Office of Bridges and Structures

Bridge Inspection Manual

Issue Date: January 1, 2014

Developed By:

HDR

PROJECT NO. TR-646 SPONSORED BY THE IOWA HIGHWAY RESEARCH BOARD

DISCLAIMER

THE BRIDGE INSPECTION MANUAL IS PUBLISHED SOLELY TO PROVIDE INFORMATION AND GUIDANCE TO BRIDGE INSPECTORS WHEN INSPECTING BRIDGES IN THE STATE OF IOWA. THIS MANUAL IS ISSUED TO SECURE, SO FAR AS POSSIBLE, UNIFORMITY OF PRACTICE AND PROCEDURE IN COMPLIANCE WITH THE NATIONAL BRIDGE INSPECTION STANDARDS. THIS MANUAL IS NOT PURPORTED TO BE A COMPLETE GUIDE IN ALL AREAS OF BRIDGE INSPECTION AND IS NOT A SUBSTITUTE FOR ENGINEERING JUDGMENT.

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List of Reference Documents

AASHTO Manual for Bridge Evaluation, 2nd Edition, 2011 Interims
AASHTO Guide Manual for Bridge Element Inspection, 1st Edition, 2011
NBE Manual, Iowa DOT, 2014
Iowa DOT Instructional Memorandum 2.120
Iowa DOT Instructional Memorandum 6.102

CHAPTER 1
REGULATIONS, ADMINISTRATION, AND POLICIES

1.1 PURPOSE OF MANUAL

The purpose of this manual is to organize, document, and combine Iowa Department of Transportation (Iowa DOT) policies and procedures for bridge inspection practices and post-inspection recommendations so Iowa DOT personnel, local agencies, and consultants will have a readily available resource for their use. Previously, bridge inspection policies and procedures were documented by various means, making it difficult to provide consistent answers to questions regarding bridge inspection topics. This manual is intended to ensure uniformity and document best practices for inspection of Iowa's bridges, especially as experienced inspection personnel retire.

1.2 DEFINITIONS, ABBREVIATIONS AND ACRONYMS, AND TERMINOLOGY

1.2.1 Definitions

The following terms in this manual are used as defined below:

- *Bridge* – A structure, including supports, erected over a depression or an obstruction such as a body of water, a highway, or a railway; having a track or passageway for carrying traffic or other moving loads; and having an opening measured along the centerline 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 contain multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.
- *Bridge Management (previously Pontis)* – A software program developed to assist in managing highway bridges and other structures.
- *Critical Finding* – A structural or safety-related deficiency for a bridge requiring immediate follow-up inspection or action.
- *Fatigue* – The tendency of a member to fail at a stress level below yield stress when subjected to cyclical loadings.
- *Fracture Critical Member* – A steel member in tension or with a tension element, whose failure would be expected to cause a partial or full collapse of the bridge.
- *Glulam* – Glue laminated timber, which is an engineered wood product consisting of individual laminations of wood, usually 2 inches or less in thickness, bonded together.
- *Gusset Plate* - A rectangular or triangular steel plate connecting members of a truss together.
- *HEC-18* – Hydraulic Engineering Circular No. 18 (HEC-18), which presents the state of knowledge and practice for the design, evaluation, and inspection of bridges for scour.
- *Histoplasmosis* – A disease contracted from contact with microscopic fungi borne from decomposing biological fluids such as bird droppings.
- *Load Rating* – The process of determining the live load capacity of a structure based on analysis of its current condition.
- *Program Manager* – The individual in charge of the bridge inspection program, who 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.

- *Quality Assurance* – Planned and systematic activities implemented within a quality system and demonstrated as needed to provide adequate confidence that deliverables will satisfactorily fulfill quality requirements.
- *Quality Control* – Efforts within a quality system encompassing operational techniques and activities used to verify an established level of quality has been achieved.
- *Scour* – Removal of material from a streambed or embankment as a result of excessive action of stream flow.
- *Scour Critical Bridge* – A bridge with a foundation element determined to be unstable for the observed or evaluated scour condition.
- *Scour Plan of Action* – A written procedure developed by the bridge owner or delegated Program Manager outlining the foundation scour monitoring plan to be followed for a specific bridge during flood events.
- *Structurally Deficient Bridge* – A bridge in which significant load-carrying elements are found to be in poor condition due to deterioration, or a bridge in which the adequacy of the waterway opening provided by the bridge is determined to be extremely insufficient to the point of causing intolerable traffic interruptions.
- *Team Leader* – An individual in charge of an inspection team responsible for planning, preparing, and performing field inspection of the bridge.
- *Thalweg* – The line defining the lowest points or maximum depth along the length of a river bed or valley.
- *Triaxial Constraint* – A 3-dimensional stress state reducing the ductility of a material. Under triaxial constraint, steel is unable to deform, and brittle fracture can occur under service conditions where ductile behavior is normally expected.

1.2.2 Abbreviations and Acronyms

The abbreviations and acronyms used in this manual are defined in Table 1.2.2.

Table 1.2.2. Abbreviations and Acronyms

Abbreviation	Term
AASHTO	American Association of State Highway and Transportation Officials
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
BME	Bridge Management Element
BMI Unit	The Bridge Maintenance and Inspection Unit of the Iowa Department of Transportation
BrM	Bridge Management software
CFR	Code of Federal Regulations
CMP	Corrugated Metal Plate
CoRe	Commonly Recognized
FCM	Fracture Critical Member
FHWA	Federal Highway Administration
HEC-18	Hydraulic Engineering Circular No. 18
HMA	Hot-Mix Asphalt
I.M. 2.120	Iowa Department of Transportation Instructional Memorandum 2.120
IOM	Independent Oversight Model

Abbreviation	Term
Iowa DOT	Iowa Department of Transportation
LPA	Local Public Agency
MR&R	Maintenance, Repair and Replacement
NBE	National Bridge Element
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NDT	Non-destructive Testing
NHS	National Highway System
OBS	Iowa DOT Office of Bridges and Structures
OSHA	Occupational Safety and Health Administration
POA	Plan of Action
PPCB	Pretensioned/Prestressed Concrete Beam
PPE	Personal Protective Equipment
PPRJ	Pavement Pressure Relief Joint
QA	Quality Assurance
QC	Quality Control
RMS	Records Management System
SI&A	Structure Inventory and Appraisal
SIIMS	Structure Inventory and Inspection Management System
UBIV	Underbridge Inspection Vehicle

1.2.3 Bridge Terminology Figures

Figures 1.2.3.1 through 1.2.3.17 are provided to standardize the terminology and labeling of bridge components to be used in bridge inspection reports. The bridges portrayed represent the majority of bridge types used throughout the State of Iowa (State), both on the State and U.S. highway system and on the local roads system.

