scour (Substructure Only)
- 4000 - Settlement (Substructure Only)
- 1140 - Decay/Section Loss
- 1160 - Cracking
- 1170 - Split/Delamination
- 1150 - Check/Shake
- 1020 – Connection
- 1180 - Abrasion/Wear

Masonry

- 6000 - Scour (Substructure Only)
- 4000 - Settlement (Substructure Only)
- 1640 - Masonry Displacement
- 1620 - Split/Spall
- 1630 - Patched Area
- 1610 - Mortar Breakdown

Joints

- 2370 - Metal Deterioration or Damage
- 2310 - Leakage
- 2320 - Seal Adhesion
- 2330 - Seal Damage
- 2340 - Seal Cracking
- 2360 - Adjacent Deck or Header
- 2350 - Debris Impaction

Bearings

- 2220 - Alignment
- 2210 - Movement
- 2240 - Loss of Bearing Area
- 2230 - Bulging, Splitting or Tearing
- 1020 – Connection
- 1000 - Corrosion

Steel Protective Coating

- 3440 - Effectiveness
- 3420 - Peeling/Bubbling/Cracking
- 3410 - Chalking
- 3430 - Oxide Film Degradation Color/Texture Adherence (Weathering Steel Only)

Concrete Protective Coating

- 3540 - Effectiveness
- 3510 - Wear

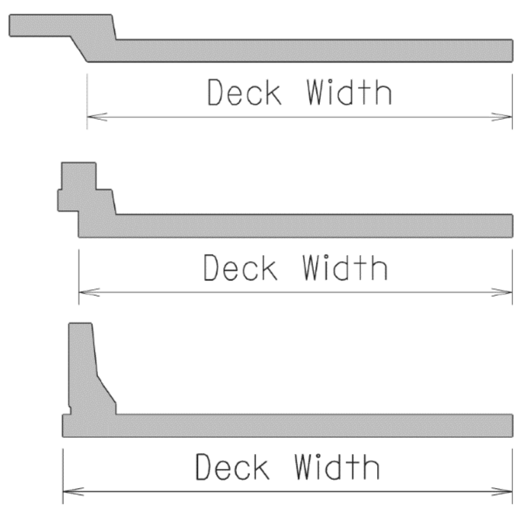
Guidance for Determining Elements and Quantities

General Notes

These definitions and quantity calculation guides are specifically for the AASHTO elements, not the NBI components. As noted before, this is to serve as a guide. Inspectors will need to use their judgment to identify and calculating quantities for elements.

Decks and Slabs

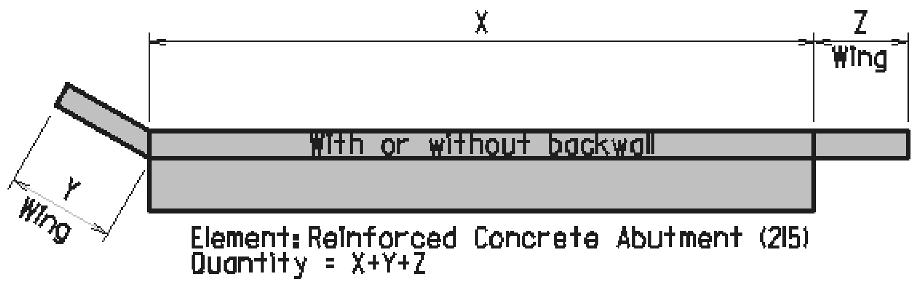
The AASHTO *Manual for Bridge Element Inspection* states that the quantity calculation should be determined edge to edge for each linear foot of deck length. The edge of the deck is considered the edge of the traffic carrying component. See the sketch below.

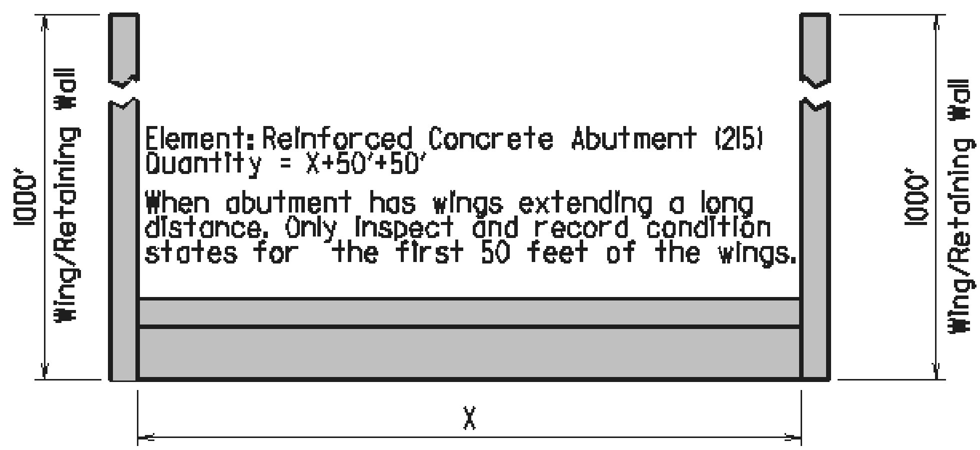


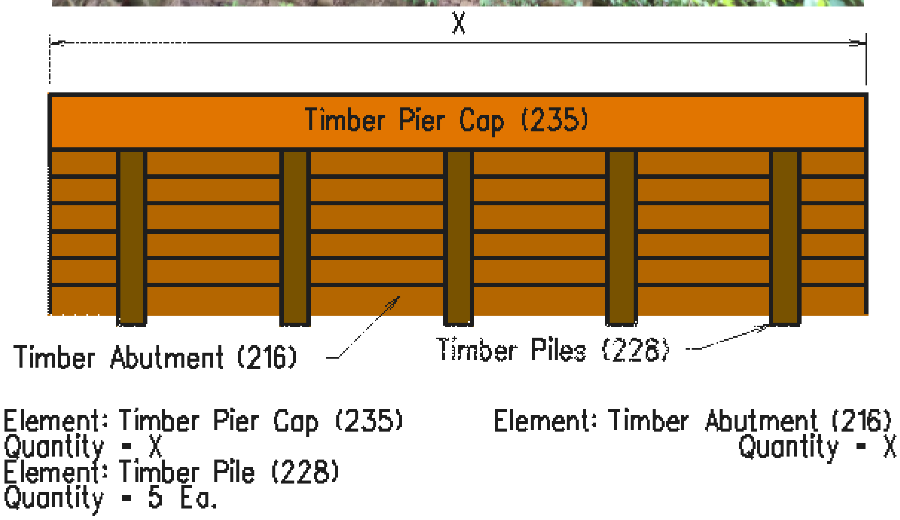
Polymer overlays consisting of coarse aggregate shall be recorded as a Wearing Surface. Low viscosity "Healer Sealers" with only fine aggregate (sand) should be recorded as Concrete Protective Surface.

Abutments

Substructure features at the end of the bridge that retain the embankment will be recorded as abutments. End bents consisting of separate components to transfer vertical loads and retain embankment will need to be recorded with multiple elements. The elements transferring vertical loads should be identified in the same manner as elements at intermediate bents. End bent consisting of just a cap on piles and wingwalls should be recorded as an abutment. Below are some diagrams and pictures to serve as a guide; as always, the inspectors will need to use their judgment.