1.2.3.1 Timber Stringer Bridge

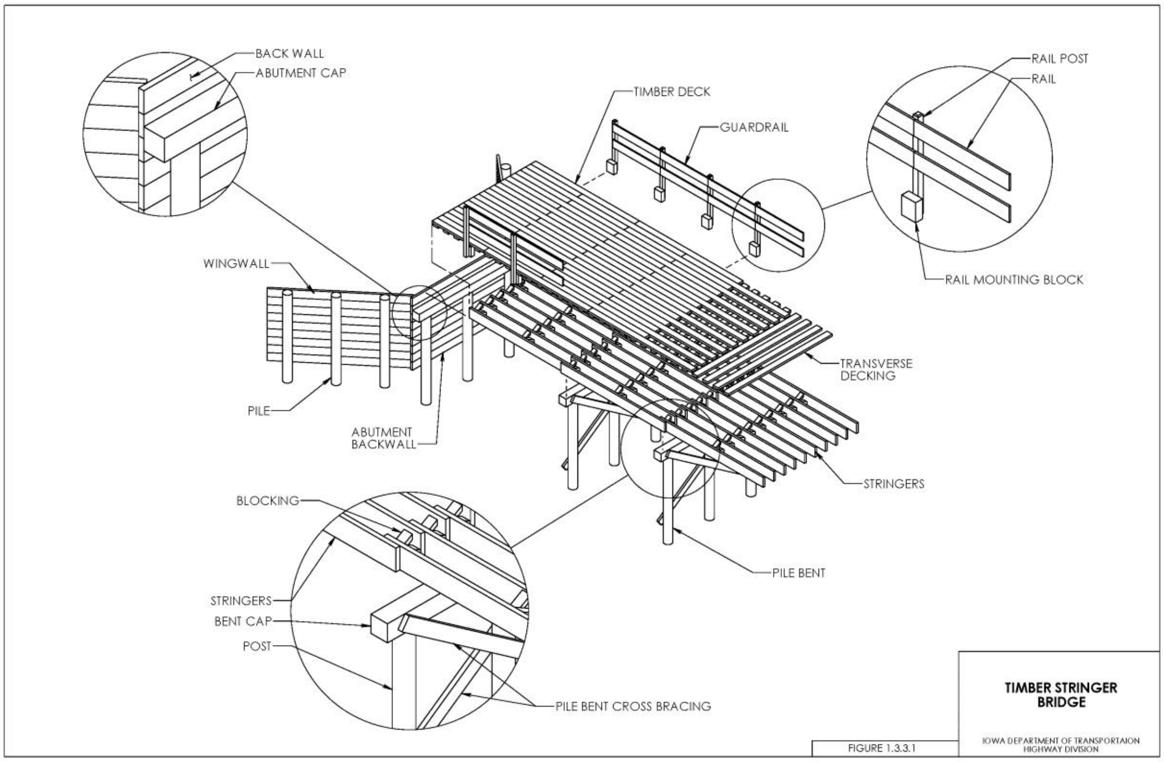


Figure 1.2.3.1. Timber Stringer Bridge Components

1.2.3.2 Reinforced Concrete Slab Bridge

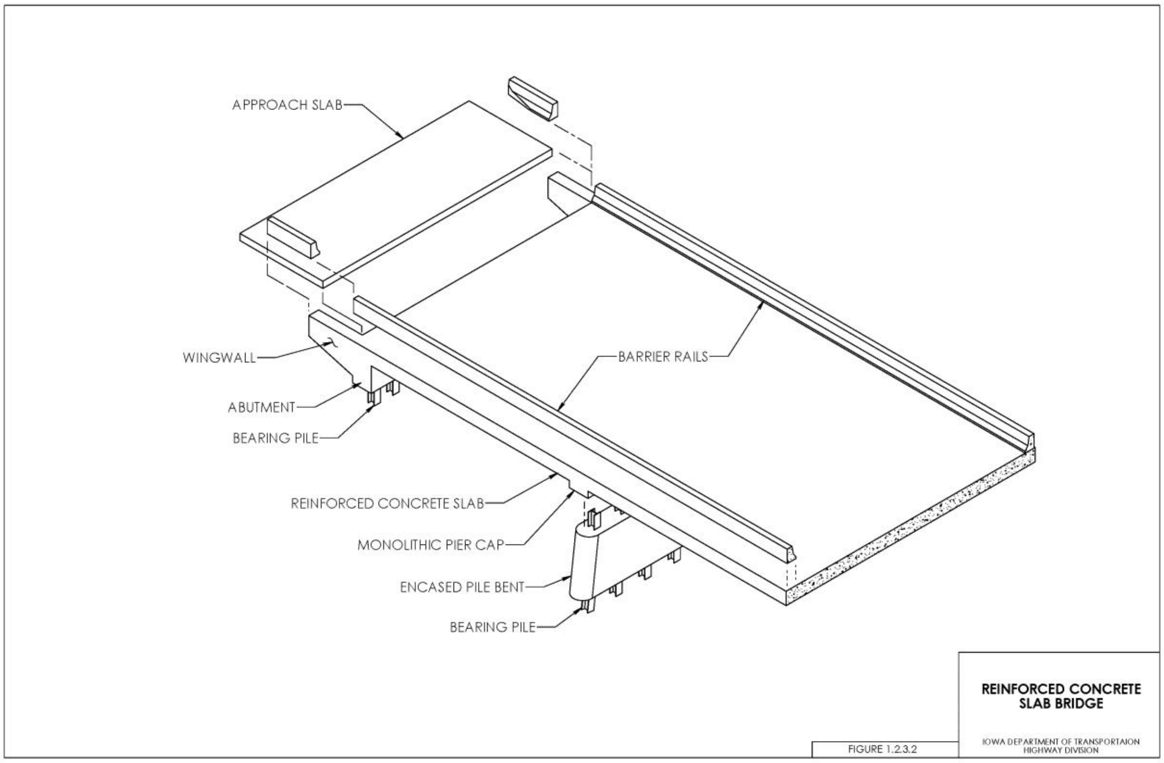


Figure 1.2.3.2. Reinforced Concrete Slab Bridge Components

1.2.3.3 Reinforced Concrete Beam Bridge

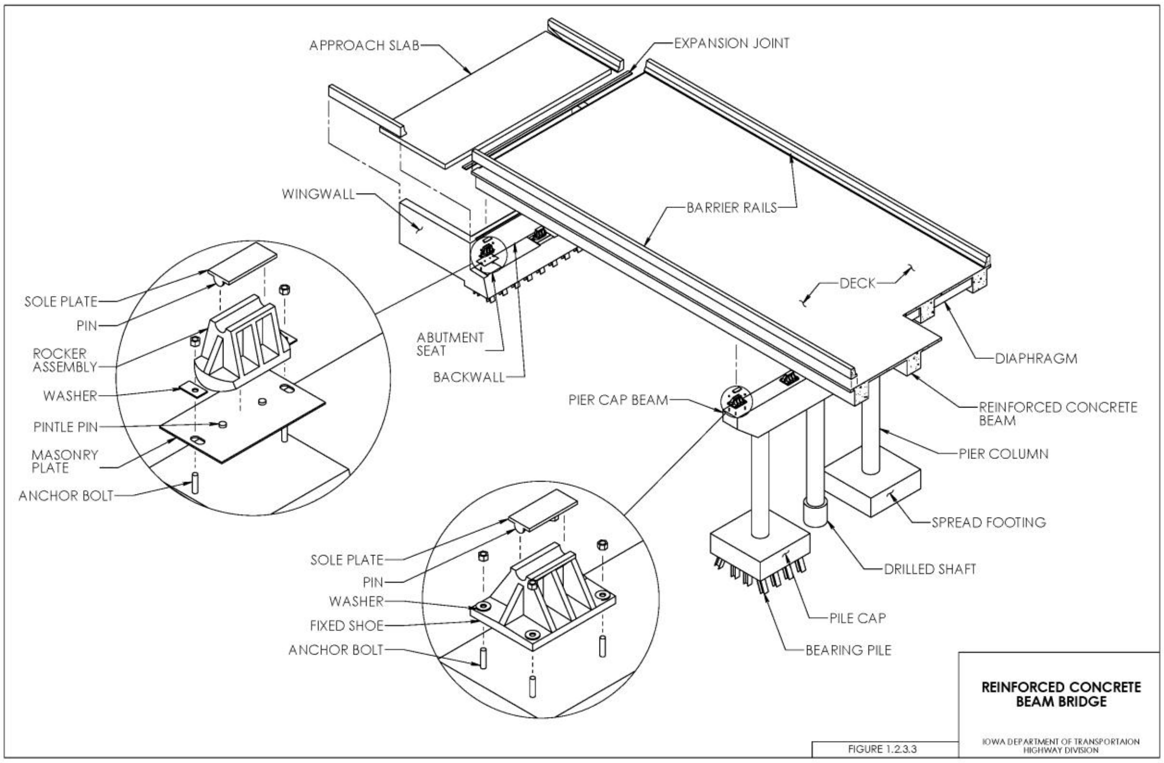


Figure 1.2.3.3. Reinforced Concrete Beam Bridge Components

1.2.3.4 Prestressed Concrete Beam Bridge

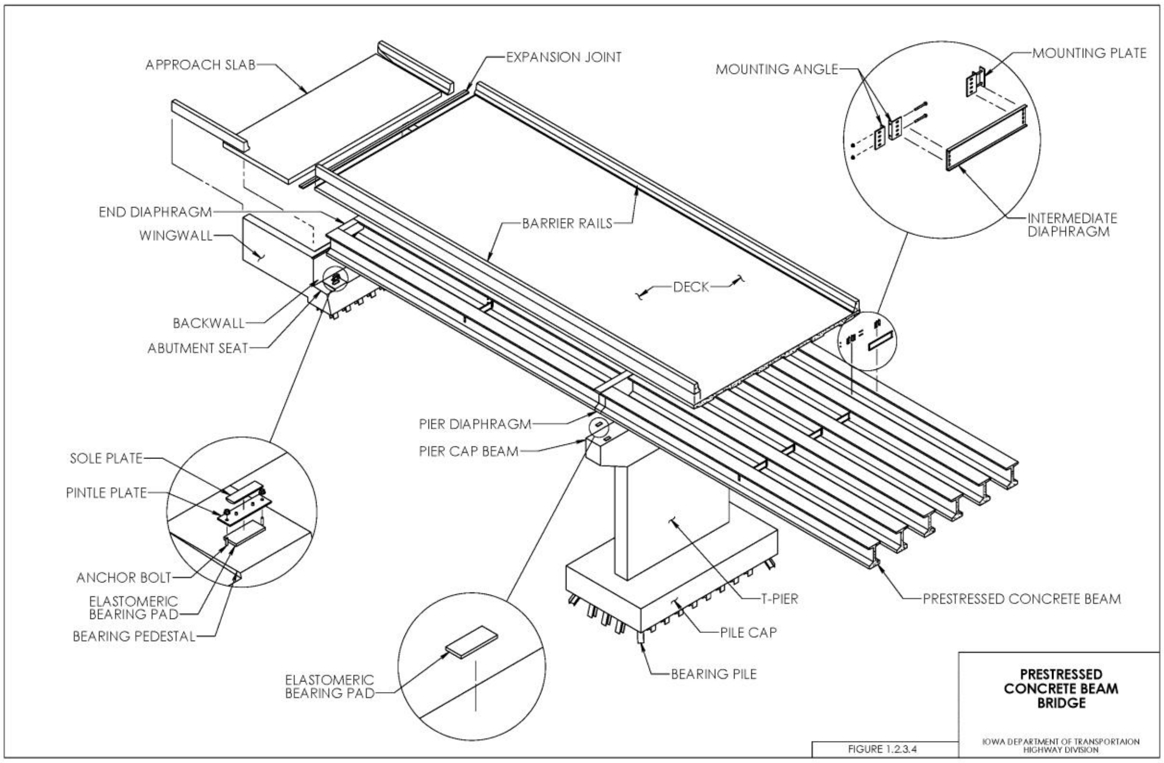


Figure 1.2.3.4. Prestressed Concrete Beam Bridge Components

1.2.3.5 Prestressed Concrete Quad Tee Beam Bridge

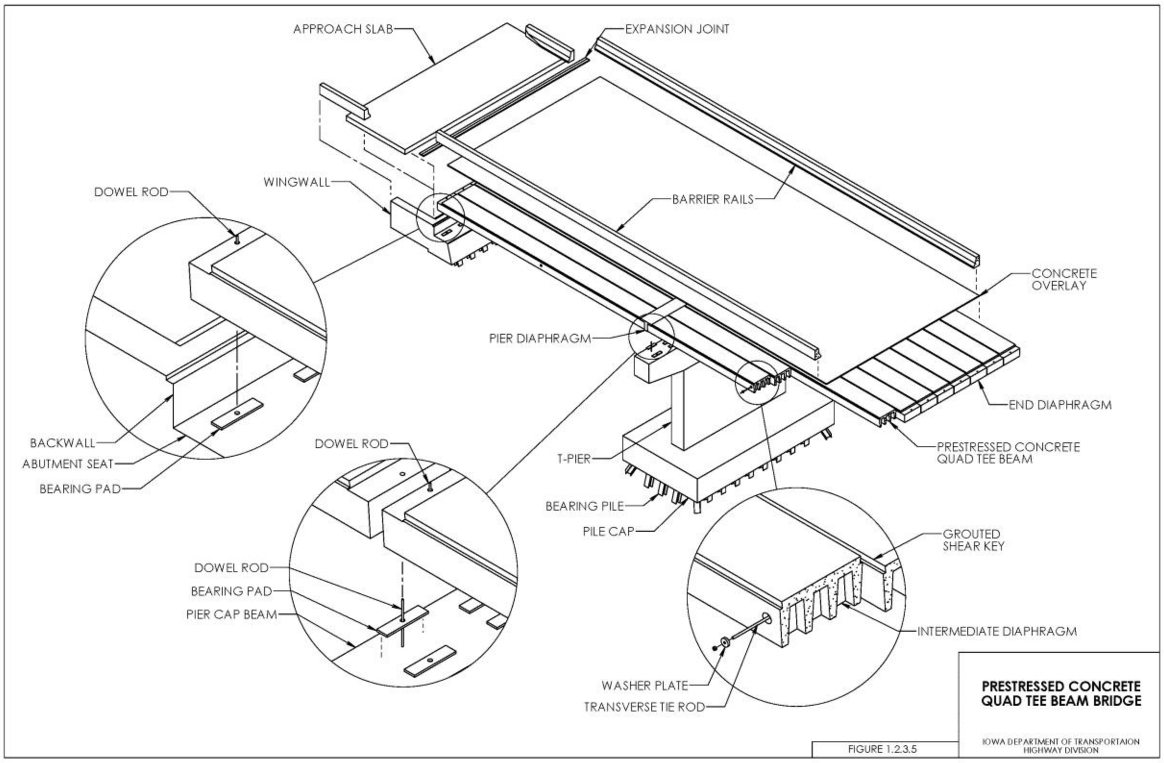


Figure 1.2.3.5. Prestressed Concrete Quad Tee Beam Bridge Components

1.2.3.6 Precast Concrete Box Beam Bridge

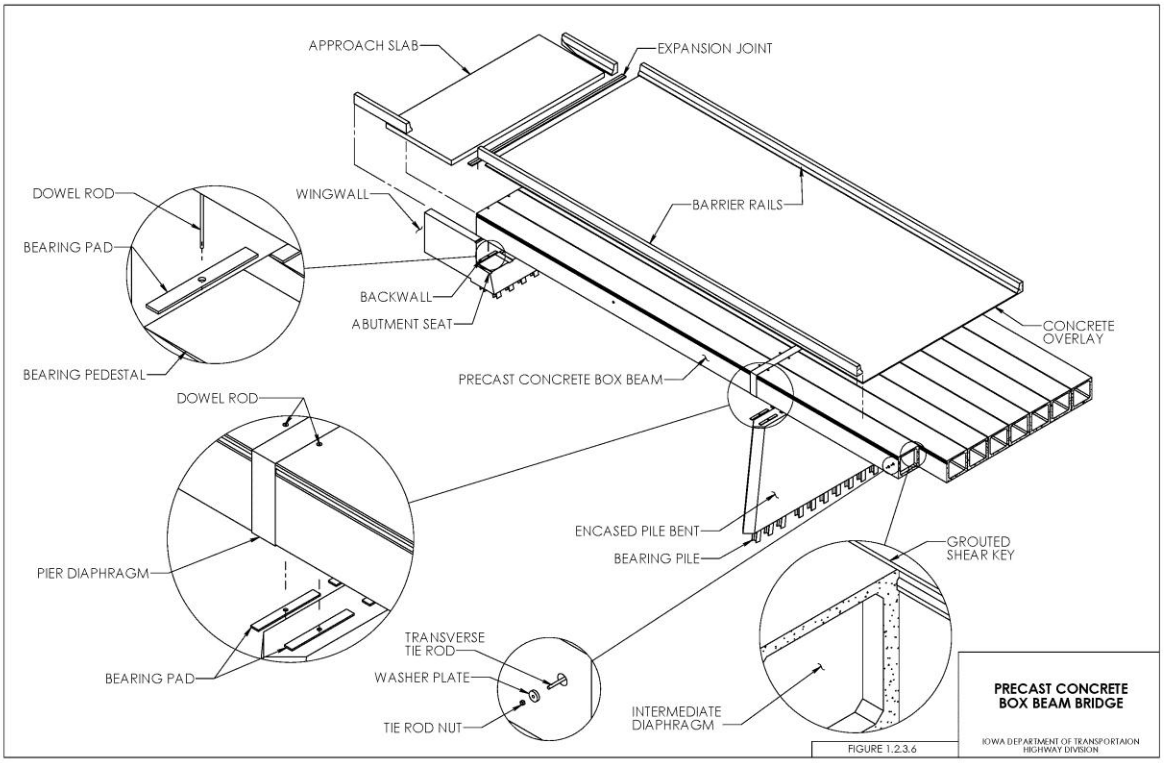


Figure 1.2.3.6. Precast Concrete Box Beam Bridge Components

1.2.3.7 Precast Concrete Panel Beam Bridge

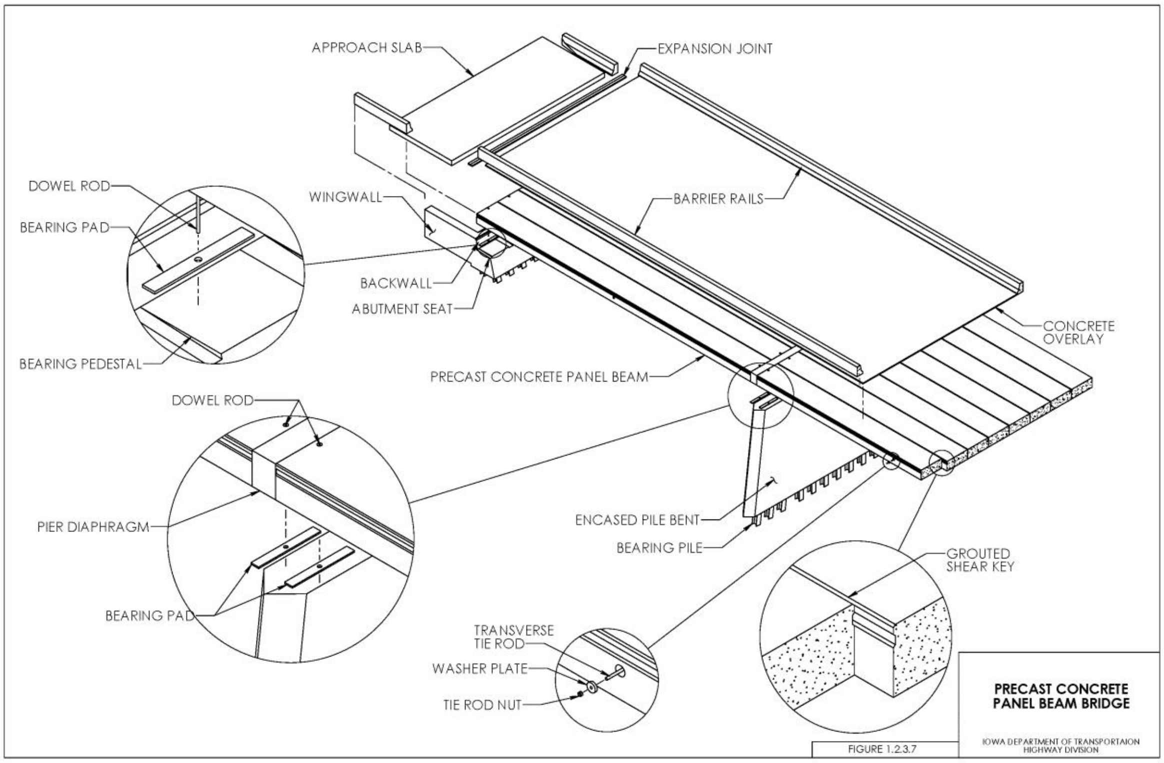


Figure 1.2.3.7. Precast Concrete Panel Beam Bridge Components

1.2.3.8 Precast Concrete Channel Beam Bridge

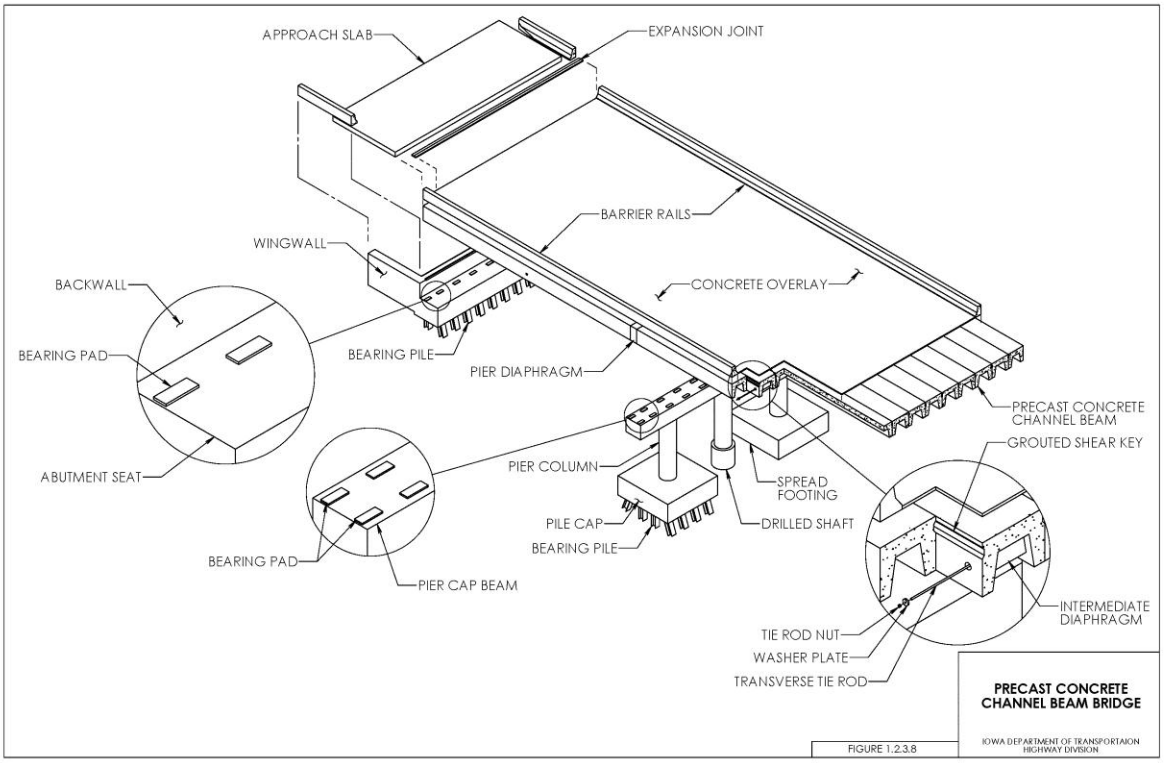


Figure 1.2.3.8. Precast Concrete Channel Beam Bridge Components

1.2.3.9 Steel Rolled Beam or Welded Steel Plate Girder Bridge

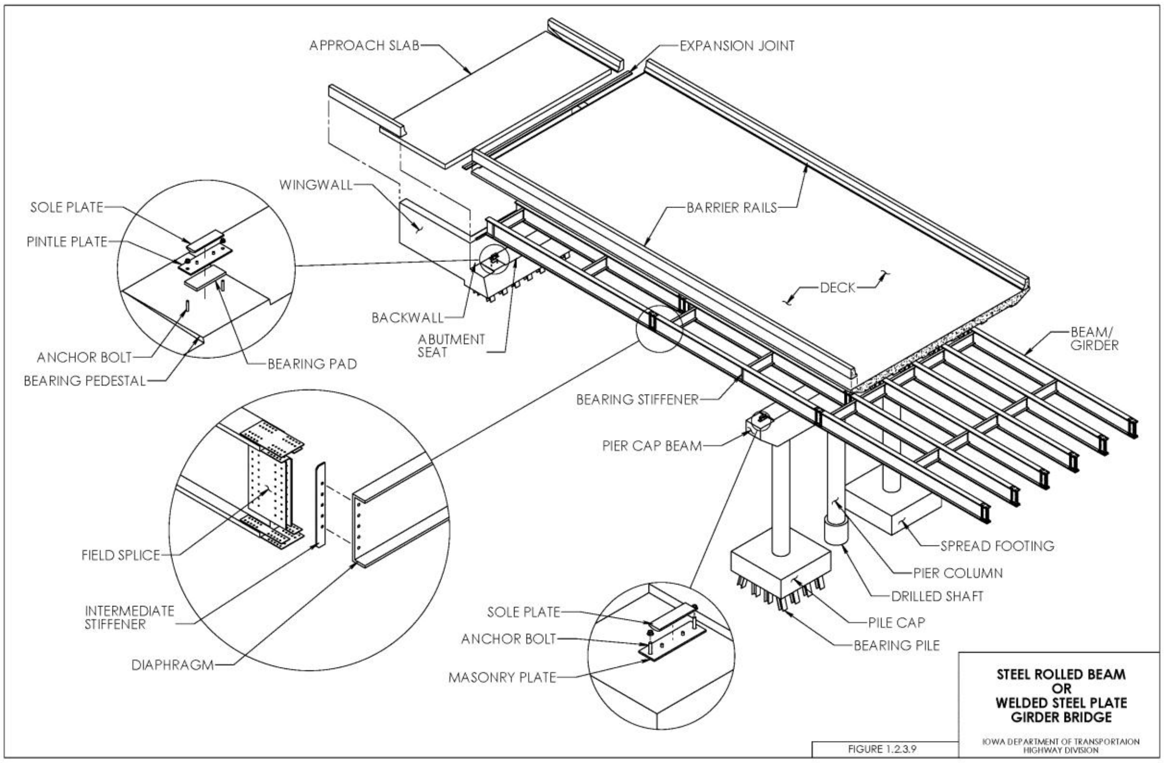


Figure 1.2.3.9. Steel Rolled Beam or Welded Steel Plate Girder Bridge Components

1.2.3.10 Steel Girder and Floorbeam Bridge

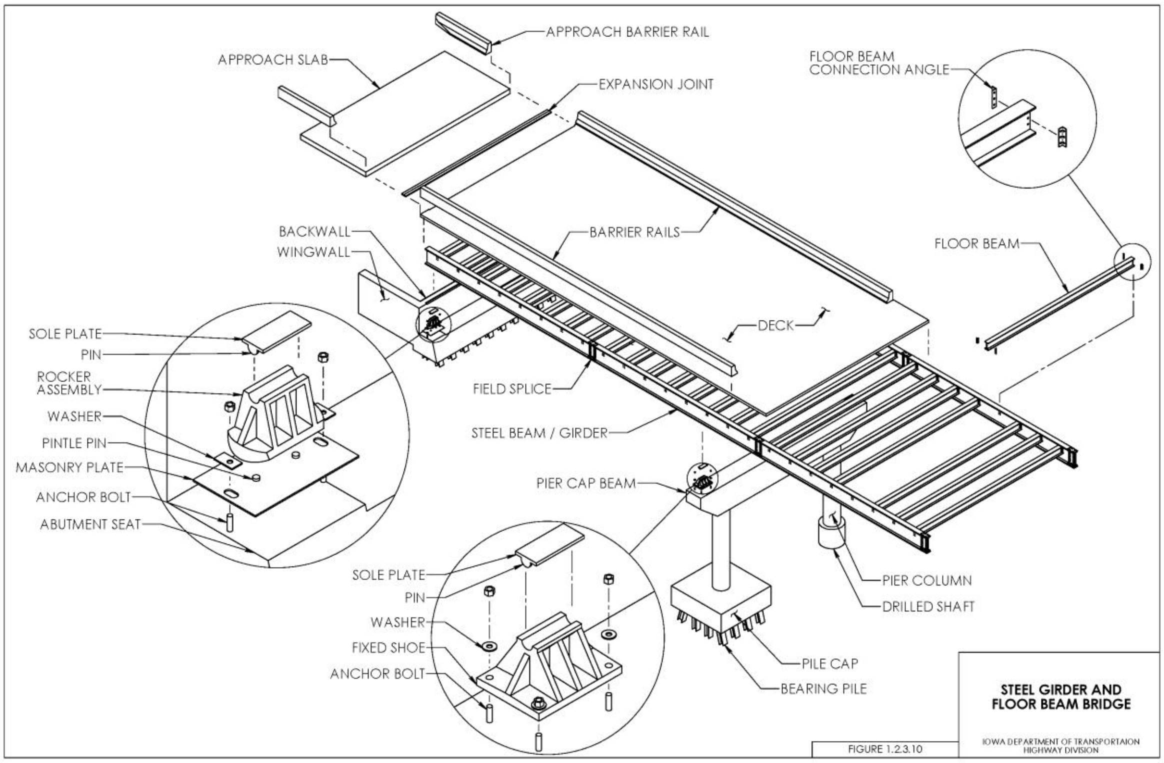


Figure 1.2.3.10. Steel Girder and Floorbeam Bridge Components

1.2.3.11 Steel Truss Bridge

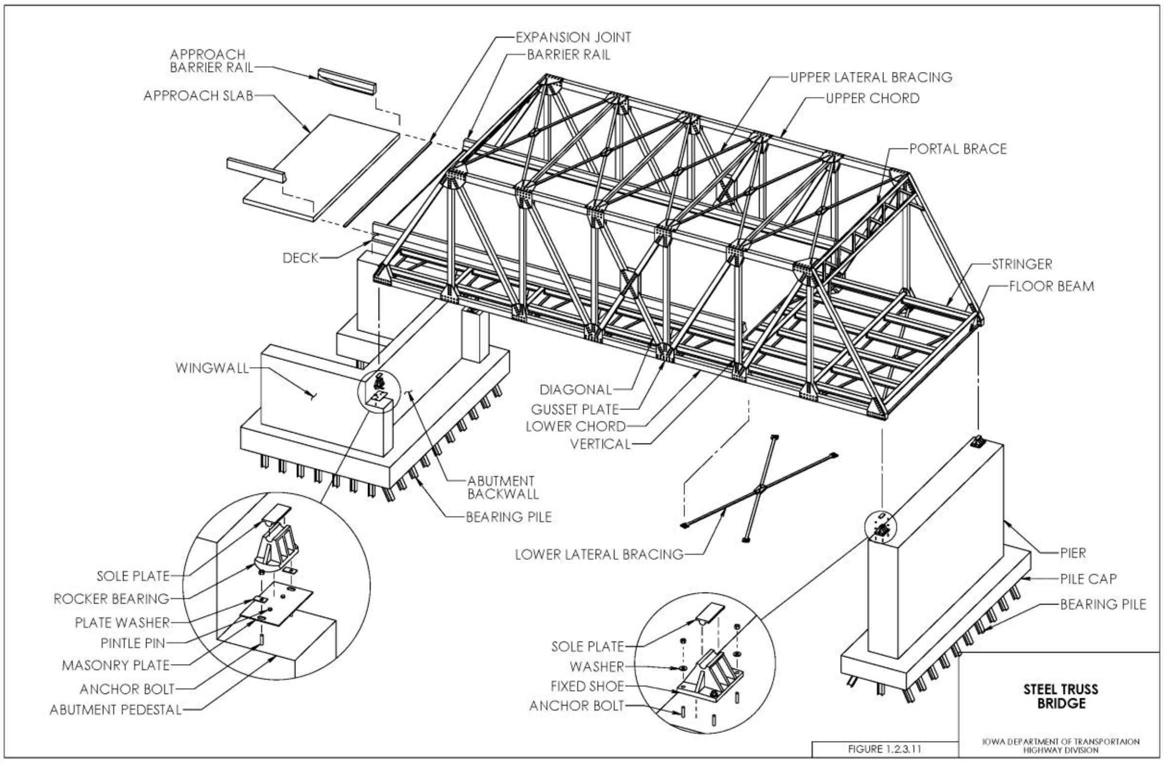


Figure 1.2.3.11. Steel Truss Bridge Components

1.2.3.12 Steel Tied Arch Bridge

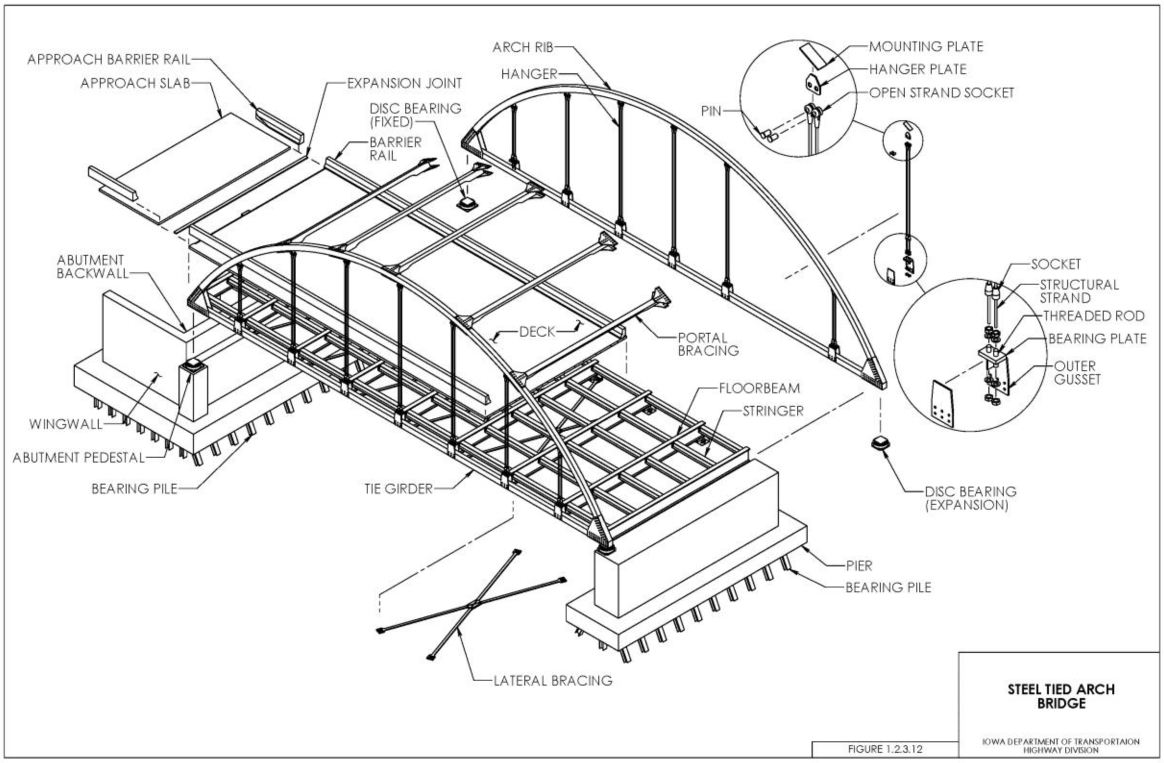


Figure 1.2.3.12. Steel Tied Arch Bridge Components

1.2.3.13 Steel True Arch Bridge

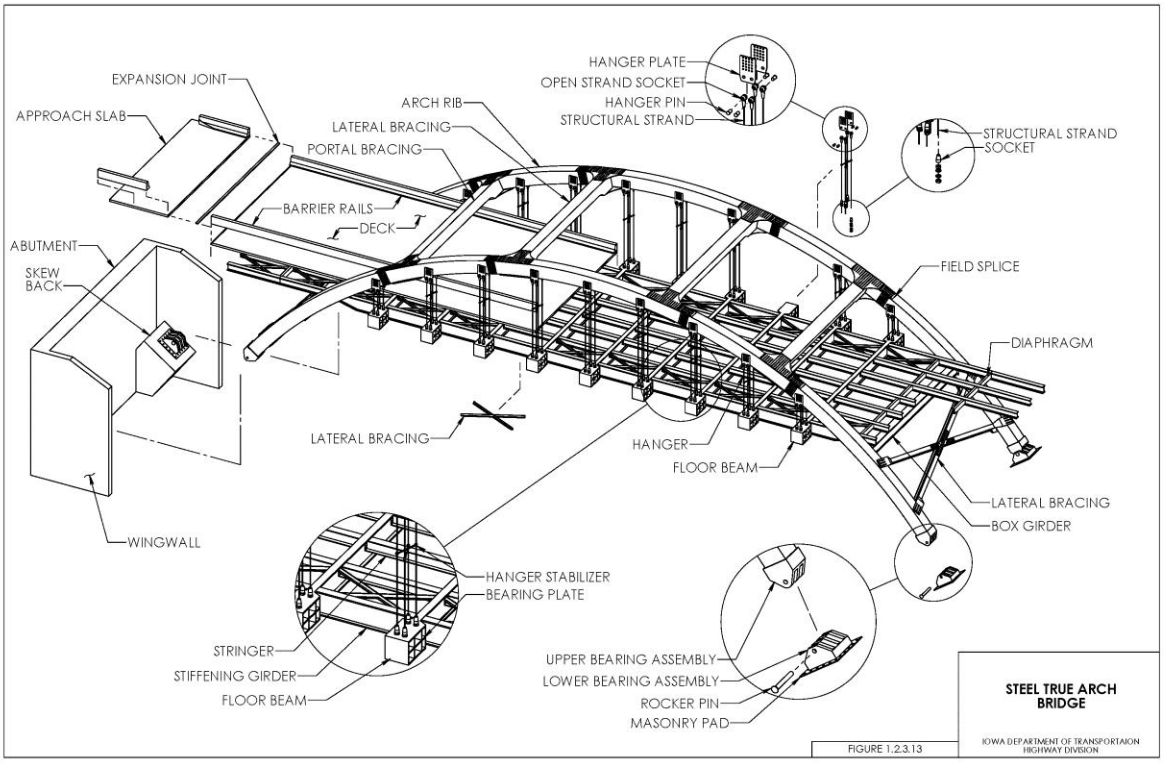


Figure 1.2.3.13. Steel True Arch Bridge Components

1.2.3.14 Concrete Spandrel Arch Bridge

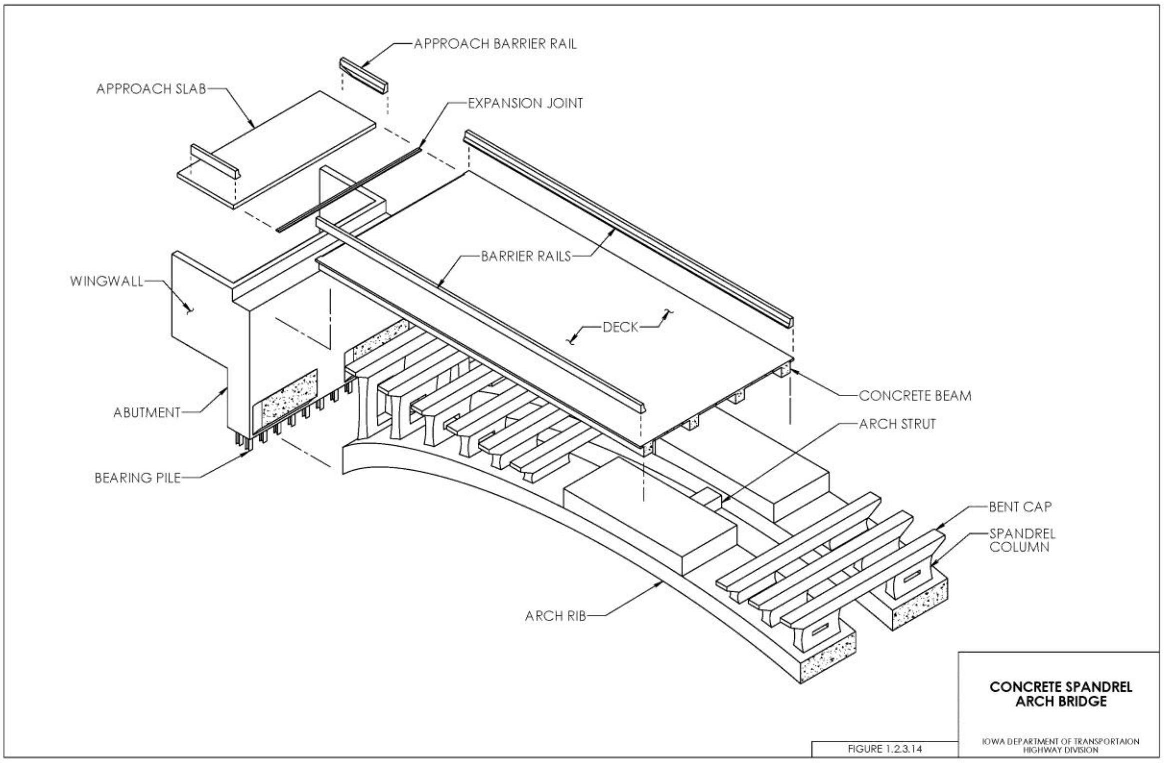


Figure 1.2.3.14. Concrete Spandrel Arch Bridge Components

1.2.3.15 Suspension Bridge

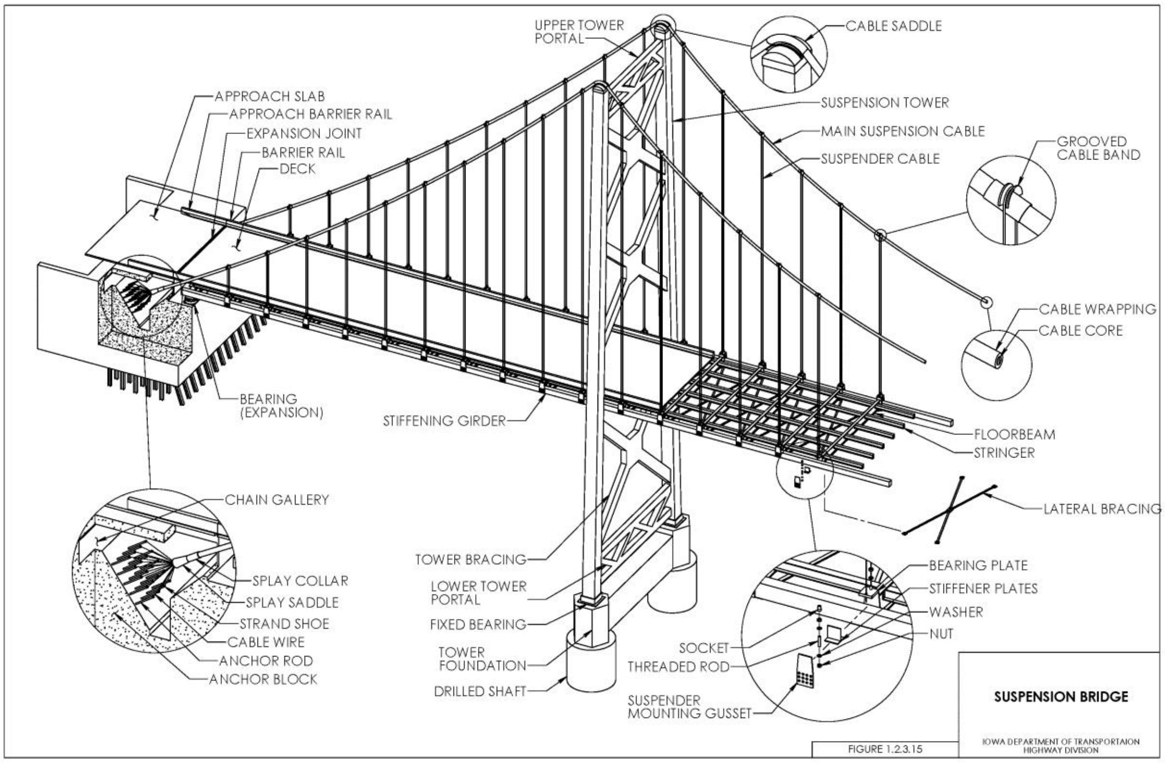


Figure 1.2.3.15. Suspension Bridge Components

1.2.3.16 Cable Stayed Bridge

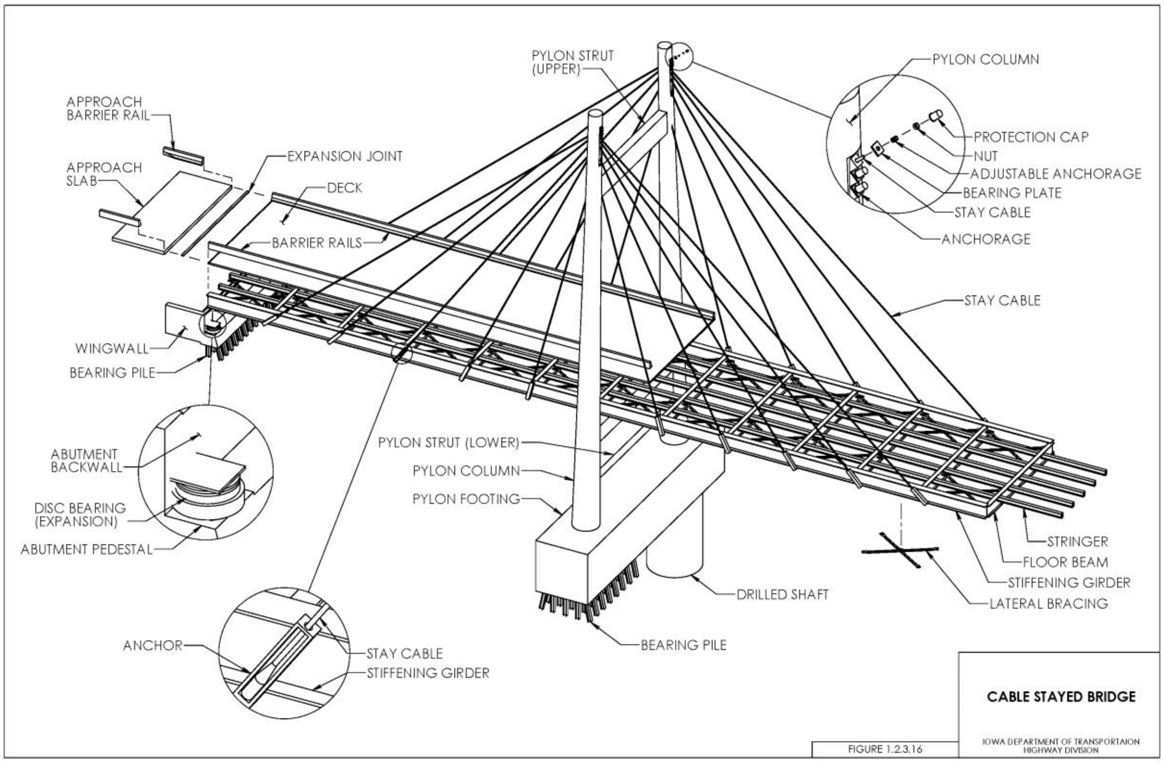


Figure 1.2.3.16. Cable Stayed Bridge Components

1.2.3.17 Culvert

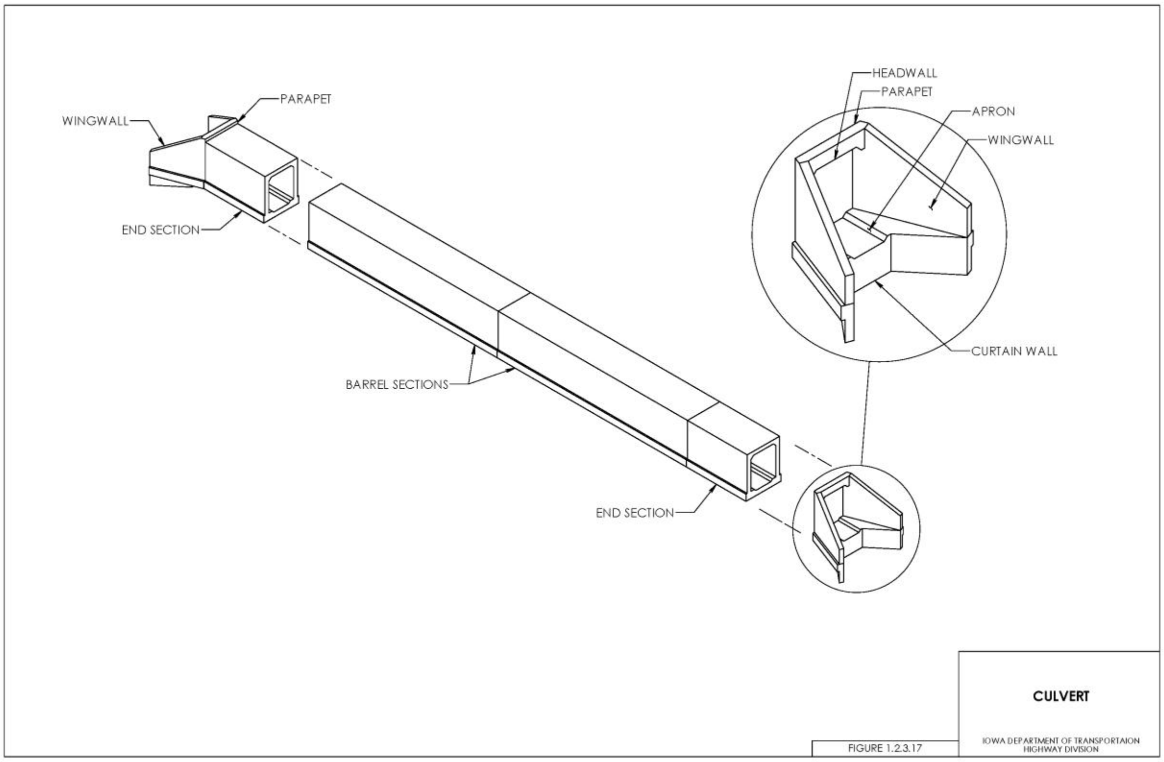


Figure 1.2.3.17. Culvert Components

1.3 HISTORY AND REQUIREMENTS OF NATIONAL BRIDGE INSPECTION STANDARDS

1.3.1 History and Background of NBIS

With the mobility introduced to society during the automobile age and the increased development of the current road system in the U.S., the demands on our nation's bridges have evolved throughout the 20th and 21st centuries. With these increasing demands, the responsibility to maintain our nation's bridges for the public's safety has taken on new importance. As bridges have aged and deteriorated, a number of significant bridge failures became the impetus for developing the current National Bridge Inspection Standards (NBIS) governing how the nation's bridges are inspected, load rated, and maintained. The first significant bridge failure leading to the current NBIS requirements was the December 15, 1967, collapse of the Silver Bridge on Route 35 between Point Pleasant, West Virginia, and Gallipolis, Ohio. In this most devastating bridge collapse in U.S. history in terms of loss of life, 46 people died as a result of an eyebar failure in this eyebar-chain suspension bridge. As a result of the collapse, President Lyndon Johnson called for an investigation, which resulted in the 1968 passing of the Federal Highway Act by Congress, U.S. Code Title 23, Section 151 setting forth the requirement to establish the NBIS.