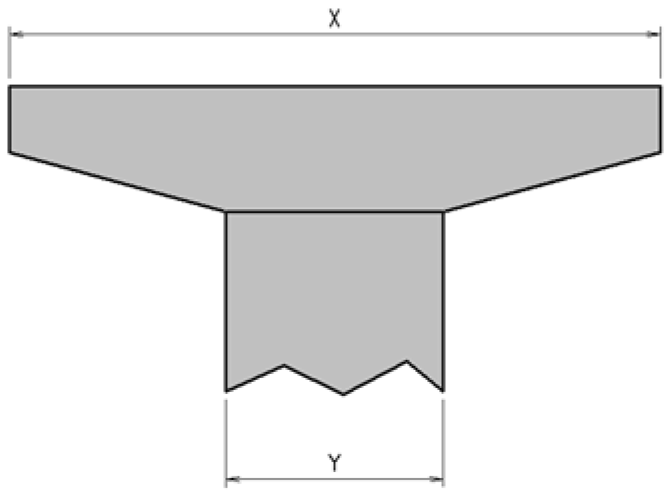




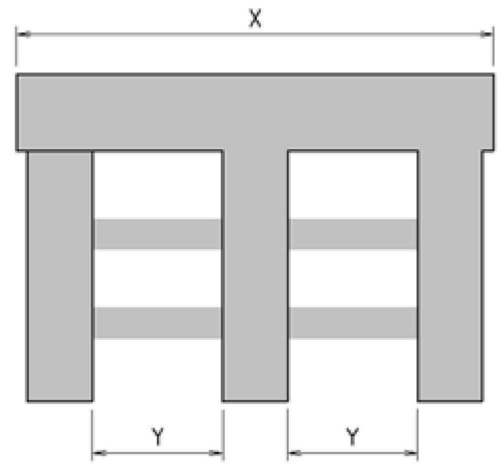


__Intermediate Bents__

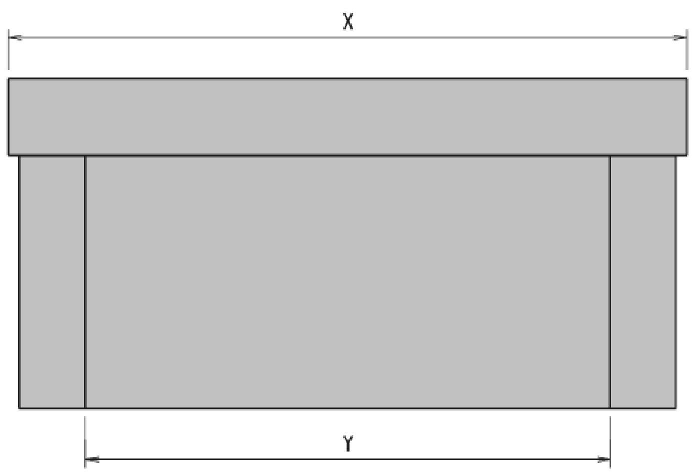
The following diagrams provide clarity for certain types of intermediate bents.



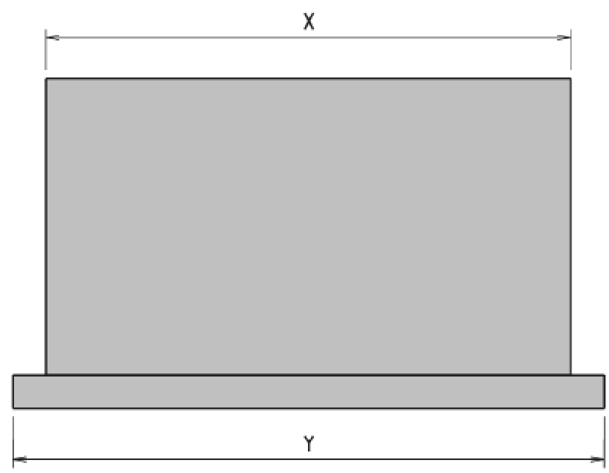
Element: Reinforced Concrete Pier Cap (234)
Quantity = X
Element: Reinforced Concrete Pier Wall (210)
Quantity = Y (If Y >=10')
Element: Reinforced Concrete Column (205)
Quantity = 1 Ea. (If Y<10')



Element: Reinforced Concrete Pier Cap (234)
Quantity = X
Element: Reinforced Concrete Pier Wall (210)
Quantity = 2*Y
Element: Reinforced Concrete Column (205)
Quantity = 3 Ea.



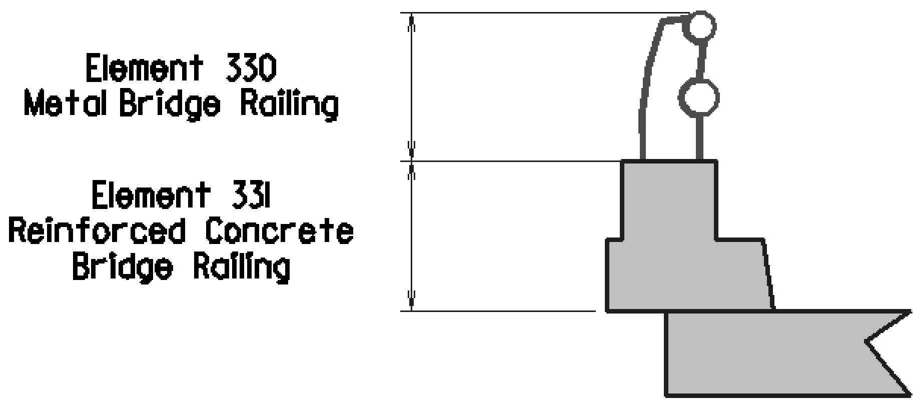
Element: Reinforced Concrete Pier Cap (234)
Quantity = X
Element: Reinforced Concrete Pier Wall (210)
Quantity = Y
Element: Reinforced Concrete Column (205)
Quantity = 2 Ea.



Element: Reinforced Concrete Pier Wall (210)
Quantity = X
Element: Reinforced Concrete Pile Cap/Footing (220)
Quantity = Y

Bridge Rails

- Bridge rails may consist of more than one element. Therefore, multiple element numbers may be required for recording the condition of a rail. See the example below.
- The quantity for bridge rails should be calculated only using the sections on the bridge, approach rails are not included.
- In the situation that defects to the underside of the bridge beyond the limits of the edge of slab as described above, may be recorded in the rail. These quantities will be recorded in linear feet. Use element notes to specify the location as needed.



Joints

- Joints under an asphalt overlay shall be documented to have the defect debris impaction in condition state 3. If the inspector has good reason to believe the joints were protected during the overlay, such as a functioning sliding plate, the condition state should reflect this fact. Likewise, the inspector may record condition state 4 for any defect if warranted.

This chapter is designed to answer questions that the Bridge Inspection Teams may have concerning coding the elements. The usefulness of this chapter is directly related to the feedback from the Inspections Teams.

Chapter 11: Agency Field Guidance

Guidance Table for Agency Fields

Item Number	Display Name	Data-base Column Name	Item Length	DataType	Group Responsible	Database Description	General Description
A-1	BridgeGroup	col_1da13c8	20	string	HBM	BridgeGroup	Label HBM for bridges inspected by HBM. Label D2 means inspected by D2. Used for inspections outside of geographic district.
A-2	Wearing Surface Thickness	col_ab5944e	7	Float Null	Inspector	NULL	Thickness of wearing surface in inches
A-3	Weathering Steel	col_e744dc9	0	string	Inspector	Weathering Steel	Yes/No response to bridge having weathering steel
A-4	Pin / Hanger	col_2eb16f9	0	string	Inspector	Pin / Hanger	Yes/No response to bridge having pin/hanger system
A-5	Stay In Place Forms	col_69b96d7	0	string	Inspector	Stay In Place Forms	Yes/No response to bridge having stay in place forms
A-6	Steel Tons	col_bc5f574	9	Float Null	HBM	NULL	Amount of steel tons that bridge has in total
A-7	(41) Structure Open/Posted/Closed	col_492f7c4	1	string		Structure Open/Posted /Closed	Duplicated NBI field - will be deleted soon
A-8	Road / Route Name	col_72f37f5	0	string		Road / Route Name	Duplicated NBI field - will be deleted soon
A-9	Section	col_3e20503	0	string	Inspector	Section	Section of route in which the bridge carries
A-10	Zone	col_0dc55f3	0	string	Inspector	Zone	Zone of Route in which the bridge carries
A-11	Seismic	col_4f78055	0	string	HBM	Seismic	Yes/No response to bridge having seismic design
A-12	Seismic Year/Zone	col_6d96a89	0	string	HBM	Seismic Year/Zone	Year and zone in which the bridge was seismically designed for

A-13	School District Email	col_26e 5975	0	string	Inspector	School District Email	school district Email for which the bridge carries bus route for
A-14	Owner Email	col_4d6 8d71	0	string	Inspector	Owner Email	County/City contact email for the owner responsible for the bridge
A-15	Late Reason	col_d44 b46b	0	string	Inspector	Late Reason	Late reason for which the bridge inspection was late - reason also email to FHWA
A-16	Code 4 Vehicle (22 tons)	col_b8c 6e42	6	Float Null	Rater	NULL	Rating field
A-17	Code 9 Vehicle (31 tons)	col_5ab 974f	6	Float Null	Rater	NULL	Rating field
A-18	Code 5 Vehicle (40 tons)	col_af3 3b3b	6	Float Null	Rater	NULL	Rating field
A-19	Code 4 (Beginning)	col_01c f942	6	Float Null	Inspector	NULL	In Field Posted Value
A-20	Code 4 (end)	col_53a b0c7	6	Float Null	Inspector	NULL	In Field Posted Value
A-21	Code 9 (Beginning)	col_37a b7e3	6	Float Null	Inspector	NULL	In Field Posted Value
A-22	Code 9 (End)	col_f2a 12cb	6	Float Null	Inspector	NULL	In Field Posted Value
A-23	Code 5 (Beginning)	col_0c3 b03e	6	Float Null	Inspector	NULL	In Field Posted Value
A-24	Code 5 (End)	col_932 0bf4	6	Float Null	Inspector	NULL	In Field Posted Value
A-25	APHN	col_d70 395c	0	string	HBM	APHN	Arkansas Primary Highway Network - identical to field in TPP
A-26	STIP Replacemen t Year	col_ea3 8eaa	0	Float Null	HBM	NULL	Year that stip shows to replace - can be found in program management bridge work view
A-27	Job Number	col_46b f24b	0	string	Inspector	Job Number	Job number (ardot) under which the contract for the bridge is located
A-28	Prog. Job Number	col_603 4648	7	string		Prog. Job Number	
A-29	Old Bridge Number	col_2ed fe99	0	string	Inspector	Old Bridge Number	Old bridge number if this structure replaced existing