In the 1968 Act, responsibility for establishing the NBIS was delegated to the Federal Highway Administration (FHWA). In 1970, the American Association of State Highway and Transportation Officials (AASHTO) Manual for Maintenance Inspection of Bridges and the FHWA Bridge Inspector's Training Manual were developed. After publishing the proposed NBIS in the Federal Register and allowing comments from individual states, FHWA published the initial NBIS in 1971.

The NBIS required all public bridges on the Federal-aid highway system to have a Structure Inventory and Appraisal (SI&A) conducted by 1972 and the data reported to FHWA. In 1978, the NBIS was extended to include all public bridges regardless of whether they were on the Federal-aid highway system. Important aspects of the NBIS were the following:

1. All states were required to perform periodic inspections of bridges greater than 20 feet in span length on at least a biennial basis.
2. Data collection was standardized and reported to FHWA.
3. Qualifications for inspection personnel were defined.
4. Training programs were developed and implemented.
5. The Bridge Replacement Program was established to provide funding for bridge replacement on the system.

Over the years, the inspection standards have been updated, often as the result of lessons learned from additional bridge failures. In June 1983, a suspended span of the Mianus River Bridge in Connecticut collapsed, killing three people. The cause of the collapse was traced to the failure of one of the four fracture critical pin and hanger assemblies that supported the suspended span. This collapse focused attention on fracture critical bridges and established national inspection guidelines, additional inspector training, and new fatigue research for these types of structures. FHWA added a new supplement to the Bridge Inspector's Training Manual 70 in 1986: Inspection of Fracture Critical Bridge Members. Fracture Critical Members were defined in the supplement as "Steel tension members whose failure would be expected to result in collapse of the span or bridge."

National attention turned to underwater inspections with the collapse of New York's I-90 bridge over the Schoharie Creek in 1987, which resulted in 10 deaths. With heavy run-off due to snowmelt and 5.9 inches of rainfall, the bearing soils beneath one of the piers were weakened due to scour. Pier No. 3 collapsed, causing the progressive collapse of Spans 3 and 4.

With over 86 percent of the bridges in the national registry spanning waterways and subject to potential scour, FHWA issued a technical advisory guide in 1988, “Scour at Bridges.” In October 1988, the NBIS was modified based on suggestions made in the 1987 Surface Transportation and Uniform Relocation Assistance Act. The national underwater inspection frequency interval was set at a maximum of 60 months, and scour-critical bridge inspections were initiated.

Most recently in 2007, the collapse of the I-35W bridge over the Mississippi River in Minneapolis, Minnesota has again heightened awareness of NBIS requirements and has focused attention on the inspection and load rating of gusset plates for truss bridges and on potential overload conditions during construction and repair activities. The conclusions drawn from the collapse of the I-35W bridge, which killed 13 people and injured 145, has resulted in new emphasis on gusset plate inspection, has led to the development of FHWA guidelines for the load rating of gusset plates, and has led to increased scrutiny of conditions and loadings that could be imposed during bridge construction or rehabilitation operations.

1.3.2 Bridge Inspection Organization

With the revisions to the NBIS that became effective in January 2005, state transportation departments were made responsible for inspecting or causing to inspect all highway bridges located on public roads fully or partially within the state’s boundaries, with the exception of bridges owned by Federal agencies. Federal agencies must, in turn, inspect or cause to inspect all highway bridges located on public roads fully or partially within the respective agency’s responsibility or jurisdiction.

To execute the duties set forth above, each state transportation department or Federal agency must include a bridge inspection organization responsible for the following:

- Statewide or Federal agency-wide bridge inspection policies and procedures, quality assurance and quality control, and preparation and maintenance of a bridge inventory.
- Bridge inspection reports, load ratings, and other requirements of the NBIS.

The NBIS does allow the delegation of the above duties, as is often the case with individual counties or municipalities performing their own inspections. Iowa has delegated inspection duties to local agencies that have bridges under their jurisdiction through Iowa Code section 314.18. However, the delegation of the duties does not relieve the state transportation departments or the Federal agencies of any responsibilities under the NBIS. A further requirement is that the state transportation departments or Federal agency bridge inspection organizations have a Program Manager, who meets specific required qualifications, to oversee the program.

1.3.3 Required Qualifications of Bridge Inspection Personnel

The Program Manager is the individual in charge of the inspection program for a particular state or Federal agency who has been assigned or delegated the duties and responsibilities for bridge inspection, reporting, and inventory. The Program Manager provides overall leadership for the program and is available to the Team Leaders to provide guidance. The requirements of a Program Manager are both of the following:

- Be a registered professional engineer or have 10 years of bridge inspection experience.
- Have successfully completed an FHWA-approved comprehensive bridge inspection training course.

A Team Leader is the individual in charge of an inspection team who is responsible for planning, preparing for, and performing a bridge inspection. In accordance with the NBIS, the Team Leader must be at the bridge site at all times during an inspection. An individual may qualify to be a bridge inspection Team Leader in one of the following five ways:

- Have the same qualifications as for a Program Manager, or
- Have 5 years of bridge inspection experience and have successfully completed an FHWA-approved comprehensive bridge inspection training course, or
- 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 and have completed an FHWA-approved comprehensive bridge inspection training course, or
- Have all of the following:
  - 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
  - Successfully passed a National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination
  - Two years of bridge inspection experience
  - Successfully completed an FHWA-approved comprehensive bridge inspection training course, or
- Have all of the following:
  - A associate’s degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology
  - Four years of bridge inspection experience
  - Successfully completed an FHWA-approved comprehensive bridge inspection training course

The NBIS requires periodic bridge inspection refresher training for Program Managers and Team Leaders as part of QC and QA. The Iowa DOT has defined periodic as being every five years. Therefore, all bridge inspection personnel are required to complete the Bridge Inspection Refresher Training course every five years following the completion of the Safety Inspection of In-service Bridges Training Course.

The individual charged with overall responsibility for load rating bridges must be a registered professional engineer.

An underwater bridge inspection diver must successfully complete an FHWA-approved comprehensive bridge inspection training course or other FHWA-approved underwater diver bridge inspection training course.

1.3.4 Bridge Inventory Requirements

Each state or Federal bridge inspection agency must prepare and maintain an inventory of all bridges subject to the NBIS within its jurisdiction. Iowa DOT utilizes the Structure Inventory and Inspection Management System (SIIMS) to maintain its bridge inventory.

Certain National Bridge Inventory (NBI) data must be collected and retained by the state or Federal agency for compilation by FHWA. The data must be reported using FHWA-established procedures as outlined in the “Recording and Coding Guide for Structure Inventory and Appraisal of the Nation’s Bridges.” The SI&A sheet displays most of the NBI data required by FHWA.

1.4 TYPES OF INSPECTIONS AND THEIR FREQUENCIES

1.4.1 Initial Inspections

An Initial Inspection is the first inspection of a bridge, which becomes a part of the bridge inventory. However, the elements of an Initial Inspection may also apply when there has been a change in the configuration of the bridge due to widening, lengthening, rehabilitation, the addition of supplemental bents, or if there has been a change in the bridge ownership.

The Initial Inspection is a fully documented investigation performed by persons meeting the NBIS qualifications for inspection personnel, and the inspection must be accompanied by an analytical determination of load capacity. The purpose of the inspection is two-fold: 1) To provide all NBI data required by Federal regulations and all other relevant information normally collected by Iowa DOT; and 2) To determine the baseline structural condition and to identify and list any existing problems or locations on the structure that may have potential problems. During the Initial Inspection, the inspector shall note any fracture critical members or details aided by a prior review of the plans. Assessments are also made of other conditions that might warrant special attention. An Initial Inspection for a newly constructed or newly rehabilitated bridge shall include all the requirements of an In-depth Inspection.

1.4.2 Routine Inspections

Routine Inspections are regularly scheduled inspections consisting of observations, measurements, or both needed to determine the physical and functional condition of a bridge, to identify any changes from the "Initial" or previously recorded conditions, and to ensure the structure continues to satisfy present service requirements.

The Routine Inspection must fully satisfy the NBIS requirements with respect to maximum inspection frequency, the updating of NBI data, and the qualifications of the inspection personnel. These inspections are generally conducted from the deck, from ground or water levels or both, and from permanent work platforms or walkways, if present. Inspections of underwater portions of the substructure are limited to observations during low-flow periods, probing for signs of undermining, or both. Special equipment such as an Underbridge Inspection Vehicle (UBIV), rigging, or staging may be necessary for a Routine Inspection in circumstances where it provides for the only practical means of access to areas of the structure being monitored.

The areas of the structure to be closely monitored are those determined by previous inspections, load rating calculations, or both to be critical to load-carrying capacity. If additional close-up, hands-on inspection of other areas is found necessary during the inspection, an In-depth Inspection of those areas should also be performed in accordance with Section 1.4.3.

The results of a Routine Inspection should be fully documented with appropriate photographs and written notes that include any recommendations for maintenance and repair and for scheduling follow-up In-depth or Special Inspections, if necessary. The Load Rating Evaluation Form shall be completed after a Routine Inspection to determine if re-evaluation of the load ratings is necessary.

For Routine Inspections, bridges shall be inspected at intervals not to exceed 24 months. The NBIS does recognize that age, traffic considerations, and known deficiencies may require establishing criteria to perform Routine Inspections at less than 24 months, and it is left to the individual state or Federal bridge inspection agencies to determine the criteria. The inspection interval for Routine Inspections may be increased from 24 months to a maximum of 48 months only with written FHWA approval if past inspection findings and analysis justify an increased inspection interval.

1.4.3 In-depth Inspections

An In-depth Inspection is a close-up, hands-on inspection of one or more members above or below the water level to identify any deficiencies not readily detectable using Routine Inspection procedures. This type of inspection can be scheduled independently of a Routine Inspection, though generally at longer intervals, or it may be a follow-up to a Damage or Initial Inspection. Traffic control and special equipment such as a UBIV, staging, and work boats should be provided to obtain access if needed. Personnel with special skills such as divers, rope access inspectors, and riggers may be required. When appropriate or necessary to fully ascertain the existence of or the extent of any deficiencies, nondestructive field tests or other material tests may need to be performed.

An In-depth Inspection may also include a load rating to assess the residual capacity of the member or members, depending on the extent of the deterioration or damage. Nondestructive load testing may be included to assist in determining a bridge's safe load carrying capacity.

In-depth Inspections are used to document all bridge elements in a more detailed manner due to conditions that are less than optimal. The definition of In-depth Inspection for Iowa is slightly different than what is described in the NBIS. Instead of using an In-depth Inspection for specific elements of a bridge and overlapping Routine with In-depth inspections, Iowa has chosen to define an entire inspection as either Routine or In-depth. Criteria have been established to differentiate Routine from In-depth inspections.

An In-depth Inspection requires all data fields relevant to the bridge in the Deck, Superstructure, Substructure, and Channel tabs be filled out or updated for the current conditions found. Descriptive inspection notes for the relevant data fields entered are recommended.

The following criteria shall be used to determine if a bridge should have an In-depth Inspection:

- For all fracture critical bridges, inspect every 24 months.
- For fatigue vulnerable bridges, inspect at 24-month or 72-month intervals depending on crack history. If crack history indicates that two or fewer locations have had fatigue cracks develop and these cracks have been arrested, an In-depth Inspection is required every 72 months.
- For structurally deficient bridges, inspect every 24 months.
- For all bridges with two or more condition ratings of 5 or less, inspect every 24 months.
- For all culverts with condition ratings of 5 or less, inspect every 24 months.
- For bridges with one condition rating of 5 or less, inspection can be an In-depth Inspection if the inspector determines it to be necessary.

Most of the bridges in Iowa are relatively small, and differentiating which elements require an In-depth Inspection and which can have a Routine Inspection is difficult to track. Therefore, when the In-depth criteria are met, all elements of a bridge should receive an In-depth Inspection and documentation. The activities, procedures, and findings should be completely and carefully documented.

1.4.3.1 Fracture Critical Member Inspections

A Fracture Critical Member (FCM) Inspection consists of a hands-on inspection of FCMs or FCM components including visual and other nondestructive evaluation. An FCM Inspection includes identification of FCMs and a plan for inspecting such members and defining the inspection procedures to be used. The frequency of inspection shall be in accordance with the NBIS.

A very detailed, close visual inspection is the primary method of detecting cracks. This may require critical areas be specially cleaned prior to inspection and additional lighting or magnification be used. Photographs should be taken and sketches should be made of the conditions found, and on-site comparison of photographs and sketches should take place at follow-up inspections. Where fracture toughness of the steel is not documented, tests may be necessary to determine the threat of brittle fracture at low temperatures.

FCMs shall be inspected at intervals not to exceed 24 months. The NBIS does recognize that age, traffic considerations, and known deficiencies may require establishment of criteria to perform FCM Inspections at less than 24 months, and it is left to the individual state or Federal bridge inspection agencies to determine the criteria. The frequency of inspection for FCMs should be reduced to a maximum of 12 months when:

1. Fatigue cracks have been found at previous inspections.
2. The alignment of FCMs or sub-elements has measurably changed from the as-built condition.
3. Deterioration in tension areas of the FCM has caused the superstructure to be at a condition rating of 4 or less.

FCMs can be inspected at a frequency less than 24 months by using an FCM Inspection (NBI Item 92A) or a Special Inspection (NBI Item 92C) at a reduced frequency.

Team Leaders who perform field inspections of Fracture Critical bridges shall complete the Fracture Critical Inspection Techniques for Steel Bridges training course.

1.4.3.2 Underwater Inspections

Underwater Inspections are used to inspect structural members that cannot be inspected visually or by wading during the Routine Inspection. These inspections are performed by a certified diver at intervals meeting the NBIS requirements, and they often require inspection by tactile probing methods. Occurrences that could result in a decision to perform Underwater Inspections at intervals less than those required by NBIS are known instances of structural damage; scour and erosion due to water movement; streambed load; ice loading; navigation traffic collision; deleterious effects of water movement; and effects of drift or elements in the water.

Typically underwater structural elements shall be inspected at intervals not to exceed 60 months. The NBIS does recognize that construction materials, environment, age, scour characteristics, condition rating from past inspections, and known deficiencies may require establishing criteria to perform inspection of underwater structural elements at less than 60 months, and it is left to the individual state or Federal bridge inspection agencies to determine the criteria. The inspection interval for underwater structural elements may be increased from 60 months to a maximum of 72 months only with written FHWA approval, if past inspection findings and analysis justify an increased inspection interval.

1.4.3.3 Special Inspections

A Special Inspection is an inspection scheduled at the discretion of the bridge owner or the responsible agency. It is used to monitor a particular known member condition or suspected deficiency and it must be performed by a qualified Team Leader familiar with the bridge and available to accommodate the assigned frequency of investigation. The individual performing the Special Inspection should be carefully instructed regarding the nature of the known deficiency and its functional relationship to satisfactory bridge performance. In this instance, guidelines and procedures on what to observe or measure must be provided, and a timely process to interpret the field results should be in place.

The determination of an appropriate Special Inspection frequency should consider the severity of the known deficiency. Special Inspections usually are not sufficiently comprehensive to meet NBIS requirements for biennial inspections. Special Inspection dates and frequency are documented by using NBI items 92C and 93C.

A Special Inspection should be scheduled when:

1. Deterioration is progressing at a rate that warrants inspection more frequently than 24 months.
2. Channel degradation or channel movement is progressing at a rate that warrants inspection more frequently than 24 months.
3. Temporary supports are in place.
4. Fatigue cracks have been found in a redundant steel structure. Special Inspections can be stopped when repair has been performed to mitigate the cracks.
5. Fatigue cracks have been found in a FCM. Special Inspections should continue even after cracks have been mitigated. Only after the potential for any future fatigue cracks has been eliminated can Special Inspections be stopped on a fracture critical bridge.
6. Collision damage has severely affected the load capacity of the bridge and repairs cannot be done within a reasonable time period. Once repairs have been made, the Special Inspections can be stopped.
7. Section loss has severely affected the load capacity of the bridge. Once repairs or rehabilitation work have been completed, the Special Inspections can be stopped.

1.4.3.3.1 Intermediate Fatigue Inspections

For bridges that are considered fracture critical and have fatigue-prone details, an Intermediate Fatigue Inspection may be scheduled as a type of Special Inspection. The purpose of an Intermediate Fatigue Inspection is to monitor fatigue-prone details. Another reason for this type of inspection would be to observe and monitor fatigue crack retrofits performed to determine if they have successfully arrested potential propagation of fatigue cracks.

Good practice procedures for Intermediate Fatigue Inspections include marking and dating locations where fatigue cracks are present. To accurately determine the ends of fatigue cracks, nondestructive test methods may need to be incorporated to supplement visual investigation. These nondestructive methods may typically include dye penetrant or magnetic particle testing methods.

1.4.3.4 Other Inspections

At the discretion of the bridge owner, other types of inspections may be used to monitor the performance of bridges or specific bridge components. Other Inspection dates and frequencies are documented by using the non-NBI fields for the inspection type called “Other.” “Other” inspections are not tracked by the FHWA for frequency compliance.

1.4.3.4.1 Damage Inspections

A Damage Inspection is an unscheduled inspection used to assess structural damage as the result of unforeseen environmental factors or human actions. Such inspections may be warranted due to events such as an unexpected overload of the bridge; a vehicle-bridge collision; a bridge being struck by an over-height vehicle; a reported deficiency by the public or maintenance personnel; or flood-induced damage from floating flood debris, bridge buoyancy conditions, wash-out of a bridge approach, or scour damage/bridge settlement.

A Damage Inspection may require an on-site assessment of whether a bridge can remain in service; therefore, consultation with a registered professional engineer may be warranted. In addition to determining whether the bridge can remain in service, the Damage Inspection should assess whether the damage to the bridge presents a risk to other facilities below or adjacent to the damaged components. Appropriate equipment should be available and personnel notified in case partial or full closure of the bridge is necessary and detour routes are required. If the bridge is closed immediately as a precautionary measure, the Damage Inspection should be followed by a structural analysis to determine the bridge’s safe load carrying capacity.

1.4.3.4.2 Pin or Pin and Hanger Inspections

Pin or Pin and Hanger Inspections are one type of inspection that could be required for steel bridges with pinned elements. This might include steel truss bridges pinned at their joints; steel arch bridges pinned at their supports or at their crown; and steel girder, steel stringer, or steel truss bridges with spans suspended by pin and hanger systems. This type of inspection requires specialized equipment and often special access methods to allow for testing of the pin members by nondestructive ultrasonic testing methods. For typical ultrasonic test procedures, a transmitter and a receiver are attached to one end of a pin member. The transmitter transforms the energy of an electrical voltage into an ultrasonic wave, and the ultrasonic wave travels through the material at a velocity dependent upon the material’s properties. The ultrasonic wave travels through the material until the test specimen boundary reflects the signal, and then the reflected signal travels back through the material to a receiver. The receiver converts the mechanical energy back to electrical energy, which is then amplified. The amplified signal, or echo, is displayed on the instrument screen, and if the member contains a discontinuity (that is, a defect), the discontinuity appears as a reflected defect echo on the screen.

Some pin and hanger members are considered FCMs. If the pin and hangers are considered FCMs, a hands-on, visual inspection of all elements of the connection is required as part of a regularly scheduled FCM Inspection. However, because the ultrasonic pin testing usually requires specialized access, such as a manlift or UBIV, to place personnel and the test equipment close to the pin, it also allows for ready access to perform supplementary hands-on inspection of the assembly.

Pin and hanger connections not considered FCMs can be inspected with ultrasonic testing methods at a 60-month frequency. This type of inspection should be tracked by designating it as an “Other” Inspection.

1.4.3.4.3 Scour Inspections

Scour Inspections are used to assess an existing bridge’s vulnerability to scour and stream instability. In addition, Scour Inspections allow for documentation of scour changes since the previous inspection. The visual inspection should document the existing condition of the bridge, including, but not limited to, pier and abutment type; foundation depth (based on existing plans or physical probing in the field); substructure location and alignment relative to the stream; scour depth at abutments and piers; bridge skew; condition or absence of scour countermeasures; stream aggradation or degradation; upstream and downstream channel stability; potential or presence of debris; lateral movement of stream; and bed and bank soil material. The visual inspection should include photo documentation of the bridge deck, roadway profile, abutment walls, piers, and upstream/downstream channel configurations, as a minimum.

The information obtained from the visual inspection can be used to evaluate the scour potential from a flood event of a known return frequency through the use of analytical tools. Hydraulic models and equations in the HEC-18 computer program are commonly used for the analysis. These results, in conjunction with the field inspection and a structural analysis, can then be used to assess existing or potential scour and, if necessary, establish a formal Plan of Action for management of the scour potential of the structure to protect public safety.

1.4.3.4.4 Posting Sign Adequacy Inspections

A Posting Sign Adequacy Inspection would typically consist of an inspection to determine if posting signs are being maintained or, in the case of a closed bridge, to determine if barricades are being maintained in place and public access is restricted. This type of inspection could also be used to spot check a posted bridge to determine if overweight vehicles are complying with posting restrictions.

1.5 IOWA DOT INSPECTION PROGRAM POLICIES

1.5.1 Safety

By its nature, bridge inspection includes inherent dangers. Inspection staff are often working from elevated heights and often over water; they are working in and around active traffic; they are often working in challenging weather conditions; in working around the abutments of bridges, they are often working along steep, slippery slopes where footing can be difficult; and they must constantly focus on gathering the pertinent information required for a bridge inspection while also keeping their own safety and the safety of their coworkers and the traveling public in mind. Each bridge inspector should remember he or she is responsible for his or her own personal safety as well as the safety of others impacted by his or her work. To that end, some policies and common sense procedures are needed to protect staff from the dangers of bridge inspection, to help them recognize hazards, implement controls, and to give them the ability to select, use, and maintain tools and equipment in their work to minimize and, if possible, eliminate accidents, injuries, and near misses.

Generally, causes of accidents can be traced to two root causes: human error and equipment failure. Human errors can, in turn, be broken down into a number of factors, which may include improper attitude, horseplay, personal limitations, physical impairments, boredom, thoughtlessness, and taking shortcuts. Therefore, bridge inspectors must practice good work habits to minimize dangers they may encounter on the job. Inspectors first and foremost must practice common sense when performing bridge inspection activities. For example, it is Iowa DOT's policy that inspectors shall be tied-off 100 percent of the time when working in the basket of a manlift or UBIV or when using assisted climbing techniques to access bridge elements for inspection. Failure to maintain this 100 percent tied-off policy will unnecessarily expose the inspector to fall hazards that could otherwise be avoided. When working outside the basket of a manlift or UBIV, the inspector should be tied-off to a fixed object rather than the basket, in case the manlift or UBIV should move.

Environmental factors can also be a source of injury. Stinging insects, spiders, snakes, and nesting animals can startle or surprise a bridge inspector causing injury or sudden unexpected movements that could result in a fall. The presence of poison ivy, poison oak, and electric cattle fences can cause on-the-job injury or, at best, discomfort. In some cases, bridge configurations constituting confined spaces could have limited access entrances, poor oxygen content, or toxic gases.

With the physical demands of bridge inspection activities, proper work habits and mental attitude are important. Inspectors also need to be well rested and alert for their job assignments, maintain good physical health, and shall not be under the influence of drugs or alcohol on the job. Even over-the-counter medications can cause impairments that can affect balance or cause drowsiness and should be used with caution. Good work practices also include common sense activities such as keeping a clean, uncluttered work environment and using tools and equipment properly and for only their intended use. Inspectors who are controlling the basket of a manlift or UBIV should be trained in the operation of that particular type of equipment so movement of the basket is performed smoothly without sudden movements that could surprise a coworker in the basket. Training in the operation of the particular access equipment will also minimize the potential for damaging the equipment or members of the bridge being inspected.

The Occupational Safety and Health Administration (OSHA) applies different regulations depending on the nature of the work activity. The General Industry standards (OSHA CFR 1910) apply to activities like bridge maintenance or inspection, surveying, or wetland assessments. The Construction standards (OSHA CFR 1926) apply to new work on bridges, roadways, or other structures. Work, including bridge inspections, will be considered to be a maintenance activity when it meets the following criteria: It is work done for the purposes of making or keeping a structure, fixture or foundation (substrates) in proper condition in a routine, scheduled, or anticipated fashion – work that is done to keep a structure in its existing state, preventing failure or decline. Inspections related to the monitoring of work performed by a construction contractor will be considered construction activity.

Inspection personnel should receive awareness training for safety hazards they may encounter on the job. This safety training may include knowledge of proper procedures when working around active traffic, fall protection training, awareness training for confined spaces, ladder safety training, training for working on railroad property, and training for work over water. When working over water, particularly if the inspector is not tied-off, a personal floatation device or a safety boat with a life ring and two-way communication should be employed.

The inspection Team Leader's responsibilities include supervising job procedures and ensuring safe practices are being followed. The Team Leader not only needs to set a good example for the inspection staff but also should enforce safety policies and institute corrective actions when these policies are not followed. It is good practice that the Team Leader performs a safety briefing on the first day of inspection for a bridge or on subsequent days when work conditions or personnel working on the bridge might change. Topics to be discussed at the safety briefing might include individual worker assignments; use of the "buddy" system; any special considerations for the particular bridge being inspected, including potential electrical hazards from power facilities on the bridge or from overhead power lines; safety procedures for work over water, other roadways, or railroads; weather conditions; the types of traffic control that will be used; methods of bridge access that will be used, such as ladders, manlifts, UBIVs, waders, and assisted climbing; safe working zones; location and phone number of nearest first responders or medical services; and communication protocol, including two-way radios and cell phones with cell phone numbers for all staff on the job and for the local District office.

Inspection personnel shall use appropriate protective clothing and Personal Protective Equipment (PPE) when performing bridge inspection activities. Clothing worn should be properly sized (neither too loose nor too tight) and appropriate for the weather conditions. Leather work boots with traction lug soles should be worn, and safety shoes or boots with toe-impact protection meeting the requirements of ASTM F 2413 or ANSI 241 are required to be worn in work areas where personnel may be carrying or handling materials such as parts or heavy tools that could be dropped and where objects might fall onto or equipment could run over the feet. Work gloves should be worn to protect against sharp edges and excessively hot or cold steel. A tool belt or pouch may be worn to provide ready access to frequently used tools, but the tools also need to be secured to prevent them from falling on passing vehicular traffic. Additional PPE shall include an ANSI 107, Class 2 or 3 High Visibility Safety Vest (Class 3 is rated for traffic speeds above 50 mph). If working at night outside the cab of a vehicle, high visibility pants and head gear are also required. Hard hats, shall meet the requirements of ANSI Z89.1. Safety goggles or safety glasses with side shields should be worn whenever chipping concrete or hammering on bridge members, and ear protection should be worn if working around loud pneumatic or power equipment. A dust mask or properly fitted respirator should be worn when working in particularly dusty conditions or in the presence of bird droppings to prevent contracting Histoplasmosis, a disease contracted from contact with microscopic fungi borne from decomposing biological fluids such as bird droppings. Finally, when walking or working on an unprotected surface 6 feet or more from the ground or a lower level, or when working from the basket of a manlift or UBIV or using assisted climbing techniques, the inspector shall wear a properly adjusted full-body harness, shock absorbing lanyard with double locking snap hooks, and a cross-arm strap with a D-ring (if needed). The harness shall meet the requirements of ANSI A10.14, ANSI/ASSE Z359, or the latest version of 29 CFR 1910.66,1926.104 or 1926.502.

1.5.2 Media Relations

Elements of the Iowa DOT Bridge Inspection Program and individual bridge records available in SIIMS may be subject to open public records laws. For example, data is annually made available to FHWA and the public regarding the number and locations of structurally deficient bridges within the State. However, if approached by a member of the press about the condition of a specific bridge or bridges, inspectors shall defer comment and refer the individual to the Iowa DOT Office of Public Affairs.

1.6 STATEWIDE INSPECTION PROGRAM POLICIES

1.6.1 Timelines for Completion of Inspections and Reports

For Routine, In-depth, FCM, Underwater, and Special Inspections, SI&A data shall be entered into SIIMS within 90 days of the date of the inspection completion.

For existing bridge modifications that alter previously recorded data and for new bridges, the SI&A data shall be entered into the State or Federal agency inventory within 90 days after the completion of work for State or federal agency bridges and within 180 days after the completion of work for all other bridges.

For changes in load restrictions or closure status, the SI&A data shall be entered into SIIMS within 90 days after the change in status of the structure.

1.6.2 Standardized Bridge Orientation and Labeling Conventions

To promote uniformity in reporting inspection data, all bridge components shall be labeled using the following numbering convention consistent with the progression of mileposts on the State highway system:

- For bridges on a roadway with a north/south designation, bridge substructure components shall be numbered in increasing order starting at the south end of the bridge, relative to the direction designation, and progressing toward the north. Thus, the south abutment would be referred to as the "near" abutment and the north abutment would be referred to as the "far" abutment. Likewise, interior supports would be numbered Pier No. 1 at the southernmost interior support and would increase in number proceeding to the north. Span numbers would also increase in number from south to north. Floorbeams and diaphragms are numbered from the near end to far end of each span. The first floorbeam or diaphragm over an abutment or pier will be designated as #0. The numbering continues consecutively thru the span to the next substructure unit where the numbering begins again at #0. Truss panel points would similarly increase from south to north from near end to far end of a span. Thus the truss panel point at the south support would be L0 for a lower chord panel point (or U0 for an upper chord panel point) and panel point L1 (or U1) for a first interior panel point. Beam or stringer lines would be numbered increasing from left to right, with Beam Line No. 1 at the westernmost beam and increasing in number to the easternmost beam. Likewise, pile numbers for exposed piles at abutments or pile bents would be numbered in increasing order from left to right (west to east).
- For bridges on a roadway with an east/west designation, bridge substructure components shall be numbered in increasing order starting at the west end of the bridge, relative to the direction designation, and progressing toward the east. Thus, the west abutment would be referred to as the "near" abutment and the east abutment would be referred to as the "far" abutment. Likewise, interior supports would be numbered Pier No. 1 at the westernmost interior support and would increase in number proceeding to the east. Span numbers would also increase in number from

west to east. Floorbeams and diaphragms are numbered from the near end to far end of each span. The first floorbeam or diaphragm over an abutment or pier will be designated as #0. The numbering continues consecutively thru the span to the next substructure unit where the numbering begins again at #0. Truss panel points would similarly increase from west to east from near end to far end of a span. Thus the truss panel point at the west support would be L0 for a lower chord panel point (or U0 for an upper chord panel point) and panel point L1 (or U1) for a first interior panel point. Beam or stringer lines would be numbered increasing from left to right, with Beam Line No. 1 at the northernmost beam and increasing in number to the southernmost beam. Likewise, pile numbers for exposed piles at abutments or pile bents would be numbered in increasing order from left to right (north to south).

1.6.3 Critical Findings/Emergency Response

Critical structural and safety related deficiencies found during the field inspection or as a result of a structural analysis of the bridge should be immediately brought to the attention of the bridge owner or responsible agency by the Program Manager or Team Leader if a safety hazard is present. This process alerts the bridge owner so that1) timely action is taken to ensure the safety of the traveling public, 2) damage or deterioration can be repaired in a proper and timely manner, and 3) the damage and repairs are documented in the bridge file. The process also aids in identifying problem areas that affect other bridges with similar details so follow-up inspections can be performed if needed.

A standard Critical Findings Report form has been incorporated into SIIMS. Conditions requiring a Critical Findings Report shall include, but are not limited to, the following:

- A partial or complete collapse of a bridge
- A structural or other defect posing a definite and immediate public safety hazard
- A condition rating of 2 or less for any of the following NBI items:
  - NBI Item 58, Deck
  - NBI Item 59, Superstructure
  - NBI Item 60, Substructure
  - NBI Item 61, Channel and Channel Protection
  - NBI Item 62, Culvert
  - NBI Item 113, Scour Critical

In cases where it is determined the bridge could be used safely at a lower posted load limit, the bridge may remain open if it is immediately posted at the reduced limit. At the discretion of a bridge owner, other conditions, not specified in this manual, may be designated that would require preparation of a Critical Finding Report.

1.6.4 Inspection Intervals for Non-regulated Structures

1.6.4.1 Pedestrian Bridges

The NBIS does not define the required interval for inspection of non-vehicular bridges, such as pedestrian bridges. The owner should develop a protocol for the inspection interval for pedestrian bridges.

1.6.4.2 Culverts

The definition of a bridge, provided in Section 1.2.1 of this manual, addresses single cell box culverts with spans greater than 20 feet and multiple cell culverts with an aggregate length between extreme ends of openings that is greater than 20 feet. Therefore, a box culvert meeting the criteria under the definition for a bridge shall fall under the required inspection intervals defined in the NBIS.

For box culverts that do not fall within the NBIS criteria for the definition of a bridge, the owner shall develop a protocol for the required inspection interval.

1.6.4.3 Privately Owned Structures

Privately owned structures not open to public use are not governed by NBIS regulations. A bridge on a public highway where the bridge is privately owned is not subject to the NBIS; therefore, FHWA has no legal authority to require private bridge owners to inspect or maintain their bridges. However, FHWA strongly encourages private bridge owners to follow the NBIS as a standard for inspecting their structures or to reroute the public road when a privately owned bridge carries a public road. The bridge owner should have a Program Manager who is assigned the above responsibilities, or the bridge owner may retain a consultant to perform the duties of Program Manager.

1.6.5 Temporary Structures

Any replacement structure, which is expected to remain in place without further project activity, other than maintenance, for a significant period of time, shall not be considered temporary. Under such conditions, that structure, regardless of its type, shall be considered the minimum adequate to remain in place. The structure must be added to the NBI and evaluated accordingly.

If a structure has been taken out of service due to condition, collapse, or removal, and a temporary structure or low water crossing has been installed, the NBI data for the original structure should have the following coding:

1. Item 41 = E – Open, temporary structure in place to carry legal loads while original structure is closed and awaiting replacement or rehabilitation.
2. Item 58 = 0 – Out of service.
3. Item 59 = 0 – Out of service.
4. Item 60 = 0 – Out of service.
5. If applicable, Item 62 = 0 – Out of service.
6. Item 64 = 0 – Temporary structure.
7. Item 66 = 0 – Temporary structure.
8. Item 103 = T – Temporary structure(s) or conditions exist.

There are NBI items that are to be coded according to the temporary structure’s conditions. The items that are to be coded are as follows:

1. Item 10 – Inventory Route, Minimum Vertical Clearance.
2. Item 47 – Inventory Route, Total Horizontal Clearance.
3. Item 53 – Minimum Vertical Clearance over Bridge Roadway.
4. Item 54 – Minimum Vertical Underclearance.
5. Item 55 – Minimum Lateral Underclearance on the Right.
6. Item 56 – Minimum Lateral Underclearance on the Left.
7. Item 70 – Bridge Posting.

The original structure must be removed from the NBI if no work has been done to replace it within five years of the time the bridge was closed. If, after the original structure is removed from the NBI, the temporary structure qualifies as a bridge, it must be added to the NBI and evaluated accordingly.

1.6.6 Temporary Supports

A structure that has temporary supports is to be evaluated as if no temporary supports are in place. Most NBI items shall be determined as if the temporary supports are not in place. Condition ratings and load ratings shall not take into account the effect of the temporary supports. The NBI items shall be coded considering the temporary supports in place are as follows:

1. Item 41 = D – Open, would be posted or closed except for temporary shoring, etc., to allow for unrestricted traffic.
2. Item 103 = T – Temporary structure(s) or conditions exist.

If the temporary supports are to remain in place more than five years, the supports are no longer considered temporary and the structure shall be evaluated accordingly.

CHAPTER 2
CONDITION EVALUATION OF BRIDGES FOR IOWA DOT PERSONNEL

2.1 INSPECTION PLANNING

2.1.1 Reviewing Past Inspection Reports, SIIMS Data, Existing Bridge Plans, and Bridge Repair Plans

The first step in preparing for any bridge inspection for bridges on the Iowa DOT State or U.S highway system is to gather information regarding the existing bridge so the inspector is educated with regard to the configuration and type of bridge as well as its documented history. This is important so the number of inspection personnel and type of equipment and tools, including non-destructive testing equipment, needed to perform the inspection can be determined. If as-built plans and/or plans of any repairs or rehabilitation projects are available, they should be reviewed to help the inspector gain an understanding of the bridge configuration and structure type as well as allow the inspector to plan ahead for the access constraints that might affect how the bridge will be inspected. Typically, if existing plans are available, they would be included as part of the bridge's record within the SIIMS database. Another helpful resource is any available shop drawings produced by the contractor or the contractor's fabricators at the time the bridge was originally built or rehabilitated.

In addition to existing plans and shop drawings, the bridge record within SIIMS should also contain past inspection reports for the bridge. Reviewing these past reports not only helps the inspector identify problem areas of the bridge previously documented, but they may also document the progression of damage or deterioration over the course of multiple inspections, thus allowing the inspector to identify trends or problem areas worsening over time. The inspection reports should also include past photographs and field sketches documenting the condition of the bridge.

2.1.2 Determining Required Inspection Documentation and Preparing Needed Sketches

In reviewing the available information for the bridge, the inspector will begin to develop an understanding of the bridge. In preparation for the upcoming bridge inspection, it may be necessary to prepare sketches or tables in advance to be used for documenting current conditions so to be more efficient in the field and to more clearly record crucial inspection findings. For example, prior to going out into the field for the bridge inspection, a table may be prepared to record bearing and expansion joint movement data, or sketches may be prepared for use in recording crack locations and sizes for the underside surface of the bridge deck or for individual piers or abutments.

2.1.3 Arranging for Access and Other Inspection Equipment

A critical component of any bridge inspection preparation is determining how the bridge components will be accessed during the inspection. In addition, depending on the nature of the bridge components, such as whether the bridge includes fracture critical components requiring arms-length access, the access requirements may require more rigorous planning.

Depending on the size of the bridge and its height above ground level, inspection access could be as simple as ground-level observations. More often than not, ladders, a UBIV, a manlift, or even rope access techniques may be necessary to properly access key bridge components. However, developing an access plan requires careful consideration of the components to be inspected; the topography and features crossed by the bridge that might limit access options; whether traffic interruptions can be tolerated; any load restrictions on the bridge; the geometry of the bridge and its sidewalks, bridge rails, and fencing; and a review of whether certain access methods may provide a cost advantage by saving time and labor even at the expense of the equipment costs or rental.