A-30	New Bridge Number	col_ced 8de9	0	string	Inspector	New Bridge Number	New bridge number if being replace
A-31	Bridge Condition Index	col_671 22bc	6	Float Null	HBM	NULL	Calculated field based off of variables
A-32	Bridge Replacemen t Cost	col_28e 660f	9	floatN ull	HBM	NULL	Calculated field based off of variables
A-33	Arnold_Road ID	col_845 27bb	0	string	HBM	Arnold_Road ID	Linear referencing system identification
A-34	Arnold_LM	col_df5 5af3	9	Float Null	HBM	NULL	Linear referencing system identification
A-35	Antilog_Roa dID	col_ee5 3a74	0	string	HBM	Antilog_Road ID	Linear referencing system identification
A-36	Antilog_LM	col_722 cb7e	9	Float Null	HBM	NULL	Linear referencing system identification
A-37	Notes	col_2b1 ab90	0	string	Inspector	AHTD Agency Notes	Inspector's note field
A-38	3 Axle Vehicle (EV2)	col_b3b 52bf	0	Float Null	Rater	3 Axle Vehicle (EV2)	Rating field
A-39	4 Axle vehicle (EV3)	col_d1c 8dbf	0	Float Null	Rater	4 Axle vehicle (EV3)	Rating field
A-40	5 or more Axle Vehicle (Notional Rating Load)	col_b09 7dab	0	Float Null	Rater	5 or more Axle Vehicle (Notional Rating Load)	Rating field
A-41	Load rating date (YYYY-MM-DD)	col_5be 0820	0	string	Rater	Load rating date	Rating field for the date of rating
A-42	Load rater	col_e35 fd79	0	string	Rater	Load rater	Drop down value for the load rater
A-43	Programmed Job #	col_df6 a3b1	0	string		Programmed Job #	
A-44	Load Rating Notes	col_7bd 1fb8	0	string	Rater	Load Rating Notes	Notes for the load rater to enter
A-45	Bats Present	col_79a 70f4	0	string	Inspector	Bats Present	Yes/No response to bridge having bats
A-46	Asset Files	col_3e1 ecf0	99	string		For storing inspection files	
A-47	SU4	col_eae dad0	0	float	Rater	NULL	Rating field
A-48	SU5	col_353 6f12	0	float	Rater	NULL	Rating field
A-49	SU6	col_c37 7cfb	0	float	Rater	NULL	Rating field

A-50	SU7	col_46e90a1	0	float	Rater	NULL	Rating field
A-51	Inspection Direction	col_cfda320	0	string	Inspector	NULL	Drop down value for the direction that the bridge was inspected.

Structural

Bridge Group – The group, District or HBM, that is responsible for inspection.

Wearing Surface Thickness – For structures which have an overlay (i.e., asphalt, timber runner, etc.) above the structural deck or for structures under fill, record the depth from the top of the structural deck to the roadway surface. If major variation of depth occurs, record the average depth and show extremes on a Form III sketch. If the measurement is over 99.9", record 99.9 and show the actual measurement on a Form III sketch.

Weathering Steel - Code "Y" for yes, if the bridge is constructed of weathering steel or "N" for no, if the bridge is not constructed of weathering steel.

Pin / Hanger - Code "H" for Pin and Hanger articulated bridges and Code "P" for Pin Bridges such as Pin Trusses.

Stay In Place Forms – Code "Y" for yes, if the bridge has stay in place forms or "N" for no, if the bridge does not have stay in place forms.

Steel Tons – This is the structural steel in bridge and can be found on the quantity sheet. It is used in cost estimates for bridge painting contracts.

Structure Open/Posted/Closed – This will be populated from Item 41.

Location

Road/Route Name -

Section -Complete the "Section Number" from the ARDOT Route and Section Map.

Zone - Complete the "Zone" from the County Zone Map.

Seismic

Seismic - Code "Y" if the bridge is designed using Seismic design specifications.

Seismic Year/Zone –

Notification

School District Email – To be used at a later date.

Owner Email – The Inspector shall see that this is filled in so that email notifications for critical findings may be sent out through the database.
Late Reason – This is a drop down menu that should be used when the inspection is going to be late.

Load Posting

Calculated:

Code4 Vehicle - Posting is required for tonnages less than 22 tons.

Code9 Vehicle - Posting is required for tonnages less than 31 tons.

Code5 Vehicle - Posting is required for tonnages less than 40 tons.

Posted:

Code4 - Code the actual posting on the signs at the thru approach to the bridge - refer to the drawings in Chapter 14. Posted bridges will be inspected at least every 12 months.

Code9 - Code the actual posting on the signs at the thru approach to the bridge - refer to the drawings in Chapter 14. Posted bridges will be inspected at least every 12 months.

Code5 - Code the actual posting on the signs at the thru approach to the bridge - refer to the drawings in Chapter 14. Posted bridges will be inspected at least every 12 months.

STIP

APHN - The Arkansas Primary Highway Network has four classifications:

0 = not on APHN
1 = NHS (All NHS routes Interstates included)
2 = Other Arterials (functionally classified as principal arterials or minor arterials)
3 = Critical Service Routes (routes that parallel the interstate - keep in mind some of these routes can be NHS or Arterials - higher function wins out)
4 = Other high traffic routes (routes with ADT over 2,000 and lead to a town with a population of 5,000 or more)

STIP - Input a value of 2 if the bridge is included in the Statewide Transportation Improvement Program. This field can be used to prevent the bridge from being included in any Bridge Management scenarios.

Job Number – The job number under which the bridge was built.

Old Bridge Number – The bridge number of the bridge that this bridge replaced.

New Bridge Number – No idea why this is here. May eliminate.

NBIS FORM GUIDELINES

When a drawing is required for one of the following forms, it should be drawn in micro-station.
NBIS Form IIA Guidelines **-** Form IIA is for describing the condition of Hanger and Pin Assemblies on Articulated and Suspended Spans. Number the spans and joints according to the drawing at the bottom of Form IIA. Number the beams from left to right looking toward increasing log mile. Comments and remarks should be used as much as possible.

NBIS Form III Guidelines - Form III is used for notes/drawings that are not covered in other forms such as soundings, FC items, wearing thickness, etc.

NBIS Form IIIB Guidelines - Form IIIB is for detailing the vertical and horizontal clearance as a highway or railroad passes under the bridge. These values will be used to code Items 54, 55, 56, and 69.

NBIS Form IV Guidelines - Form IV is used to help describe the superstructure and substructure when contract plans are not available, and it's necessary to draw and detail the bridge. The form is self-explanatory and has space for comments. If the beam spacing is not uniform or there are different beam sizes, it may be necessary to describe the geometry on Form III.

NBIS Form IVA Guidelines - Form IVA is for describing the different members of a truss. Form III should be used to detail Elevation and cross-sections of the truss and detail more complicated truss members.

Chapter 12: Inspection of Signs

Major Sign Structure Inspection

Sign structures are very important to the traveling public for their informational value. The structural integrity of these signs is also critical to the safety of the traveling public due to the location at which these structures are built. If a sign structure falls into traffic it could cause a serious accident. It is important to routinely perform and document inspections of these sign structures.

Results of the inspection will be maintained at the District level and not sent to the Bridge Division except for the initial inspection. Contact Maintenance Division if there is cause for concern.

All charges for sign structure inspection should be made to the county, route and section under Function 481, “Structure Inspection”.

The 5 Major Classifications of Sign Structures

1. Overhead – characterized by space frame welded or bolted structural sections (trusses) spanning over the highway supported by single post, 2 chord, or 4 chord towers resting on concrete footings and pedestals and in some instances resting on some portion of a bridge (see Sketch No. 1). Structural sections can consist of monotube, planar (two chord) truss, tri-chord truss, or quad-chord truss structures.

   Members are described as top and bottom chords; verticals; diagonals; top and bottom horizontals; and top, bottom and interior diagonals. Towers can be in the form of single posts, or space welded or bolted structural sections (trusses) made up of vertical chords; horizontals; and diagonals.