If it is determined that a manlift or UBIV is required to access the bridge components for inspection, advance planning is required to either schedule the equipment, if State owned, or to determine availability and rent the equipment from an outside source. A variety of UBIV options are available that allow the vehicle reach and the number of rotating turrets to be tailored to the specific constraints of the bridge to be inspected. This may be especially critical for truss bridges, where the ability to maneuver the boom of a UBIV through and between truss members may be dependent on the configuration of the UBIV.

2.1.4 Arranging for Advanced Bridge Washing

It is important that bridge components are free of debris, animal nesting materials, and bird droppings to allow the most efficient use of the inspection team's time in the field. Therefore, coordinating with Iowa DOT district maintenance personnel in advance of the bridge inspection is important to ensure required bridge cleaning activities are completed before the inspection team arrives at the bridge site. Inspections scheduled during winter months may not allow advanced bridge washing due to freezing conditions. Additionally, some environmental regulations may limit periods when active nests of migratory birds, such as swallows, may be removed.

2.1.5 Executing Any Required Agency Notifications and Permits

Many bridges on the State or U.S. highway system cross facilities requiring advance notification or permits with other agencies. Bridges over navigable waterways such as the Mississippi and Missouri rivers will require advance notice to the U.S. Coast Guard so barge operators can be advised of the inspection activities, especially if the inspection will require the mechanical arms of a UBIV to be extended below the superstructure of a bridge where it could conflict with barge traffic.

Similarly, bridges over railroads will require notification of the railroads so a UBIV does not conflict with active train traffic. In addition, the use of a railroad flagger will be required to control train movement during bridge inspection activities. If railroad right-of-way must be crossed or used to provide bridge access, the bridge inspector must have a railroad flagger present, and a right-of-access permit may need to be obtained. The railroad must be notified far enough in advance to allow them time to schedule a flagger for the inspection and to obtain the access permit.

If there are any critical utilities mounted on the bridge or crossing the bridge that could cause safety concerns (for example, an overhead high voltage line that needs to be de-energized to avoid conflict with the mechanical arm of a UBIV), advance coordination with the utility may be needed.

2.1.6 Adjusting Work Schedules

As practicable, but still maintaining NBIS compliance with required inspection frequencies, bridge inspections should be performed when weather conditions will have minimal impact on workflow. If possible, inspections for bridges over rivers and streams should periodically be scheduled during low-flow months to allow the best view of components above the waterline. For the most effective inspections, periods of extreme temperature or high winds should be avoided.

The Team Leader should also use his or her best judgment to determine if inspection activities should be suspended due to changing weather conditions. For example, potential exposure to lightning, particularly when working on steel bridges, could be justification for suspending inspection operations to ensure crew safety.

2.2 CONDITION EVALUATION OF NATIONAL BRIDGE INVENTORY (NBI) ITEMS

2.2.1 Appraisal Evaluations

A number of NBI items for bridges are inspected and evaluated for comparison to acceptable standards. For example, various components of bridge approach guardrail are to be inspected to determine if they meet currently accepted standards. Although deterioration or damage should be noted as part of the inspection report, the actual appraisal evaluation of the particular component is based only on whether the configuration and geometry of the component meets current standards.

2.2.1.1 Waterway Adequacy

Waterway Adequacy (NBI Item 71) calls for the inspector's appraisal evaluation of the waterway adequacy; therefore, this item appraises the waterway opening with respect to the passage of flow through the bridge. Appraisal ratings take into account the functional classification of the roadway, the expected frequency of overtopping, and potential traffic delays as a result of overtopping. Table 2.2.1.1 summarizes appropriate appraisal evaluation values for Waterway Adequacy (NBI Item 71).

Table 2.2.1.1. Appraisal Values for Waterway Adequacy

Functional Classification			Description
Principal Arterials – Interstates, Freeways, or Expressways	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local Roads	
Code			
N	N	N	Bridge not over a waterway.
9	9	9	Bridge deck and roadway approaches above flood water elevations (high water). Chances of overtopping remote.
8	8	8	Bridge deck above roadway approaches. Slight chance of overtopping roadway approaches.
6	6	7	Slight chance of overtopping bridge deck and roadway approaches.
4	5	6	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with insignificant traffic delays.
3	4	5	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with significant traffic delays.
2	3	4	Occasional overtopping of bridge deck and roadway approaches with significant traffic delays.

Functional Classification			Description
Principal Arterials – Interstates, Freeways, or Expressways	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local Roads	
Code			
2	2	3	Frequent overtopping of bridge deck and roadway approaches with significant traffic delays.
2	2	2	Occasional or frequent overtopping of bridge deck and roadway approaches with severe traffic delays.
0	0	0	Bridge closed.

2.2.1.2 Approach Roadway Alignment

Approach Roadway Alignment (NBI Item 72) calls for the inspector's appraisal evaluation of the approach roadway alignment; therefore, this item identifies bridges that do not function properly or adequately due to the alignment of the approaches. It is not intended the approach roadway alignment be compared to current standards but rather to the existing highway alignment; therefore, this appraisal differs from other appraisal evaluations. The basic criterion is how the bridge approach alignment relates to the general highway alignment for the section of highway on which the bridge is located. The approach roadway alignment will be rated intolerable (a code of 3 or less) only if horizontal or vertical curvature requires substantial reduction in operating speed from that on the highway section. A very minor reduction in speed will be rated a code of 6, and when a speed reduction is not required, the appraisal code will be an 8. Additional codes may be selected between these general values.

2.2.1.3 Traffic Safety Features (Bridge Railing and Approach Guardrail)

Traffic Safety Features (NBI Item 36) calls for appraisal evaluations of a number of traffic safety features associated with the bridge railing and approach guardrail. Although collision damage and deterioration of the components evaluated in Traffic Safety Features (NBI Item 36) should be noted in the inspection report, the appraisal evaluations for the following items should evaluate only whether they meet current design standards:

- Bridge Railings (NBI Item 36A) – Materials for bridge railing can be concrete, metal, timber, or a combination thereof. Bridge railing should provide a smooth, continuous face of rail on the traffic face, with posts (if applicable) set back from the face of the rail. Structural continuity of the rail members, including anchorages, is essential. The railing system shall be able to resist the applied loads at all locations. Careful attention must be given to the treatment of the railing at the bridge ends. Exposed rail ends, posts, and sharp changes in the geometry of the railing should be rated a zero. The heights of bridge railing shall be measured relative to the reference surface, which shall be the top of roadway, top of future overlay (if future resurfacing is anticipated), or the top of curb (if the curb projection is greater than 9 inches from the traffic face of railing). Bridge railings and traffic portions of combination railing shall not be less than 2 feet 3 inches from the top of the reference surface. Parapets designed with sloping faces intended to allow the vehicles to ride up on them at low contact angles shall be at least 2 feet 8 inches in height. For traffic railings, the maximum clear opening below the bottom rail shall not exceed 17 inches, and the maximum opening between succeeding rails shall not exceed 15 inches. Effective

November 20, 2009, the AASHTO Manual for Assessing Safety Hardware defines the standards for approved bridge railing and establishes six test levels for bridge railing based on speed and type of facility. National Highway System (NHS) routes are typically required to have TL4 bridge railings at a minimum.

- Transitions (NBI Item 36B) – The transition section, which extends from the approach guardrail to the bridge railing, acts to stiffen the flexible guardrail as it connects to the rigid bridge railing, and it must be firmly attached to the bridge railing. The gradual stiffening of the guardrail system could be done by decreasing the post spacing, increasing the post size, embedding the posts in concrete bases, increasing the guardrail depth (W-beam to Thrie-beam), or a combination of these methods. The ends of curbs and safety walks need to be gradually tapered out or shielded.
- Approach Guardrail (NBI Item 36C) – The approach guardrail must be of adequate length and have the structural qualities to shield motorists from the hazards at the bridge site in addition to being capable of safely redirecting an impacting vehicle without snagging or pocketing an impacting vehicle. Consecutive sections of overlapping guardrail shall be configured with overlaps facing away from the traffic direction. Guardrail shall have a nominal height of at least 27 inches above the reference surface (with a $\pm$ tolerance of 2 inches).
- Approach Guardrail Ends (NBI Item 36D) – The ends of approach guardrail should be flared, buried, shielded (by means of an impact attenuator), or made to break away. If the end of an approach guardrail is buried, it must extend outside the lateral clear zone limits before turning down so as not to launch an errant vehicle.

The three possible codes that may be entered for each of the Traffic Safety Features (NBI Items 36A – 36D) are shown in Table 2.2.1.3.

Table 2.2.1.3. Appraisal Values for Traffic Safety Features

Code	Description
0	Inspected feature does not meet currently acceptable standards for safety, or a safety feature is required and none is provided.
1	Inspected feature meets currently acceptable standards.
N	Not applicable, or a safety feature is not required.

2.2.2 General Condition Rating Codes

Condition ratings are used to describe the existing physical state of bridge components as compared to their original as-built conditions. In order to promote uniformity between bridge inspectors, the condition codes used to rate bridge components should characterize the overall condition of the entire component being rated and are not intended to rate localized defects or nominally occurring instances of deterioration or disrepair. Correct assignment of a condition code must, therefore, consider both the severity of the deterioration or disrepair and the extent to which it is widespread through the component being rated. If there are localized defects, the bridge owner should be notified (by means of the inspection report) with recommendations for possible repair, rehabilitation, or retrofits.

The load carrying capacity of the component is not to be used in evaluating condition items. The fact that a bridge was designed for less than the current legal loads, and that the bridge may even be posted, should have no influence on the condition ratings.

The Deck (NBI Item 58), Superstructure (NBI Item 59), Substructure (NBI Item 60), Channel and Channel Protection (NBI Item 61), and Culvert (NBI Item 62) are the items used to describe the general condition ratings of bridges and culverts and are to be updated after each inspection cycle. Therefore, the condition of these items provides a simple snapshot of the current overall condition of a bridge or culvert.

Descriptive conditions used within the text of an inspection report or descriptive labels used in the comment fields for SIIMS should correlate to the numerical rankings described below for NBI Items 58, 59, 60, and 61 based on the deficiencies found for the individual components. The guidelines presented in Table 2.2.2 should be used to group the descriptive conditions for the various components.

Table 2.2.2. Grouping of Descriptive Conditions

Code	Descriptive Condition	Description
7, 8, 9	GOOD	Component defects are limited to only minor problems.
5, 6	FAIR	Structural capacity of the component is not affected by minor deterioration, section loss, spalling, cracking, or other deficiency.
0, 1, 2, 3, 4	POOR	Structural capacity of the component is affected or jeopardized by significant deterioration, section loss, spalling, cracking, or other deficiency.

2.2.2.1 Deck (NBI Item 58), Superstructure (NBI Item 59), and Substructure (NBI Item 60)

The general condition ratings shown in Table 2.2.2.1 shall be used as a guide in evaluating the Deck (NBI Item 58), Superstructure (NBI Item 59), and Substructure (NBI Item 60).

Table 2.2.2.1. General Condition Ratings for Deck, Superstructure, and Substructure

Code	Description
N	NOT APPLICABLE
9	EXCELLENT CONDITION
8	VERY GOOD CONDITION – No problems noted.
7	GOOD CONDITION – Some minor problems.
6	SATISFACTORY CONDITION – Structural elements show some minor deterioration.
5	FAIR CONDITION – All primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.
4	POOR CONDITION – Advanced section loss, deterioration, spalling, or scour.
3	SERIOUS CONDITION – Loss of section, deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present.
2	CRITICAL CONDITION – Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present, or scour may have removed substructure support. Unless closely monitored, it may be necessary to close the bridge until corrective action is taken.
1	IMMINENT FAILURE CONDITION – Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic, but corrective action may put it back in light service.
0	FAILED CONDITION – Out of service; beyond corrective action.

2.2.2.2 Channel and Channel Protection (NBI Item 61)

The general condition ratings shown in Table 2.2.2.2 shall be used as a guide in evaluating Channel and Channel Protection (NBI Item 61).

Table 2.2.2.2. General Condition Ratings for Channel and Channel Protection

Code	Description
N	Not applicable. Use when bridge is not over a waterway (channel).
9	There are no noticeable or noteworthy deficiencies that affect the condition of the channel.
8	Banks are protected or well vegetated. River control devices such as spur dikes and embankment protection are not required or are in a stable condition.
7	Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel have minor amounts of drift.
6	Bank is beginning to slump. River control devices and embankment protection have widespread minor damage. There is minor streambed movement evident. Debris is restricting the channel slightly.
5	Bank protection is being eroded. River control devices and/or embankment have major damage. Trees and brush restrict the channel.
4	Bank and embankment protection is severely undermined. River control devices have severe damage. Large deposits of debris are in the channel.
3	Bank protection has failed. River control devices have been destroyed. Streambed aggradation, degradation, or lateral movement has changed the channel to now threaten the bridge and/or approach roadway.
2	The channel has changed to the extent the bridge is near a state of collapse.
1	Bridge is closed because of channel failure. Corrective action may put it back in light service.
0	Bridge is closed because of channel failure. Replacement is necessary.

2.2.2.3 Culvert (NBI Item 62)

The general condition ratings shown in Table 2.2.2.3 shall be used as a guide in evaluating a Culvert (NBI Item 62).

Table 2.2.2.3. General Condition Ratings for Culvert

Code	Description
N	Not applicable. Used if structure is not a culvert.
9	No deficiencies.
8	No noticeable or noteworthy deficiencies that affect the condition of the culvert. Insignificant scrape marks caused by drift.
7	Shrinkage cracks, light scaling, and insignificant spalling that 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.

Code	Description
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 that 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 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 is closed. Corrective action may put it back in light service.
0	Bridge is closed. Replacement is necessary.

2.3 EVALUATION OF NATIONAL BRIDGE ELEMENTS

The proper assessment of bridge elements is a key aspect of sound bridge management. In the early 1990s, the introduction of element-level inspection methods and evaluation became a significant advancement in the bridge inspection practice nationwide and was eventually adopted by a vast majority of all state transportation departments in the U.S. Coupled with the refinement of bridge management systems, AASHTO developed the Guide for Commonly Recognized (CoRe) Structural Elements to define a system to record the condition of bridge elements. With the 2011 AASHTO Guide Manual for Bridge Element Inspection, the CoRe system has been replaced, and improvements have been made to fully capture the condition of bridge elements by reconfiguring the element language to utilize multiple distress paths within the defined condition states. MAP-21, the Federal transportation funding bill authorized in 2012, requires element-level data to be reported for all bridges on the NHS within 2 years of enactment of the bill.

The AASHTO Guide Manual for Bridge Element Inspection provides a comprehensive set of bridge elements designed to be flexible in nature to satisfy the needs of all agencies. The element set presented in the AASHTO Guide Manual for Bridge Element Inspection includes two element types identified as either National Bridge Elements (NBEs) or as Bridge Management Elements (BMEs). The combination of these two element types comprise the full AASHTO element set. All of the elements, whether NBE or BME, have the same four possible standard condition states (Condition State 1 = Good, Condition State 2 = Fair, Condition State 3 = Poor, or Condition State 4 = Severe). Using these condition states, the defect definitions, and appropriate quantity summaries for elements provided in the AASHTO Guide Manual for Bridge Element Inspection, the element-level documentation has the ability to define the amount of a particular element in each of the four possible condition states.

The NBEs represent the primary structural components of bridges necessary to determine the overall condition and safety of the primary load carrying members. The NBEs are a refinement of the deck, superstructure, substructure, and culvert condition ratings defined in FHWA's Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges. Additional elements included in this section are bridge rail and bearings. The NBEs are designed to remain consistent from agency to agency in order to facilitate the capture of bridge element condition at the national level. Descriptions of the NBE can be found in the NBE Manual prepared by OBS.

2.4 GENERAL INSPECTION PROCEDURES

2.4.1 Deck Inspection

2.4.1.1 Concrete Decks

Concrete decks should be inspected for cracking, spalling, potholes, efflorescence, leaching, delamination, exposed reinforcing steel, and full or partial depth failures. Narrow cracks (1/16 inch and wider) in the top and bottom surfaces should be shown on sketches. The path of a crack and its location should be sketched to scale as is practical. Photographs of individual cracks are generally not needed, but if included, they should include a scale or a common item like a pencil for reference.

Hollow areas should be sketched to scale and dimensioned as is practical. Photographs of hollow areas are generally not needed for the report. The method of sounding used (that is, random hammer tap, chain drag, or rotary percussion sounding) should be documented. Spalling, scaling, and patches should be sketched to scale as is practical. Sketches need to be drawn to scale so Bridge Element quantities can be tabulated, checked, and reproduced by another inspector. If an inspector reports a deck is 40 percent hollow, then another inspector should be able to look at the inspector's sketch and calculate a similar quantity of hollow area.

If the concrete deck consists of partial- or full-depth pretensioned panels, it should also be inspected for failures at the pretension and post-tension anchor zones, failures of grout-fill joints between panels, and failures of bearing edges along supporting beams.

Inspection teams must prepare a cross section sketch and measure bridge rail heights for all bridges. The team's sketch must be an accurate cross section showing the number of beams (not applicable for slab bridge); the values recorded for NBI Item 50, Curb or Sidewalk Width, NBI Item 51, Bridge Roadway Width Curb-to-Curb, and NBI Item 52, Deck Width Out-to-Out; the bridge rail heights; any overlays; overlay material; and dates of any changes, such as overlays, widening, or retrofit rails.

Curb and barrier rail conditions should be photographed; sketches are generally not needed for curb and barrier rail deterioration. The overall condition of bridge railings should be examined, including the alignment and the height of the rails. Sighting down the line of a bridge rail can be a quick way to identify obvious problems and may also highlight other structural problems, such as substructure settlement. The height of the bridge rail, especially for bridge decks that have been overlaid, should be checked to determine if it meets current design standards. Any damage due to traffic impact should be noted as well as any rotation of the bridge rail. Broken steel or timber railing elements should be noted as well as structural defects that may affect the intended function of the bridge rail, which is to redirect errant vehicles. For precast concrete bridge rails, any apparent anchorage failures or separation from the bridge deck should be noted.

2.4.1.2 Decks with Concrete Overlays

Iowa DOT uses two types of overlay material:

- Low Slump concrete (Class O PCC)
- High Performance Concrete (Class HPC-O PCC)

As shown in Figure 2.4.1.2, the estimated bridge quantities will include both Low Slump concrete (Class O PCC) and High Performance Concrete (Class HPC-O PCC) as alternatives on the construction plans, so it may be necessary to ask the Iowa DOT construction office which alternative was used. As-built plans should indicate which alternative was installed as well.