2. Propped Cantilever – characterized by space frame welded or bolted structural sections (trusses) extending out over the roadway with one span supported at both ends and an additional span cantilevered from either side. The end is supported by a single 2 or 4 column tower, and the prop support is most commonly a 2 column tower. Both supports rest on concrete footings and pedestals and in some instances rest on some portion of a bridge (see Sketch No. 2).

   Members are described identical to those in the Overhead.

3. Overhead Cantilever – characterized by space frame welded or bolted structural sections (trusses) extending out over the roadway with only one end supported by a single post, 2 column tower, or 4 column tower resting on a concrete footing and pedestal and in some instances resting on some portion of a bridge (see Sketch No. 3).

   Members are described identical to those in the Overhead.

4. “T” Mount – characterized by space frame welded or bolted structural sections (trusses) where the frames are mounted on a single tower to form a “T” with the frames extending out from the tower in two directions. The tower rests on a concrete footing and pedestal and in some instances rest on some portion of a bridge (see Sketch No. 4).

Members are described identical to those in the Overhead.

5. Bracket Mount – characterized by steel or aluminum structural sections welded and bolted together to form a sign frame support that is bolted to the bridge (see Sketch No. 5).

There are 4 types of materials associated with major sign structures:

- Aluminum – used in a high percentage of overhead space frames of simple and cantilever design.
- Galvanized Steel – used in a high percentage of overhead space frames and bracket mount sign structures.
- Stainless Steel – may be used in bolts for aluminum structures.
- Concrete – used in foundations for sign structures.

Types of Inspection for Major Sign Structures

- Initial Inspection – This inspection is made after initial erection to assure proper construction. It is common for bolts on sign structures, shortly after installation, to become loose and should be rechecked during this inspection. This will also serve as the first inspection made for initial documentation purposes. A copy of this inspection will be sent to Bridge Division.

- Routine Inspection – Most inspections will be made every four (4) years after the initial inspection. Bridge mounted sign structures whether overhead, overhead cantilever, or bracket mount will be inspected at a minimum of every two (2) years.

- Accident/Damage Inspection – These inspections will be made after a major wind event or traffic incident that might have damaged the structure. This could include traffic impact to the post, an overheight hit of the sign panels or truss, etc. Accident inspections will be made to inspect specific areas of concern (that the inspector deems necessary).

- Other Special Recurring Inspection– These inspections would be recommended by the Inspector if a sign structure is found to have deficiencies or other problems that require more frequent inspection than the typical inspection frequency.

Inspection Procedures for Major Sign Structures

Pre-Inspection

Identify all safety hazards that may be encountered during the inspection and determine the proper avoidance/mitigation measures to ensure the safety of the inspection team and the public. Utilize all proper safety equipment including a double-lanyard harness when necessary.

Inspection

1. Start the inspection at the foundation. The foundation, typically made of concrete, is checked for cracks, spalls, and other signs of deterioration. Many times drainage pathways in the foundation become blocked with debris, not allowing water to escape from the inside of the

post. Some structures have grout pads to support the post base. These are often susceptible to deterioration. It is important to check historical documents to see if grout pads were part of the original design. If they were not, many times the existing deteriorated grout pads can be removed.

Watch for locations where sign structures are set close enough to the road that winter salt spray and snow plow wind rows can accumulate on the base support and cause deterioration of anchor rods and concrete pedestals.

2. Post to foundation connections usually consist of anchor rods that transfer the load from the structure post to the foundation. Anchor rods can become corroded over time and fail under fatigue loading. Many anchor rods initially installed may have been too short or too long. If too short, a coupler may have been used that cannot transfer the load. Many long rods are cut or flame torched which may change the mechanical properties of the rod.

   Anchor rods should be initially sounded by the inspector with a hammer to determine if the anchor rods are loose, broken, or severely corroded. In addition to hammer sounding, nondestructive evaluation techniques (NDT) such as ultrasonic testing (D-meter) should be used to determine the length of anchor rods and determine if fractures are present in the rod. Most cracks are found in the upper foot of the anchor rod. Extra attention and testing should be done on cantilever structures and foundations with only four anchor rods present.

3. Anchor rod nuts should be checked for tightness and general condition. Loose or missing leveling nuts as well as top nuts can lead to load redistribution and overstressing of anchor rods. Nuts should be hammer sounded or checked using a large wrench. The inspector should check for broken, missing, or loose washers. Lock washers should not be used because they do not allow proper nut tightening and therefore reduce fatigue life. Double nuts should be used instead of lock washers if necessary.

4. The base plates that the anchor rods go through should be checked for defects. The base plates could be broken, cracked, or warped. Inadequate drainage can lead to advanced corrosion.

   The post to base plate weld should be examined closely for cracking. Cracking may also be found at the termination of any stiffener plates. Close inspection and/or NDT techniques such as dye penetrant testing may be required to locate any cracks and accurately determine their limits. Cracks found during an inspection should have their beginning and end points marked on the structure along with the date so their progression can be monitored.

5. Any handholes present should be inspected. The handholes themselves, cut into the post, can prove to be areas of weld crack initiation. Handholes allow access for the inspector to see inside the post. Most of the noted corrosion of sign structure posts has occurred on the inside of the post as water and debris accumulate to form a corrosive environment. The inspector should look inside the handhole and inspect the interior of the post for corrosion. If there is no handhole or if the inspector cannot remove the handhole cover, a thickness meter (D-meter) can be used to determine if reduced section area is present due to interior corrosion. Missing handhole covers should be noted as they present an entry for water and animal life.

6. The post/tower should be examined for its general condition. Posts are frequently found with missing top caps that keep rain out. Many steel posts are galvanized and over time some of the coating begins to wear. The plumbness of the post should be checked. An out-of-plumb post could reveal foundation problems, past vehicular impacts, or initial erection errors. If a post is severely out-of-plumb, the vertical clearance over the traveled way may need to be checked.

7. The post/tower to truss connections should be checked for missing fasteners or misalignment. Overhead truss structures often have saddles and U-bolts at the truss to post connections. These should be examined for missing or loose nuts and cracked casings. Cantilever trusses are generally connected with high strength bolted flange connections. These should be examined for fit-up and loose or missing bolts.

8. The space frame, overhead truss, or mast arm should be inspected next. Truss members have welded or bolted connections that need to be checked. Failed welds in aluminum structures have been a source of concern. These welds can be difficult to access and may require special equipment and/or additional safety measures to access.

   Sign trusses are usually fabricated into smaller sections and erected at the site. The truss chord connection is the critical connection between these sections. A flanged splice connection may contain both bolted and welded connections. Since chords are critical truss members, their connections are critical as well. Connection fit-up, loose or missing bolts, and weld cracks should be areas of concentration during the inspection.

9. Sign panels should be inspected with the truss inspection. Many sign panel fasteners become loose over time. The inspector should note if any sign panels were added to the structure after initial erection or if sign panels were replaced with larger panels. This increased area can be dangerous if the original structural designer did not account for such changes. Larger sign panels will result in more wind loading on the structure.

10. After the inspection of all structural members, the inspector should proceed to any supplemental elements such as catwalks, electrical components, and other elements that do not comprise the actual structural system.

Documentation for Major Sign Structures

Each major sign structure has been given a unique number; contact Bridge Division for numbers.

The unique number will be in the form “TTrrrccnn”, where:

“TT” indicates the type structure as follows:

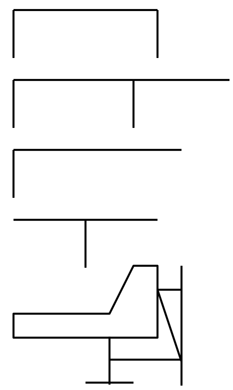
OH – Overhead Structure

PC – Propped Cantilever

OC – Overhead Cantilever

TM – “T” Mount

BM – Bracket Mount



“rrr” indicates the Route as 430 or 030.

“cc” indicates the County code as 60 indicates Pulaski County.

“nn” indicates a unique number for the structure on that route.

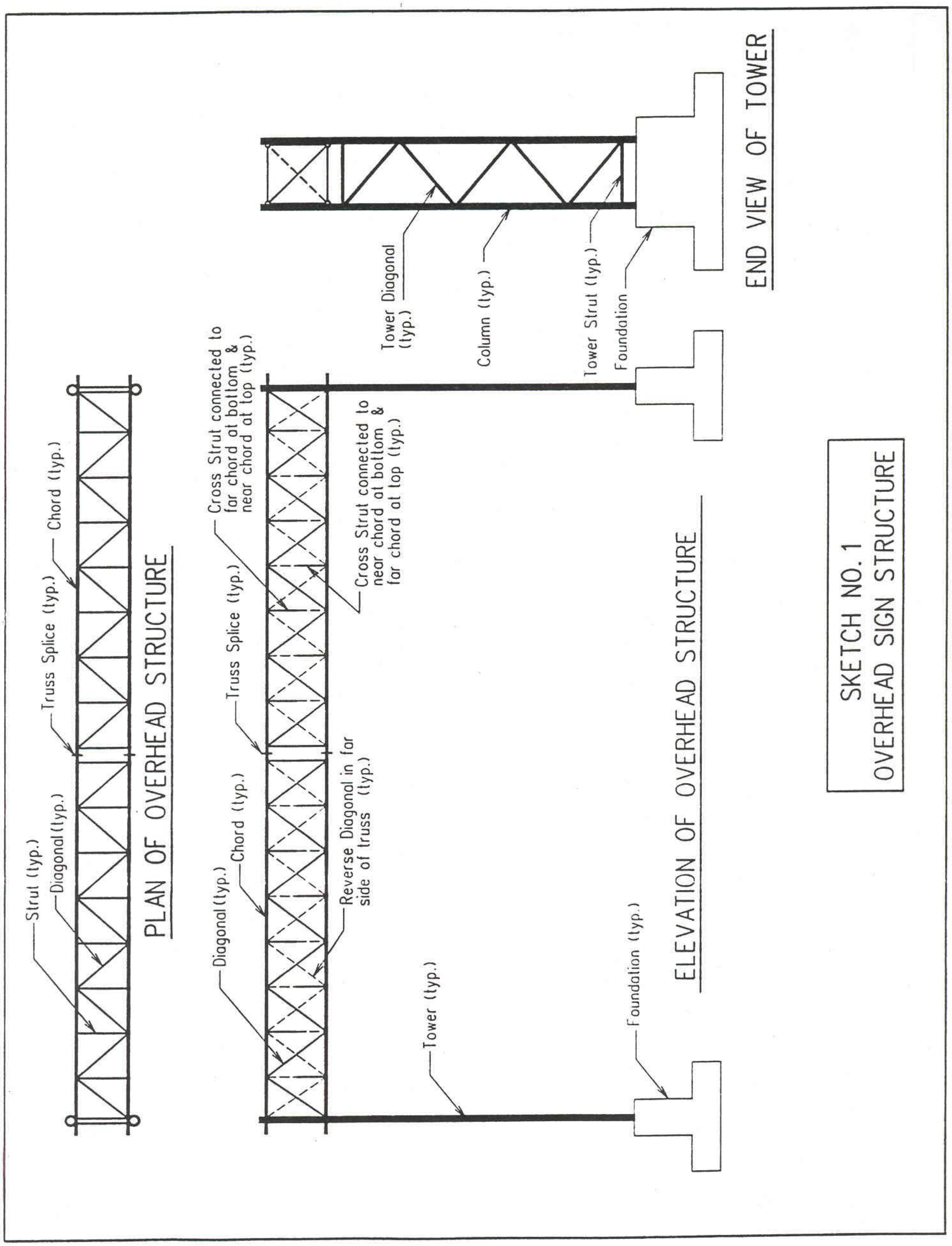
Sign Structure numbers should be painted or stamped on all structures in a prominent location.

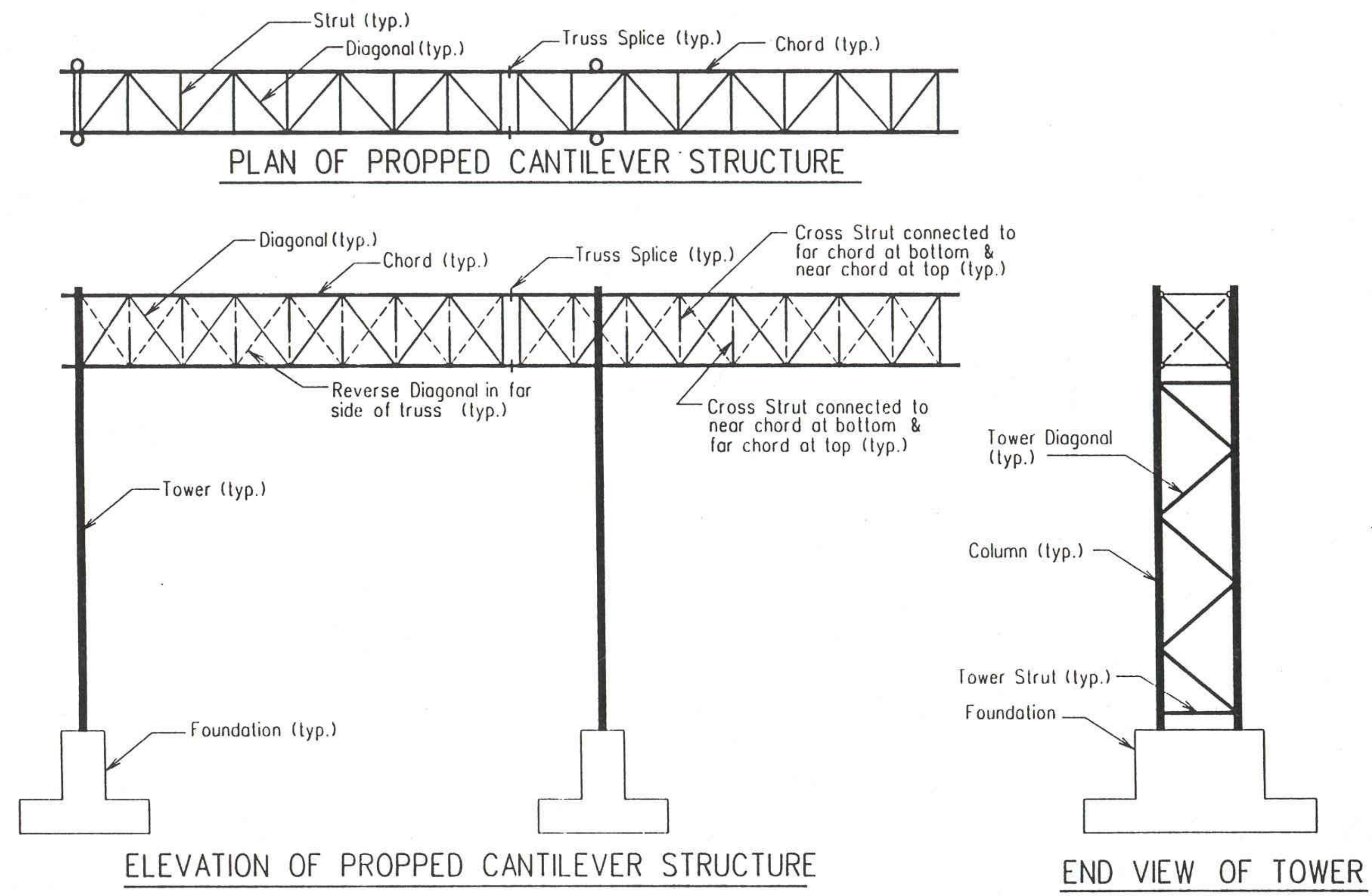
Use a Form III drawing/notes where needed for any clarification of inspection.

Include date of inspection, inspector(s), and type of inspection.