ESTIMATED BRIDGE QUANTITIES			SEE SHEET 14 FOR ADDITIONAL BID ITEMS RELATING TO ROADWAY REPAIRS.		
ITEM NO.	ITEM CODE	ITEM	UNIT	TOTALS	AS BUILT QUANTITIES
1	2401-6750001	REMVL (REMOVALS, AS PER PLAN)	LS	1	1
2	2402-2720000	EXCAVATION, CL 20	CY	14.0	14
3	2403-0100000	STRUCT CONC (MISC)	CY	29.3	29.3
4	2404-7775005	REINFORC STEEL, EPOXY COATED	LB	3418	3418
5	2413-0698072	BRIDGE FLOOR REPAIR, CL A	SY	102	98.075
6	2426-6772016	CONC REPAIR	SF	80	114.299
7	2528-8400048	TEMPORARY BARRIER RAIL, CONCRETE	LF	1350	1350
8	2533-4980005	MOBILIZATION	LS	1	1
		ALTERNATE A			
9A	2413-0698068	BRIDGE FLOOR OVERLAY (CL O PCC)	SY	513.8	
		ALTERNATE B			
9B	2413-0698069	BRIDGE FLOOR OVERLAY (CL HPC-O PCC)	SY	513.8	513.8

Figure 2.4.1.2. Sample Bridge Quantity Table

The first Iowa DOT letting allowing the HPC overlay alternative was in March 2007. If a bridge has an HPC overlay, this information needs to be tracked in three places within SIIMS:

1. On the Bridge Descriptions tab in the Deck text box with a sentence similar to the following:
    a. "The deck is PC concrete and was overlaid with Class HPC-O PC concrete in 2011."
2. On the Supplementary Inspection Information tab
    a. Provide the year of installation.
    b. Provide the overlay design number.
    c. List letters "HPC-O PCC" in the comment box.
3. On the deck cross-section sketch
    a. List letters "HPC-O PCC" on the sketch.
    b. Provide year of the installation.

Iowa DOT inspection teams are asked to obtain a slab thickness for bridges overlaid in 2011 and in past (older) construction seasons. Deck thicknesses for girder bridges will be taken from the overlay plans and do not need field verification.

A consultant will likely determine slab thicknesses for bridges overlaid in 2012 and future construction seasons. The Iowa DOT inspection teams will be notified to obtain the thickness if a consultant cannot be contracted for this work.

2.4.1.3 Sounding Concrete Decks

A sounding is performed by use of one of several methods. Chain drag, hammer tapping, or steel rod/pipe tapping are the three typical methods used to sound a deck for delaminations (hollow areas). These methods can be used separately or together to gather the data needed to make a determination of the area of the deck that is delaminated. When using a hammer or steel rod/pipe, taps should be approximately 2 feet apart and should cover the entire area of the deck. The chain drag will generally be used in a sweeping motion with passes that are approximately 2 feet apart and cover the entire deck area.

Areas around deck cracks 1/16 inch or wider should be given closer attention due to the higher probability of a delaminated area developing. Discolored areas of the deck should also be sounded more vigorously.

When a delaminated area is found, the extents of the delamination should be documented on a sketch. The total area of delamination on a deck should be calculated and included in the inspection notes.

2.4.1.3.1 Sounding Concrete Decks with Concrete Overlays

The following criteria shall be used to determine whether a concrete bridge deck with a concrete overlay requires sounding:

1. A deck with a new overlay does not require sounding until the overlay is 10 years old unless extensive cracking or significant spalling occurs, thus indicating a problem with the overlay.
2. The frequency of sounding, after the initial sounding, will be based on the findings of the initial sounding. Office of Bridges and Structures (OBS) engineering staff will determine the recommended frequency.
3. A deck that has been epoxy injected or had patching by contract shall be sounded on the third inspection after this work was completed. The frequency of future soundings will be determined by OBS engineering staff.
4. If a deck has become hollow over 40 percent of the deck area, no future soundings are required. If the deck is epoxy injected, patched by contract, or re-overlaid, sounding should begin again on the third inspection after this work is completed.

Spalling, scaling, and patching of the overlay should be documented with sketches and photographs at all inspections. Photographs of typical or the most severe deterioration are recommended.

2.4.1.3.2 Sounding Concrete Decks without Overlays

Concrete decks without an overlay shall initially be sounded when the deck is 20 years old. A sounding may be required sooner if evidence of extensive cracking is found or spalling is occurring. After the initial sounding, OBS engineering staff will determine the frequency of future soundings. Spalling, scaling, and patching should be documented at all inspections with sketches. Photographs of typical or the most severe deterioration are recommended.

2.4.1.4 Steel Decks

Steel grid decks should be inspected for corrosion, broken welds, broken or damaged bearing bars or cross bars, and section loss. Concrete-filled steel grid decks should be checked for spalling or scaling of the concrete infill, water ponding, corrosion of steel grid members, and leakage on the underside of the deck. Corrugated metal decks should be checked for evidence of rust-through and open cracks in the wearing surface. Orthotropic steel decks also need to be checked for evidence of rust-through; cracks in the steel plate, web elements, or welded connections; and debonding of the overlay.

2.4.1.5 Timber Decks

Timber decks should be inspected for splits; checks; broken planks; crushing; excessive wear; rot; and loose, broken, or missing fasteners. Areas exposed to traffic should be examined for weathering, wear, and impact damage. Drainage deficiencies can manifest themselves as rot or stained lumber on the top or bottom of the deck or on the outside edges of the deck. Laminated timber decks should be checked for loose or delaminating members, and if the laminated members are post-tensioned together, post-tensioning anchorages should be checked for corrosion, crushing, decay, or signs of anchor failure.

2.4.1.6 Bridge Joints

Iowa DOT bridge inspections document the following two types of joints:

- Deck joints
- Pavement pressure relief joints

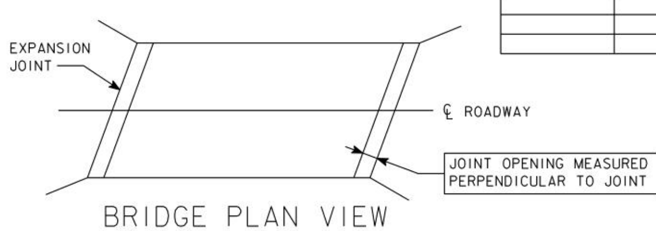
2.4.1.6.1 Deck Joints

Deck joints are designed to accommodate deck and superstructure expansion and contraction caused by temperature changes. The inspection should confirm the joints are functioning properly and should document any deterioration to the joints.

A BME for the joint type should be used to report the condition of the joints. The description of the BME for joint condition can be found in the NBE manual prepared by OBS.

Proper function is reported by preparing a bridge plan view sketch along with a table to summarize the joint opening. The joint opening is the distance available for bridge movement, and this value should change with temperature changes. The sketch and table of the joint opening should be similar to Figure 2.4.1.6.1-1.

SCALE	BRIDGE NO.	SKETCH BY	TEMPERATURE	DATE	PAGE
N/A	SKETCH OF EXPANSION OR PRESSURE-RELIEF JOINT	GLP	75°	7-20-09	B-25



	JOINT OPENING AT:				
LOCATION	LEFT GUTTER	CENTERLINE	RIGHT GUTTER	JOINT TYPE	REMARKS
115' BACK ON NEAR APPROACH	-	2"	-	POLY RELIEF	SEALED
NEAR ABUTMENT	1¼"	¾"	½"	SLIDING STEEL PLATE	DEBRIS FILLED
FAR ABUTMENT	½"	¾"	¾"	SLIDING STEEL PLATE	DEBRIS FILLED
120' AHEAD ON FAR APPROACH	-	2"	-	POLY RELIEF	SEALED

Figure 2.4.1.6.1-1. Joint Opening Sketch

The air temperature should be documented, and the joint opening should be measured in three locations (2 feet from the left and right gutterlines and at the bridge centerline).

Sliding steel deck joints can be difficult to measure if the deck has been overlaid. Figure 2.4.1.6.1-2 shows a common sliding steel deck joint modification from an overlay project.

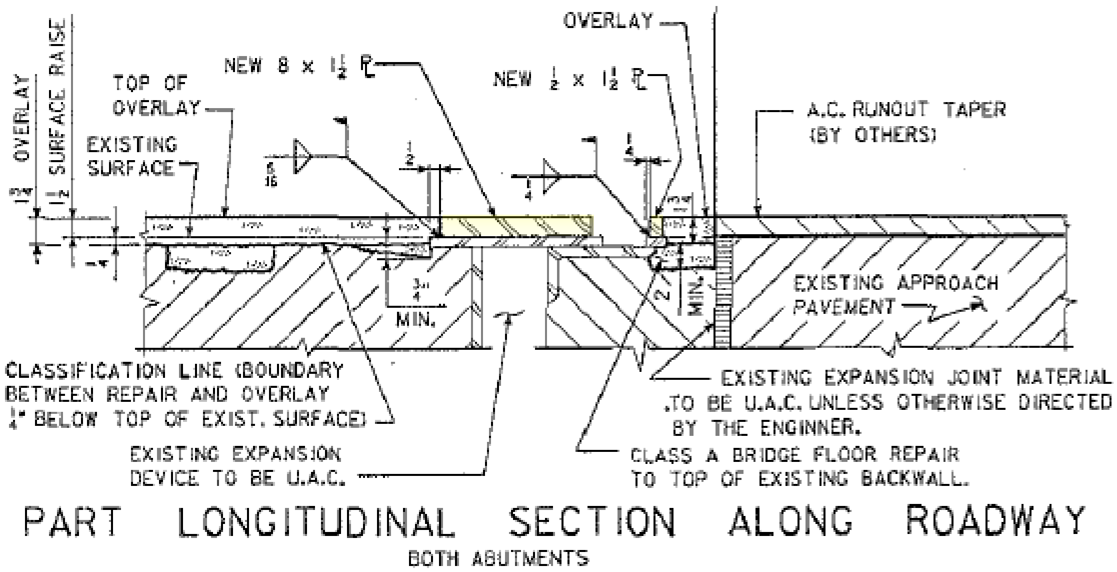


Figure 2.4.1.6.1-2. Sliding Steel Joint Retrofit

The new wear plates and stop bars are often physically smaller than the originals to allow space for the contractor to weld them in place. If the original design opening in the above example was 2 inches at 50 degrees Fahrenheit, the opening in the example above will appear to be 2 ¾ inches after placement of the overlay.

Unlike the detail above, actual joints will be filled with sand, gravel, salt, and vegetation that will make measuring the opening between the original wear plate and stop bar difficult, if not impossible. The inspector should compare field observations of the new wear plates and stop bars to the overlay plans to calculate the joint opening.

Sliding steel plate joints are not intended to be water tight and normally leak. They are undesirable for all bridge types, especially pretensioned/prestressed concrete beam (PPCB) superstructures. Iowa DOT no longer permits sliding steel joints on PPCB bridges and is actively working to retrofit existing installations. Sliding steel plate joints are commonly damaged by snow plows, especially those joints modified during an overlay project. Indications of damage include joint deflection and banging at the joints when vehicles pass. These may indicate loose anchorages or broken welds. The District Bridge Repair Crew Leader should be notified if sliding steel joints are found to have loose wear plates or stop bars that could break loose and protrude into traffic.

2.4.1.6.2 Pavement Pressure Relief Joints

Pavement Pressure Relief Joints (PPRJ) are designed to accommodate the expansion of concrete pavement. These joints are desirable in concrete pavements approaching a bridge to prevent the expanding pavement from “pushing” on the bridge. In general, if a PPRJ has a joint opening wider than 2 inches, it will provide adequate movement for the pavement. Inspection should confirm the joint opening is wider than 2 inches and should document deterioration.

There is not a BME for PPRJs, so proper joint opening and deterioration must be reported by preparing a sketch similar to the example shown in Figure 2.4.1.6.1-1. As for the deck joints, the air temperature should be documented and the joint opening should be measured at the bridge centerline and 2 feet from the gutterlines.

If an inspector finds a PPRJ with an opening less than 2 inches, a recommendation to re-cut the PPRJ may be necessary. Before making this recommendation, the following should be considered:

1. Is the joint an EF joint?
2. Does the bridge have integral abutments with visible deck joints?

EF joints are a specific type of PPRJ. They are constructed with dowels spanning between two slabs. EF joints are marked with an "X" in the pavement next to the joint, as shown in Figure 2.4.1.6.2.

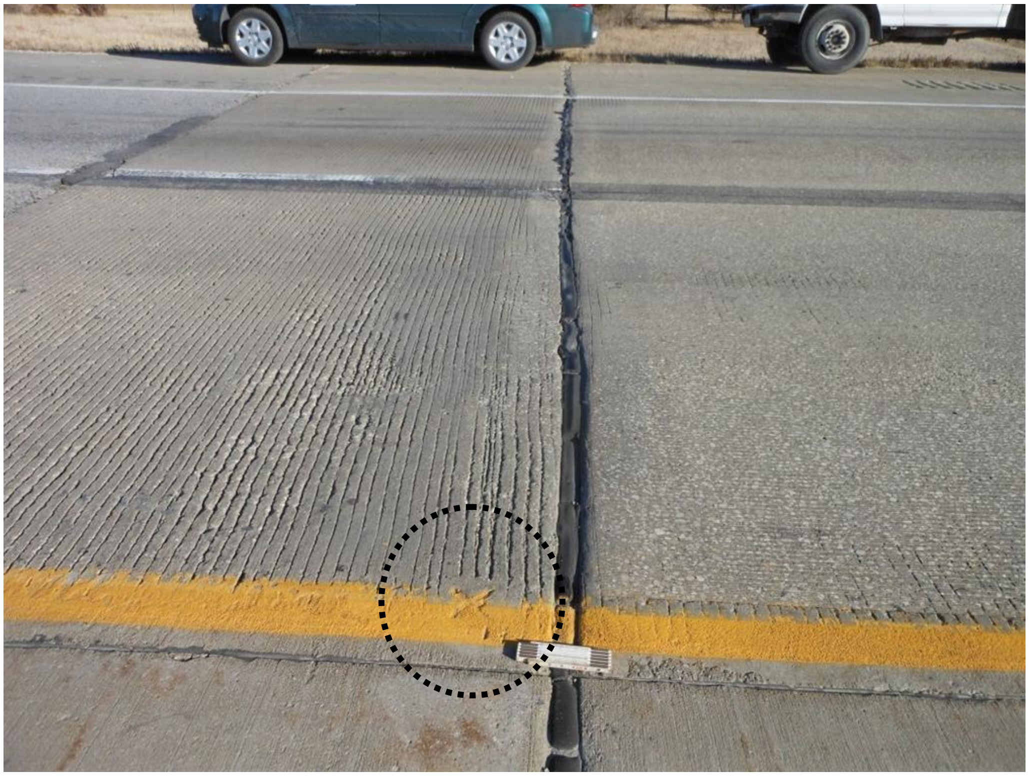


Figure 2.4.1.6.2. EF Joint Pavement Marking

An EF joint does not necessarily require replacement when the opening is less than 2 inches. An EF joint cannot simply be re-cut; sections of pavement must be removed to make room for replacement slabs, so inspectors should not recommend re-cutting an EF joint. If the joint opening is less than 2 inches, inspectors should look for damage to the pavement at the EF joint before recommending replacement.

Bridges with integral abutments are built with expansion joints between the deck and the approach pavement. If the deck joint opening and the PPRJ opening measure 2 inches or more when combined, then the approach pavement has adequate room for expansion. No recommendation is needed to re-cut the

PPRJ in this situation. However, if the deck joint at an integral abutment has been filled with hot-mix asphalt (HMA) during an HMA overlay of the approach, then the joint is no longer considered an expansion joint, and the PPRJ alone must measure 2 inches or more to have adequate room for expansion.

PPRJs are generally located 60 to 75 feet from the ends of a deck. If there is not a PPRJ within 100 feet of the end of a deck and evidence of a PPRJ is not visible when standing 100 feet from the end of a deck, a recommendation to re-cut the PPRJ may be necessary.

When PPRJs are visible, their distance from the deck must be recorded because it is common for PPRJs to be covered when a roadway is overlaid with an asphalt leveling course. If a PPRJ is covered with HMA and is no longer visible, the joint is still considered adequate if the joint opening was previously wider than 2 inches. Inspectors should report when the joint was covered in the joint sketch and should monitor the location for raveling asphalt.

A PPRJ that does not extend through the shoulder is considered adequate. This situation should be noted in the joint sketch, but it is not a condition that needs to be addressed.

2.4.1.7 Coding NBI Item 58 (Deck Condition Rating)

The overall condition of a bridge deck should be coded as shown in Table 2.2.2.1 for NBI Item 58, Deck. For culverts or other structures without a deck, such as a corrugated metal structural plate arch bridge, code N (not applicable) should be used for NBI Item 58. Decks integral with the superstructure, such as for a cast-in-place box girder bridge or a concrete T-beam bridge, shall be rated for the deck only, and the superstructure condition of the integral deck-type bridge should not influence the deck rating.

The condition of supplemental wearing surfaces, joints or expansion devices, curbs, sidewalks, parapets, railings, and drainage scuppers should not be considered in the overall deck evaluation. However, their condition should be noted in the inspection report.

An NBI rating of 5 or less requires a comment on the reasons for this condition rating. A condition rating of 5 begins to affect the Sufficiency Rating negatively.

2.4.1.8 National Bridge Elements

The description of the NBE for deck condition can be found in the NBE manual prepared by OBS.

The NBE should include comments and inspection notes under each element as necessary. Comments and inspection notes should be included when there is a portion of the element in condition state 3 or 4.

2.4.1.9 Additional SIIMS Deck Data

The Deck section in SIIMS has several items that are not part of the NBI or NBE data. These items are to be updated as necessary at each Routine or In-depth Inspection.

2.4.1.9.1 Deck Drains

The deck drain type is to be chosen from the drop-down menu in SIIMS. The drop-down options include the following types of deck drains:

- Unextended
- Empties into Pipe
- Steel Extension

- Plastic Extension
- Miscellaneous
- None

The condition of the deck drain should be determined as Good, Fair, or Poor. If no drain extension exists, N/A should be selected from the condition drop-down menu. If a drain is in poor condition, a comment should be included that describes why it is considered to be in poor condition.

2.4.1.9.2 Curb Type – Left and Right

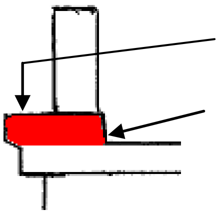
The type of curb on the bridge deck should be chosen from the drop-down menu in SIIMS for the left and right curbs. The drop-down options include the following types of curb:

- <9”
- ≥ 9”
- Sidewalk
- Sidewalk with Traffic Division
- Curb with Retrofit Rail
- Miscellaneous
- None

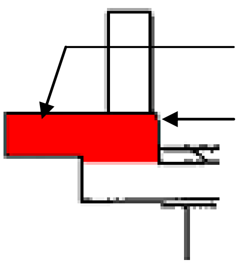
The condition of the curb should be determined as Good, Fair, or Poor. If the curb type is “None”, N/A should be selected from the condition drop-down menu. If a curb is in poor condition, a comment should be included describing why it is considered to be in poor condition.

2.4.1.9.3 Cantilevered Curb

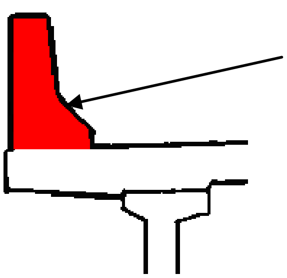
A cantilevered curb refers to a curb that overhangs the edge of the deck. The concern with this type of curb is corrosion of the tension reinforcing along the gutter line. Figure 2.4.1.9.3 shows sample sketches of non-cantilevered and cantilevered curbs. A barrier rail on a thin concrete deck that is supported by steel channels or steel cantilevers is not considered a cantilevered curb.



Curb type – Left/Right = Curb with Retro Rail
Rate condition of entire curb area shown in red.
Cantilevered Curb = Yes
Rate condition of traffic face of curb only.

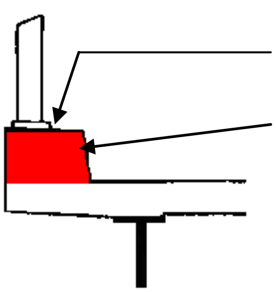


Curb type – Left/Right = Curb with Retro Rail
Rate condition of entire curb area shown in red.
Cantilevered Curb = Yes
Rate condition of traffic face of curb only.