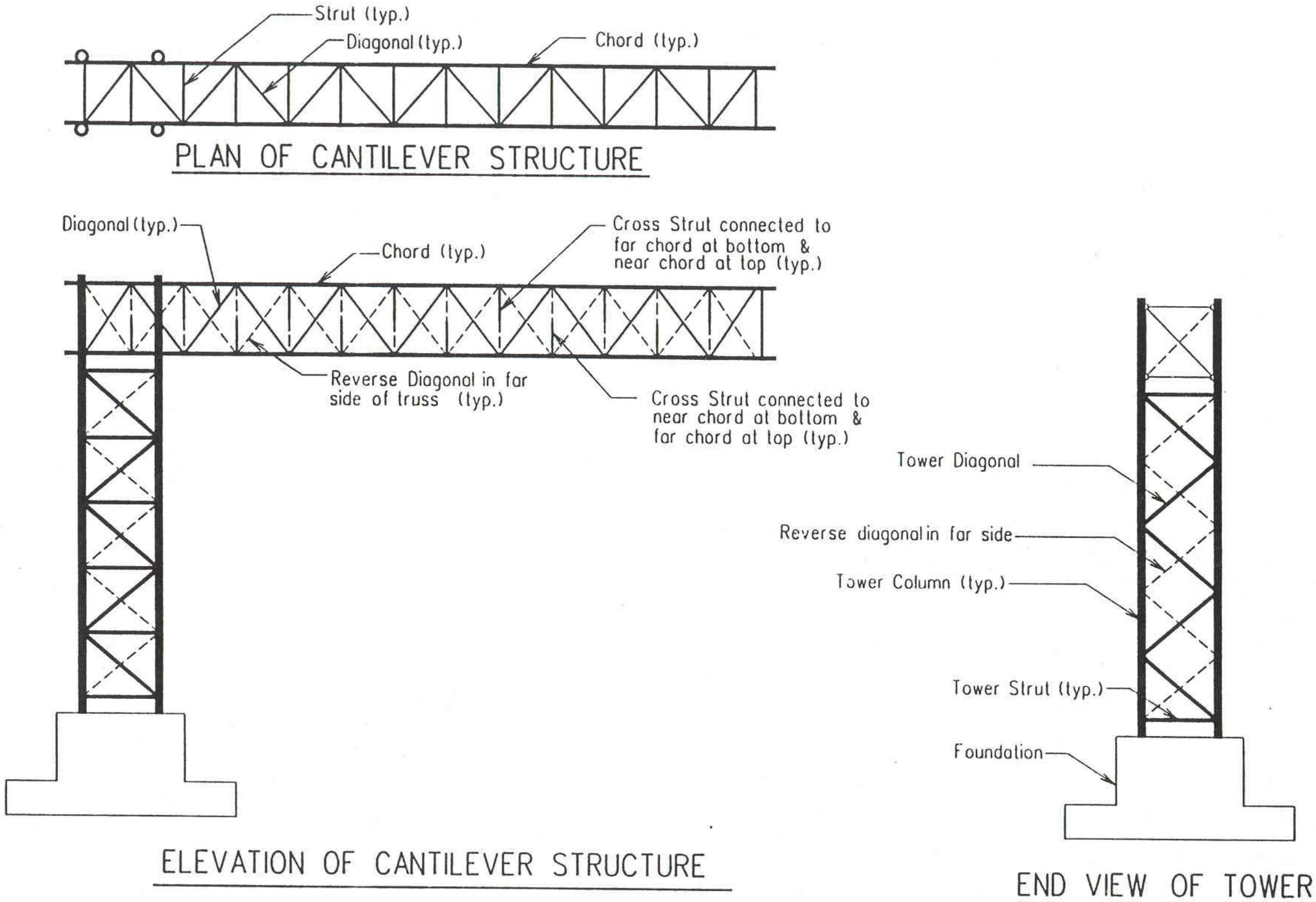
Rate the overall condition of the Foundation, Columns, and Superstructure using the same system a used in bridge rating.

Any maintenance and repair needs should be documented on the inspection report and a copy forwarded to the District Maintenance Engineer.

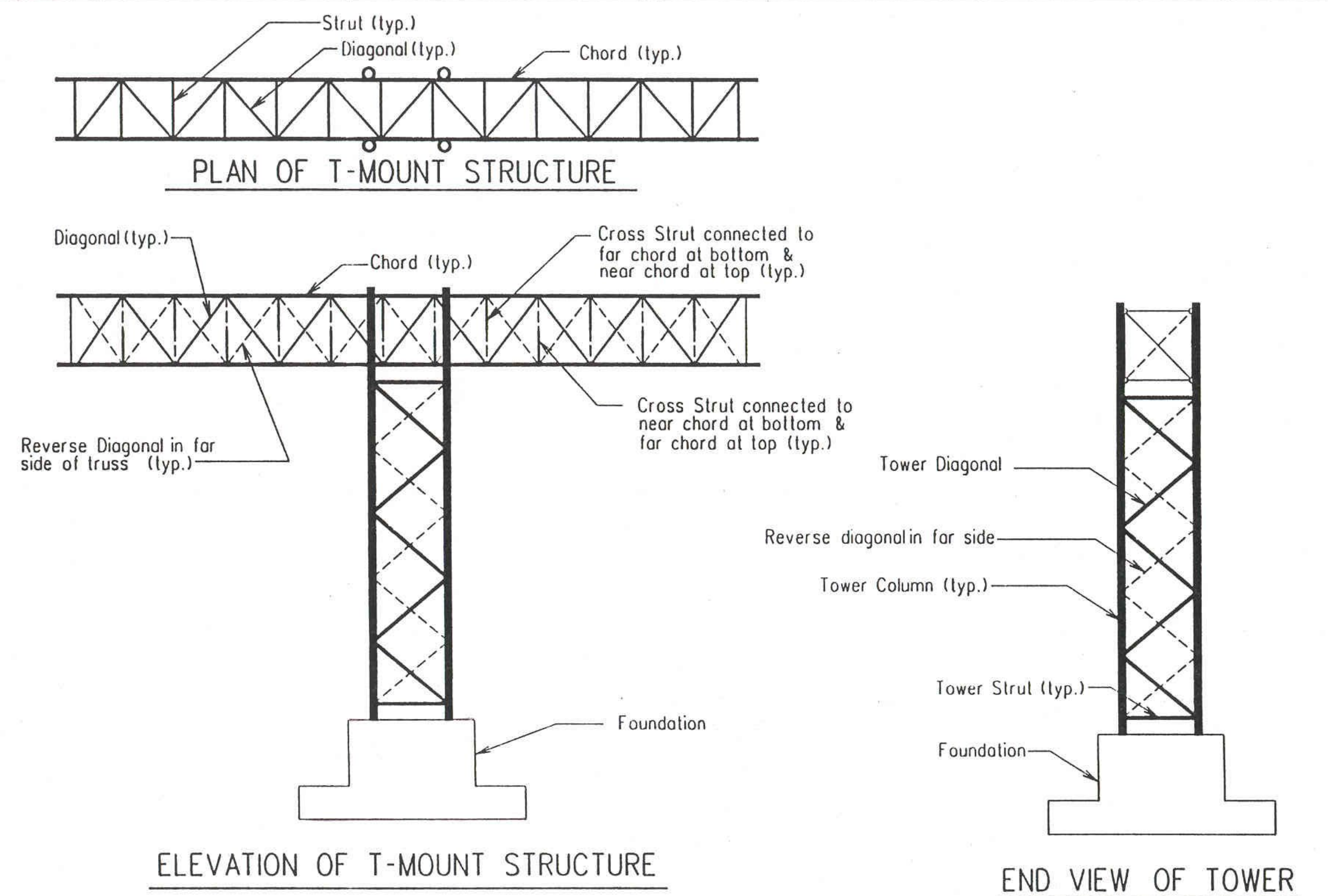

PLAN OF OVERHEAD STRUCTURE
Strut (typ.)
Diagonal (typ.)
Truss Splice (typ.)
Chord (typ.)
ELEVATION OF OVERHEAD STRUCTURE
Diagonal (typ.)
Chord (typ.)
Reverse Diagonal in far side of truss (typ.)
Truss Splice (typ.)
Cross Strut connected to near chord at bottom & far chord at top (typ.)
Cross Strut connected to far chord at bottom & near chord at top (typ.)
Tower (typ.)
Foundation (typ.)
END VIEW OF TOWER
Tower Diagonal (typ.)
Column (typ.)
Tower Strut (typ.)
Foundation
SKETCH NO. 1
OVERHEAD SIGN STRUCTURE



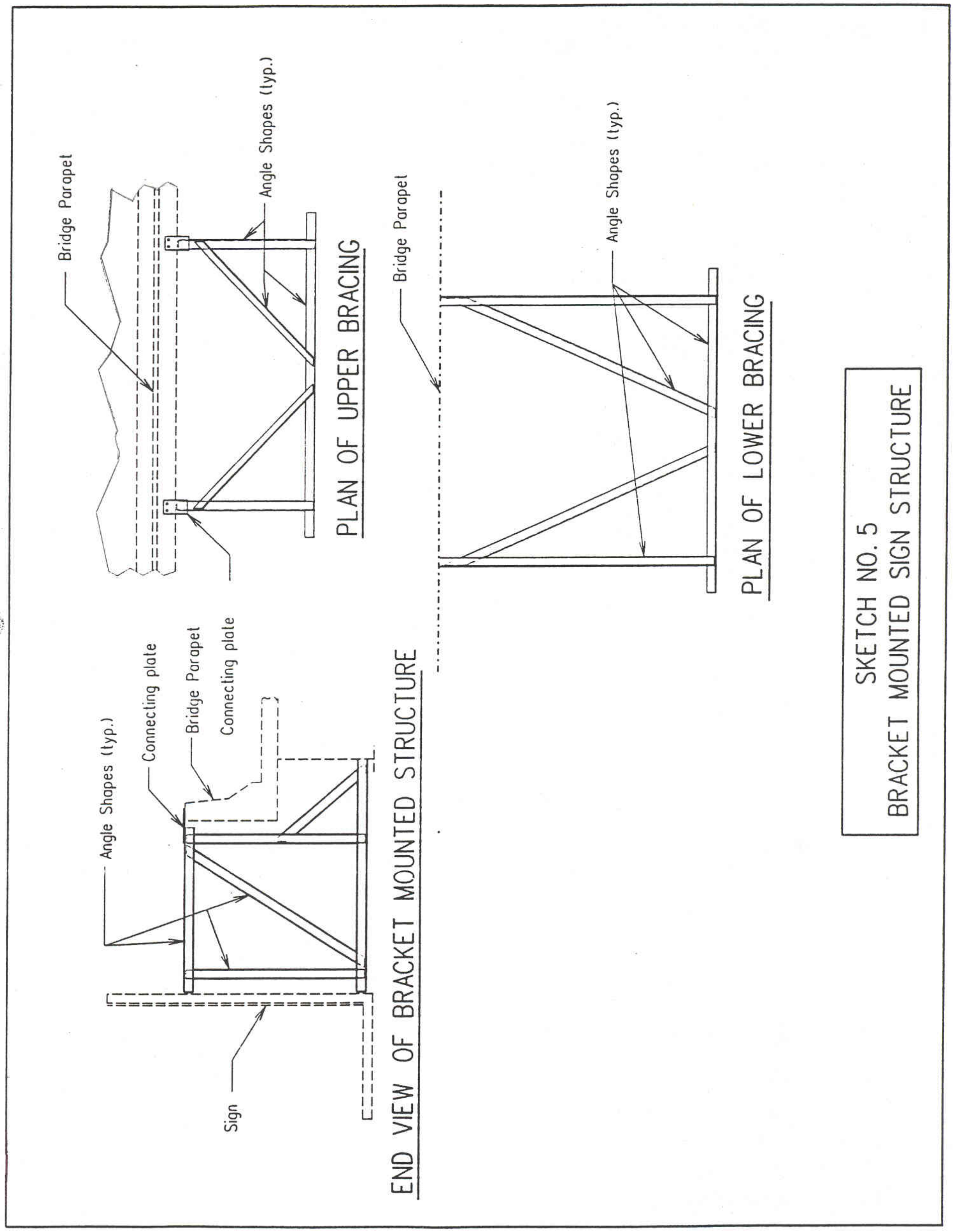
SKETCH NO. 2
PROPPED CANTILEVER SIGN STRUCTURE



SKETCH NO. 3
CANTILEVER SIGN STRUCTURE



SKETCH NO. 4
T-MOUNT SIGN STRUCTURE



Bridge Parapet
Angle Shapes (typ.)
PLAN OF UPPER BRACING
Bridge Parapet
Angle Shapes (typ.)
PLAN OF LOWER BRACING
Angle Shapes (typ.)
Connecting plate
Bridge Parapet
Connecting plate
Sign
END VIEW OF BRACKET MOUNTED STRUCTURE
SKETCH NO. 5
BRACKET MOUNTED SIGN STRUCTURE

Chapter 13: Inspection of High Mast Poles

High Mast Light Pole Inspection

High-Mast Light Poles are important to the safety of the traveling public due to the illumination they give to interchanges. High-Mast Light Poles could also be dangerous to the public due to the height of these structures and their vicinity near the roadways. A failure could cause a serious accident. It is important to perform and document inspections on these structures.

Results of the inspection will be maintained at the District level with no submittals to the Bridge Division. If there is cause for concern contact the Maintenance Division. *UPDATE Late 2021: Heavy Bridge Maintenance will be responsible for the inspection of all high mast poles in inventory.*

Only High-Mast Light Poles greater than 95 feet will be considered for the purpose of inspection. All charges for High-Mast Pole inspection should be made to the county, route and section under Function 481, "Structure Inspection".

The 2 Major Classifications for High Mast Light Poles

1. ROUND slip in fit – characterized by their round tubular shape of progressively smaller diameter made up of 2, 3, 4 or 5 sections.

2. MULTI-SIDED slip in fit – characterized by their multisided tubular shape of progressively smaller diameter made up of 2, 3, 4 or 5 sections.

Material for High-Mast Light Poles is steel. Steel High-Mast Light Poles are either galvanized or exposed. Exposed steel is of the type designed for that purpose and is characterized as having a rough rusty texture. Galvanized steel is characterized as having a rough zinc texture both inside and outside.

Types of Inspection for High Mast Light Poles

- Initial Inspection – This inspection is made after initial erection to assure proper construction. This will also be the first inspection made for initial documentation purposes.

- Routine Inspection – Most inspections will be made every four (4) years after the initial inspection. At this inspection, all elements of the structure will be examined.

- Accident/Damage Inspection – These inspections will be made after a major wind event or traffic incident that might have damaged the structure. Accident inspections will be made to inspect specific areas of concern (that the inspector deems necessary).

- Other Special Recurring Inspection– These inspections would be recommended by the Inspector if a high mast pole is found to have deficiencies or other problems that require more frequent inspection than the typical inspection frequency.

Inspection Procedures for High Mast Light Poles

1. Start the inspection at the foundation. The foundation, typically made of concrete, is checked for cracks, spalls, and other signs of deterioration. Many times drainage pathways in the foundation become blocked with debris, not allowing water to escape from the inside of the post. Some structures have grout pads to support the pole base. These are often susceptible to deterioration. It is important to check historical documents to see if grout pads were part of the original design. If they were not, many times the existing deteriorated grout pads can be removed.

2. Pole to foundation connections usually consist of anchor rods that transfer the load from the structure pole to the foundation. Anchor rods can become corroded over time and fail under fatigue loading. Many anchor rods initially installed may have been too short or too long. If too short, a coupler may have been used that cannot transfer the load. Many long rods are cut or flame torched which may change the mechanical properties of the rod.

   Anchor rods should be initially sounded by the inspector with a hammer to determine if the anchor rods are loose, broken, or severely corroded. In addition to hammer sounding, nondestructive evaluation techniques (NDT) such as ultrasonic testing (D-meter) should be used to determine the length of anchor rods and determine if fractures are present in the rod. Most cracks are found in the upper foot of the anchor rod.

3. Anchor rod nuts should be checked for tightness and general condition. Loose or missing leveling nuts as well as top nuts can lead to load redistribution and overstressing of anchor rods. Nuts should be hammer sounded or checked using a large wrench. The inspector should check for broken, missing, or loose washers. Lock washers should not be used because they do not allow proper nut tightening and therefore reduce fatigue life. Double nuts should be used instead of lock washers if necessary.

4. The base plates that the anchor rods go through should be checked for defects. The base plates could be broken, cracked, or warped. Inadequate drainage can lead to advanced corrosion.

   The post to base plate weld should be examined closely for cracking. Cracking may also be found at the termination of any stiffener plates. Close inspection and/or NDT techniques such as dye penetrant testing may be required to locate any cracks and accurately determine their limits. Cracks found during an inspection should have their beginning and end points marked on the structure along with the date so their progression can be monitored.

5. Any handholes present should be inspected. The handholes themselves, cut into the pole, can prove to be areas of weld crack initiation. Handholes allow access for the inspector to see inside the pole. Much of the noted corrosion of high mast poles has occurred on the inside of the pole as water and debris accumulate to form a corrosive environment. The inspector should look inside the handhole and inspect the interior of the pole for corrosion. If there is no handhole or if the inspector cannot remove the handhole cover, a thickness meter (D-meter) can be used to determine if reduced section area is present due to interior corrosion. Missing handhole covers should be noted as they present an entry for water and animal life.

6. High mast lights usually have the apparatus for lowering the luminaire ring located inside the base of the pole. Checking the operation of this system is not normally part of the inspection. However, the apparatus is normally supported by steel members connected to the inside of the pole and these should be examined for loose connections and weld cracks and defects as these can migrate to the pole.

7. High mast poles often consist of more than one section. These are "spliced" by use of a slip joint, in which the upper segment simply slips over the lower segment. The condition of this joint should be examined for cracks, deformation along the base of the connection, and rust stains. Slip joints, partly because of the tendency of water to be drawn into them by capillary action, sometimes experience corrosion between the two segments. This can lead to the build up of pack rust, particularly in weathering steel poles, that may lead to a vertical crack emanating from the bottom of the upper pole segment.

8. Inspection of the luminaire ring is not usually part of the structural inspection. However, visual observation of any defects or non-functioning luminaires should be recorded. Some defects noted in the luminaire ring may relate to mechanical or structural components and should be examined further.

9. Due to the difficulty of accessing pole splices and luminaire rings, inspection techniques other than arms length inspection are normally used for these areas. The use of UAVs (unmanned aerial vehicles) is recommended for the inspection of splices and luminaire rings. UAVs allow for a more detailed inspection of these areas than obtained by just using binoculars. High powered binoculars or spotting scopes can be used if a UAV is not available or practical. The use of UAVs for inspection is outlined in *Chapter 14: UAVs in Bridge Inspection* of this manual. All requirements and safety measures stated in that chapter shall apply to the inspection of high mast poles.

Documentation for High Mast Light Poles

Each High-Mast Light Pole should be given a unique number, route, section and log mile.

The unique number should be in the form "rrrccnn" where:

"rrr" indicates the Route as 430 or 030.

"cc" indicates the County code as 60 indicates Pulaski County.

"nn" indicates a unique number for the structure on that route.

The unique number should be painted or stamped on the structure for identification.

Include date of inspection, inspector(s), and type of inspection.

Use a Form III drawing/notes where needed for any clarification of inspection.

Structural deficiencies should be reported to the District Maintenance Engineer if owned by ARDOT. Other structural deficiencies should be sent to the owner.

Chapter 14: UAVs in Bridge Inspection

Overview:

This policy will outline the minimum requirements for operating and using UAVs (unmanned aerial vehicles) to aid in the Arkansas Bridge Inspection Program. Each Arkansas Department of Transportation Employee (ARDOT) will need to sign off on this document to use these tools within the Bridge Inspection Program. It is understood from the Arkansas Bridge Inspection Program that a UAV is a tool in a growing toolbox for an inspector to best inspect a bridge. Use of a UAV can greatly enhance the overall inspection process when incorporporated correctly into the process. The following documentation describes the correct process:

Minimum Requirements to operate UAVs within the Bridge Inspection Program include the following:

A. To operate (physically be the person flying the drone), an employee must have their Part 107 UAV pilot's license. This license must be current and on file with Heavy Bridge Maintenance Personnel files.
B. Pilots must be either Assistant Bridge Inspector, Bridge Inspector, Statewide Bridge Inspector, or an HBM Engineer.
C. Pilots must complete an online training course for the drone they plan to fly and/or be trained by a Heavy Bride Maintenance pilot with extensive experience on that drone.
D. For the first day of using a UAV, an experienced pilot from HBM must be on-site to help with questions.

Safety guidelines for Pilots operating UAVs for Bridge Inspection:

A. Pilots will follow all rules under part 107.
B. Pilots will under no circumstances maintain sustained flight over traffic or pedestrians.
    a. Only flying a drone in transit perpendicular to traffic is allowed through part 107.
C. Pilots must complete a preflight checklist before each flight.
D. Pilots must take extreme caution on flying within proximity to bridge superstructure where GPS signal will be weak.
E. The Remote Pilot in Command is responsible for all drone operations for a particular bridge inspection.

Use Cases for UAVs for bridge inspection:

A. UAVs will not be used to replace hands on fracture critical inspections.
    a. UAVs can provide supplemental information/data for FC members in addition to FC hands on inspections.
B. UAVs can be used in Routine, Special, and Accident/Damage inspections in accordance with the NBIS.
    a. Please refer to https://www.fhwa.dot.gov/uas/resources/hif19056.pdf for specific use cases for a drone to be incorporated into your inspection.
    b. Reach out to Kevin Weston in HBM for further information.

Data Gathered with UAVs:

A. The Bridge Inspection Program recognizes that video footage captured during a typical manual flight will result in significant data files.
    a. Example: 1 day of flying could result in 200 GB of data.
B. Data capture with the help of a drone will be maintained for one inspection cycle.
    a. Video will be retained from one inspection until the next inspection of that bridge.
    b. After that second inspection comes around, the video will be deleted.
C. Data captured can be stored on a Department Server such as csd7, csd4, san1, etc… or in an online format such as Sharepoint or Skydio Online.
    a. Try to limit storage in personal file locations such as on your machine or on onedrive. (reason: if a individual retires – that footage will be hard to obtain.)
D. Video and Photos are acceptable to capture from a drone. If video is used, the entire video must be reviewed. Snapshots of the video may be used and included in the Bridge inspection report.
    a. The team lead will designate who is responsible for reviewing all the footage capture by a drone video.

Appendix A

NBIS Code of Federal Regulations (CFR) Chapter 23 Highways – Part 650

JANUARY, 2005 NBIS REGULATIONS

CODE OF FEDERAL REGULATIONS
PART 650--BRIDGES, STRUCTURES, AND HYDRAULICS

1. The authority citation for part 650 continues to read as follows:

Authority: 23 U.S.C. 109 (a) and (h), 144, 151, 315, and 319; 33 U.S.C. 401, 491 et eq., 511 et seq.; 23 CFR 1.32; 49 CFR 1.48(b), E.O. 11988 (3 CFR, 1977 Comp. p. 117); Department of Transportation Order 5650.2 dated April 23, 1979 (44 FR 24678); sec. 161 of Public Law 97-424, 96 Stat. 2097, 3135; sec. 4(b) of Public Law 97-134, 95 Stat. 1699; and sec. 1057 of Public Law 102-240, 105 Stat. 2002; and sec. 1311 of Pub. L. 105-178, as added by Pub. L. 105-206, 112 Stat. 842 (1998).

2. Revise subpart C to read as follows:

Subpart C--National Bridge Inspection Standards

Sec.
650.301 Purpose.
650.303 Applicability.
650.305 Definitions.
650.307 Bridge inspection organization.
650.309 Qualifications of personnel.
650.311 Inspection frequency.
650.313 Inspection procedures.
650.315 Inventory.
650.317 Reference manuals.

Subpart C--National Bridge Inspection Standards

§ 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 Sec. 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.

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 (SIandA) 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 four 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 agency wide 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 ten 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 five 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) Two 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) Four 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 twenty-four 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 forty-eight-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 sixty 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 seventy-two 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 twenty-four 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 sheet 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_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.aashto.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.

[1] The National Highway Institute training may be found at the following URL: http://www.nhi.fhwa.dot.gov/Home.aspx

Appendix B

Bridges requiring an Underwater Inspection

Bridge	District
01391	1
02271	1
02899	1
05141	1
05491	1
05952	1
06665	1
06748	1
06830	1
A3625	1
A3724	1
A6518	1
B3625	1
B3724	1
B6518	1
05121	2
05211	2
05825	2
05898	2
06267	2
18052	2
A6270	2
B6270	2
M3334	2
02488	3
03476	3
03674	3
05566	3
05718	3
05817	3
05823	3
06174	3
06447	3
07335	3
18270	3
A0285	3
00413	4
03337	4

Bridge	District
03975	4
04336	4
04509	4
04722	4
05007	4
05176	4
05180	4
05275	4
05600	4
05963	4
05964	4
06789	4
07352	4
12207	4
12208	4
12209	4
13108	4
17325	4
17353	4
17405	4
19136	4
19523	4
A0350	4
A1210	4
A3272	4
A6686	4
B3272	4
B6686	4
00612	5
02056	5
02202	5
03300	5
03301	5
03922	5
05534	5
05552	5
05661	5
05668	5

Bridge	District
B5536	5
00663	6
01093	6
01101	6
02768	6
03929	6
04221	6
04236	6
04445	6
04601	6
04704	6
04848	6
05292	6
05320	6
05517	6
05705	6
05872	6
06152	6
06178	6
06179	6
06381	6
06429	6
06675	6
06715	6
07292	6
19623	6
23123	6
A3424	6
A3717	6
A5700	6
B3424	6
B3717	6
B5700	6
G5700	6
I5700	6
J5700	6
M0323	6
M2814	6

Bridge	District
06303	7
06362	7
A6362	7
01198	8
01597	8
01971	8
01972	8
02724	8
03032	8
03304	8
03361	8
03362	8
03543	8
03544	8
03642	8
03643	8
03644	8
03684	8
04225	8
04355	8
04429	8
04467	8
05003	8
05004	8
05050	8
05064	8
05420	8
06047	8
06095	8
06113	8
06591	8
07098	8
07156	8
07264	8
16246	8
16252	8
17693	8
17694	8

Bridge	District
A3313	8
A6824	8
A6917	8
B3313	8
B6824	8
B6917	8
00702	9
02388	9
02597	9
03367	9
03636	9
04686	9
05432	9
05745	9
05769	9
05770	9
06059	9
06731	9
07248	9
16751	9
23507	9
A1421	9
00508	10
01984	10
02540	10
03023	10
03783	10
05735	10
06021	10
06627	10
07263	10
15981	10
A0615	10

03447	4
03542	4
03609	4
03909	4

05899	5
06316	5
06674	5
A5536	5

07343	6
01381	7
02466	7
05348	7

20045	8
23129	8
23131	8
A0402	8