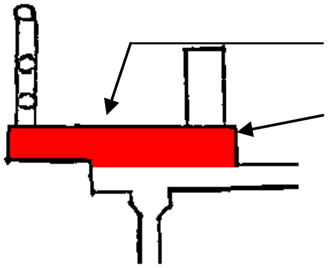


Curb type – Left/Right = None

Cantilevered Curb = None

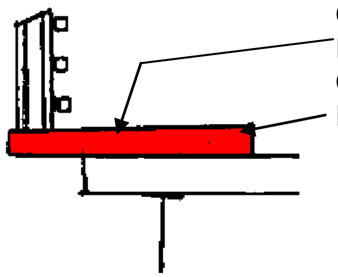


Curb type – Left/Right = 9”
Rate the entire area shown in red.
Cantilevered Curb = No
Rate condition of traffic face of curb only.



Curb type – Left/Right = Sidewalk with Traffic Division
Rate the entire area shown in red.
Cantilevered Curb = Yes
Rate condition of traffic face of curb only.

Figure 2.4.1.9.3. Non-Cantilevered and Cantilevered Curbs



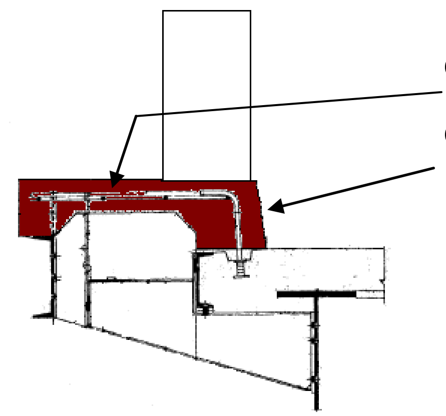


Figure 2.4.1.9.3 (continued). Non-Cantilevered and Cantilevered Curbs

2.4.1.9.4 Bottom of Deck Delamination over Traffic

Delamination is defined as concrete that sounds hollow and shows a visible crack that is partially or completely around the perimeter of the hollow area. Delaminations on the bottom of a deck over traffic lanes of a highway, a railroad, parking area, sidewalk, or recreational trail have the potential of falling onto vehicles or pedestrians below and must be removed according to Maintenance Instructional Memorandum 6.102.

The District should be notified of the delaminated areas via an e-mail message that includes the following information:

1. Bridge ID (Maintenance number) and FHWA number
2. Bridge location and span(s) where delaminations were found
3. Sketch of delamination locations
4. A request for e-mail notification to OBS when the delaminations have been removed
5. E-mail address and phone number of OBS contact

“Yes” is to be chosen from the drop-down menu in SIIMS when delaminations are found. Once “Yes” has been chosen, this should never be changed to “No” unless the deck is replaced. When this item is “Yes,” a note should be made in the comment field after each inspection saying whether or not more loose concrete was found.

2.4.1.9.5 Left and Right Bridge Rail

The left and right bridge rail type is included in the SIIMS data for a national research project. These items should be updated only if the barrier rail type changes. The types available in the drop-down menu are:

1. Metal Tube Bridge Rail
2. Safety Shape Concrete Barrier (F-shape/Jersey)
3. Timber Bridge Rail
4. Thrie Beam Bridge Rail
5. W-Beam Bridge Rail

2.4.1.9.6 Left and Right Guardrail

The guardrail installations should be inspected using the following guidelines:

1. Approach guardrails should be inspected to the limits of the end terminal. In some installations, the approach guardrails continue for long distances past the bridge structures. In these instances, the inspectors must use their judgment to determine where to stop the guardrail inspection. If over half of the guardrail's length extends past the pressure relief joint, the inspection can end at the pressure relief joint.
2. Guardrails surrounding piers and along the toe of berms must be inspected **if they are physically attached** to the substructure. Any deterioration found should be photographed and described using the appropriate substructure Bridge Element.
3. Guardrails surrounding piers and along the toe of berms **not attached** to the substructure should be given a visual inspection as occasioned during your normal movements around the structure to accomplish your inspection. Collision damage that has damaged the rail or posts should be photographed and described using the appropriate substructure Bridge Element.
4. Include a note on the deck tab if the approach guardrails could not be inspected due to snow cover or high traffic volumes.
5. The inspection does not require digging down around posts to search for rot.

The guardrail descriptions should be completed by the inspection team. The August 2010 Guardrail Identification Manual should be used to identify the end, rail, and transition types.

Guardrails over culverts should be inspected, but descriptions and ratings do not need to be entered on the Deck tab, which is <u>not</u> used for culverts. Any deterioration found should be documented and described using the appropriate culvert Bridge Element.

If the deterioration or damage appears to have been addressed or marked by the District, a recommendation is not necessary. For example, if impact barrels or traffic cones have been placed along a damaged rail, a recommendation is not needed.

A condition should be selected from the drop-down menus for each element of the guardrail. If the condition is designated as "Poor," a description of the reasons for the poor condition should be entered in the comment field.

2.4.1.9.7 Approach Pavement

The three main types of approach surfacing are as follows:

1. Concrete – Full-depth concrete, even when there is an HMA overlay
2. Asphalt – Full-depth HMA with no concrete substrate
3. Gravel – Full-depth granular material

In SIIMS, the inspector should indicate which approach surfacing is present or if some other surfacing is present. A comment describing the approach should be included.

2.4.2 Superstructure Inspection

Superstructure members should be inspected for signs of distress, which may include horizontal or vertical displacement of components affecting structural stability, cracking, deterioration, section loss, collision damage, or overload damage.

A discussion of how member components should be numbered and identified for the inspection report is provided in Section 1.6.2 of this manual.

2.4.2.1 Concrete Slab

A concrete slab bridge does not contain beams or girders. The deck is the superstructure. Concrete slab bridges contain larger reinforcing bars than a standard deck. Continuous slabs have large reinforcing bars over the piers near the top of the deck. Transverse cracking over a pier should be documented because of the increased potential for corrosion of the main reinforcing steel in this area.

Concrete deterioration near the abutments should be documented whether it is occurring on the top or bottom of the deck. Severe deterioration in this area can affect the shear capacity of the concrete slab. Repairs to this area due to deterioration are difficult. Temporary support of the deck may be required in some cases.

Photographs and sketches of deterioration in high stress areas are required.

2.4.2.2 Reinforced Concrete Beams

A reinforced concrete beam bridge is a cast-in-place concrete structure. The beams are placed monolithically with the deck in most cases. The deck may contain more reinforcing than a conventional deck on a girder bridge. Deterioration of the deck can have a greater impact on the load capacity of this type of bridge than a typical girder bridge.

Cracking of the deck or girders in high stress areas shall be documented with sketches. Signs of rust staining should also be included in the inspection documentation with photographs and written descriptions.

Girder deterioration shall be sketched and photographed at bearing areas.

2.4.2.3 Prestressed Concrete Beams

Prestressed concrete beam bridges are typically I-beam, bulb tee beam, channel beam, double tee beam, or box beam structures. In all of these types of bridges, stressed strands or bars induce compressive forces into the concrete to give the beam increased load carrying capacity. This load carrying capacity can be compromised by concrete deterioration around these strands or bars. The most common area for concrete deterioration or spalling is at the ends of the beams where salt-laden water can leak onto the beam ends through open or leaking deck joints and contaminate the concrete, thus causing corrosion to begin in the strand or bar. Prestressed steel is more susceptible to corrosion and will corrode faster than mild steel reinforcing.

The second most common reason for loss of prestress capacity is due to impact loads by over-height vehicles. Impacts can cause spalling around the strand or bars so the compressive force applied to the concrete is lost in the impacted area. If a strand or bar is severed because of impact, this also causes a loss in prestress force.

Cracking in the high stress areas of prestressed beams shall be documented with sketches in the inspection report. The number and location of strands or bars exposed due to deterioration or impact damage are to be included in the inspection report. Photographs of deterioration or damage are required.

2.4.2.4 Steel Beams and Girders

Steel beam or girder bridges are made up of two or more beam lines of I-shaped members. Inspection of steel superstructure elements should include checking steel members for paint failure, corrosion, section loss, evidence of fatigue or fracture, evidence of overload, collision damage, connection damage, and possible damage from excessive heat. Inspection procedures typically include visual methods to find defects as well as physical methods such as hammer sounding, cleaning to remove rust scale, and measuring remaining steel thickness. Visual and physical inspection procedures should focus on high stress zones, areas exposed to drainage run-off, areas exposed to traffic, previous repair locations, previously noted defects, and fatigue-prone or fracture-prone details.

Properly performing paint coatings should be free of chalking, pitting, rust, or generalized rust staining. The overall paint condition should be assessed based on the condition of the majority of the surface, not just localized areas of rusting.

For weathering steel members, the typical oxide colors that can be expected for properly performing weathering steel include a yellow-orange color for new steel or a purple-brown color for members in service for many years. Weathering steel members exhibiting a black or yellow color could indicate a failed condition of the protective oxide and may show small flakes (approximately ¼ inch in diameter) or laminar sheets of loose oxide film. When inspectors are checking for section loss due to corrosion, the member should be scraped to remove rust scale and the member thickness should be measured to determine the section remaining. The overall condition of the weathering steel should be rated according to the scale shown in Figure 2.4.2.4.

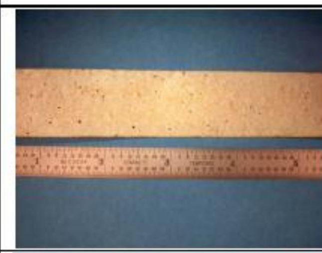
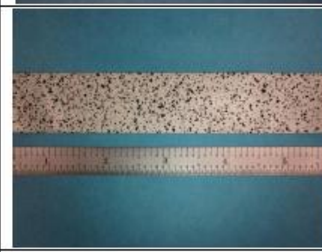
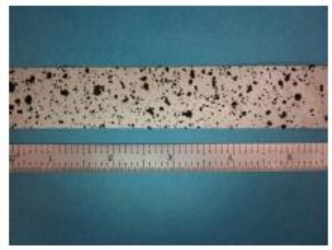
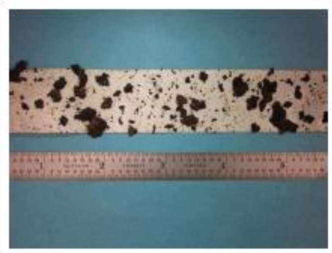
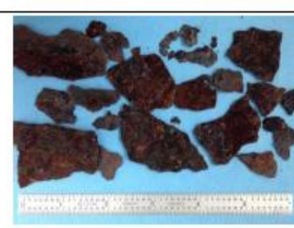
Patina Rating	Condition Description	Example Condition in Field	Example Tape Test Specimen
8 Very Good	Uniform color pattern, generally dark brown with some lighter reddish-brown, metallic and purple-brown spots. May be difficult to see small rust product clusters. Texture may be dimpled or rough but uniform in pattern. Patina layer is thin but dense and very adherent, indicative of very good protective properties. Superior adherence; tape test sparse with only very small flakes (< 1 mm).		
7 Good	Uniform color pattern, generally dark brown with some lighter reddish-brown, metallic and purple-brown spots. Individual rust product clusters visible. Texture is dimpled or rough but uniform in pattern. Patina layer is thin but dense and adherent, indicative of good protective properties. Tape test easily removes very small (< 1 mm) flakes.		
6 Satisfactory	Dark brown coloration, but begins to show minor variation. 1-5 mm flakes loose on surface, easily removed with tape test. Underlying layer adherent, still relatively dense, thin and protective. Texture more granular and loose flakes may be less-protective, holding water and salts. Chalky poultice layer may be present, but not significantly affecting performance (i.e., flake size).		
5 Fair	Dark brown with black and some color variation. Blotchy with some salty or rusty stains. Medium (5-25 mm) flakes over most of area loose and non-protective, easily removed with tape test. Layer beneath flakes thicker and more permeable, with some pitting beginning. Non-protective; contaminants penetrating. Elements with poultice may show significant associated flaking.		
4 Poor	Color is dark brown and black but non-uniform, with widespread blotchiness and staining. Non-protective. Large (> 25 mm) flakes, or layered delamination beginning in some areas. Thickness/permeability of rust increased, with pitting and section loss possible. Poultice areas have thin delamination sheets or very large flakes. Layer below loose poultice may appear similar, but still somewhat adherent.		
3 Serious	Blackish, stained, blotchy appearance. Formation of laminar sheets with deeply pitted semi-adherent layer beneath; chunks and sheets of rust product removable by hand. Aggressive advancement of pitting and section loss; can be up to 50%. Complete failure of patina to protect base steel.		

Figure 2.4.2.4. Weathering Steel Patina Rating

The weathering steel patina rating should be documented in the NBEs for the steel girders. Any tape test strips should be photographed and included in the documentation of the inspection.

Bolted or riveted connections should be inspected for loose or missing bolts or rivets, section loss to the bolt or rivet heads, and corrosion of the connecting parts. Pack rust can build up between the connection plate and the girder element, which can cause bending in the connection plate and unanticipated tensile stress in the bolts or rivets.

Instances of overload to a steel structure will usually be manifested in high stress zones. Therefore, if overload is suspected, particular attention should be paid to bearing areas where the load would be transferred from superstructure to substructure; high shear zones adjacent to member supports and points of concentrated loads; and high moment regions, including the middle third of a span for positive moment and the end fourths at intermediate supports for negative moment in continuous spans.

Areas of collision damage should be carefully inspected for signs of fracture or member cracking; distortion due to collision should be documented and quantified in the inspection report. If cracks or gouges in the steel members have occurred due to collision damage, dye penetrant or magnetic particle testing may be required to accurately determine the extent of the defect.

2.4.2.4.1 Fatigue-Prone Details

Fatigue-prone details include, but are not limited to, the following:

- Welded cover plates, particularly the end terminations
- Web gap area at diaphragm stiffeners when out-of-plane bending is possible
- Welded gusset plate connections to girder webs, flanges or truss members
- Weld terminations of longitudinal stiffeners
- Coped areas in a floorbeam or cross beam
- Tack welds in tension areas
- Intersecting welds

Fatigue is the tendency of a member to fail at a stress level below yield stress when subjected to cyclical loadings. Fatigue-prone details require additional attention. If fatigue cracks or fractures are noted, non-destructive testing methods, such as dye penetrant testing or magnetic particle testing, may be required to determine the extents of cracks in steel members. Ultrasonic methods are typically used to test pin members for defects. Thickness gauges (D-Meters) or calipers can be used to determine the thickness of steel remaining for a particular member.

Triaxial constraint is a 3-dimensional stress state that reduces the ductility of a material. Under triaxial constraint, steel is unable to deform, and brittle fracture can occur under service conditions where ductile behavior is normally expected. Due to the nature of these unique conditions, the chance for member failure is greater for these conditions and they warrant added emphasis during inspection. Finally, the ability of inspectors to recognize conditions of triaxial constraint is important to guard against brittle failure.

AASHTO prioritizes fatigue details into categories from A (least critical) to E’ (most critical). The inspector shall be familiar with the various fatigue categories and be able to classify the categories encountered in the field to determine the seriousness of the detail. Fatigue-prone details should be identified and noted in the inspection report so that details can be monitored for cracks in subsequent inspections.

2.4.2.4.2 Fracture Critical Members

FCMs are steel members in tension or with a tension element, whose failure would be expected to cause a partial or full collapse of the bridge. The NBIS requires FCMs to be inspected at "arms length."

Floorbeams are primary superstructure members that transmit loads from the deck to the main girders or trusses. Floorbeams are generally considerably smaller than the main girders and are oriented perpendicular to traffic. There may be direct contact with the bottom of the deck or they may support longitudinal stringers, parallel to the main girders or truss. Stringers may be continuous or simply supported at the floorbeams. Steel floorbeams are considered fracture critical when:

1. The connections to main girders are considered flexible or hinged;
2. There are no stringers;
3. The stringers are configured as simple spans; or
4. The stringers are continuous and the floorbeam spacing is greater than 14 feet.

2.4.2.4.2.1. FCM Pre-inspection Preparation

Prior to inspecting a bridge with known FCMs, the following procedures should be used in preparation for the inspection:

1. Review the FCM locations as identified in the bridge file.
2. Identify all fatigue-prone details requiring a hands-on inspection.
3. Determine what documentation will be needed as part of this inspection.
4. Determine the workflow needed and access requirements for inspecting the FCMs in the most efficient manner.
5. Discuss the workflow with all the members of the inspection team so they understand their roll in the inspection. It is recommended the workflow be documented and kept in the bridge file.
6. Assess the equipment needs to perform this inspection. This will include lighting adequate to identify small defects. It is recommended to keep a list of the equipment needed for the inspection in the bridge file.
7. Make arrangements to have the superstructure washed if debris, bird nests, or bird droppings inhibit proper inspection of important areas.
8. Make arrangements to have the necessary access equipment available for the inspection.
9. Verify who shall be notified if a potentially serious condition is found.

2.4.2.4.2.2. Requirements During FCM Inspection

During an FCM inspection, the following procedures should be used:

1. Perform a hands-on inspection to visually inspect the FCMs for deterioration, defects, damage, and cracks. Perform a hands-on inspection of all fatigue-prone details. A hands-on inspection is defined as the inspector being able to touch all surfaces of the tension carrying regions of FCMs.

2. Clean suspect locations for better visual assessment, and use appropriate non-destructive testing methods to verify potential crack locations and member thickness in deteriorated areas.
3. Photograph and sketch locations where deficiencies are found. Include appropriate dimensions and perspectives on all sketches. Close-up photographs should be taken before and after any cleaning, paint removal, or testing. Include a photograph of the general location so others can understand exactly where close-up photographs were taken.
4. Confirm by using a checklist or other appropriate means that all FCMs were inspected.
5. If a serious defect is found, notify the appropriate personnel immediately to determine what actions are necessary.

2.4.2.4.3 Hinges

A hinge in a steel girder is a location where bending moments are not transferred because of a pin and hanger connection or a rotational connection system. A joint will be present in the deck at a hinge location. Hinges require careful inspection because of the complexity of the connection and the high stresses present.

2.4.2.4.3.1. Pin and Hanger Connections

A typical pin and hanger hinge configuration is shown in Figure 2.4.2.4.3.1. Pin and hanger connections may be considered FCMs. Because of the complexities of the connection and the high stresses present, pin and hanger assemblies should receive a close-up inspection as part of a scheduled Routine or Fracture Critical inspection. Hanger links should be checked for out-of-plane bending. Retaining nuts should be checked for cracks and to confirm retaining nuts are tight. Pins should be visually inspected for signs of corrosion. Pin/pin and hanger connections should be examined for evidence of movement of the hanger links off the ends of the pin, fracture of hanger links, misalignment or bowing of the hanger links (often from pack rust), bleeding rust stains, wear on the pins, or pin fractures. Because hinges are located at deck joints, leaking joints can promote corrosion in the hinge components. Thus, the assemblies can become bound due to corrosion of components, which can cause unanticipated tensile stress on the pins or bending stress on the hanger links. Often web plates at pin and hanger connections are stiffened and reinforced with web doubler plates to provide additional bearing area for pins. Doubler plates should be checked for pack rust that could apply an outward force to hanger plates and retaining nuts.

Pins for pin and hanger assemblies shall be ultrasonic tested on a 60- to 72-month frequency.

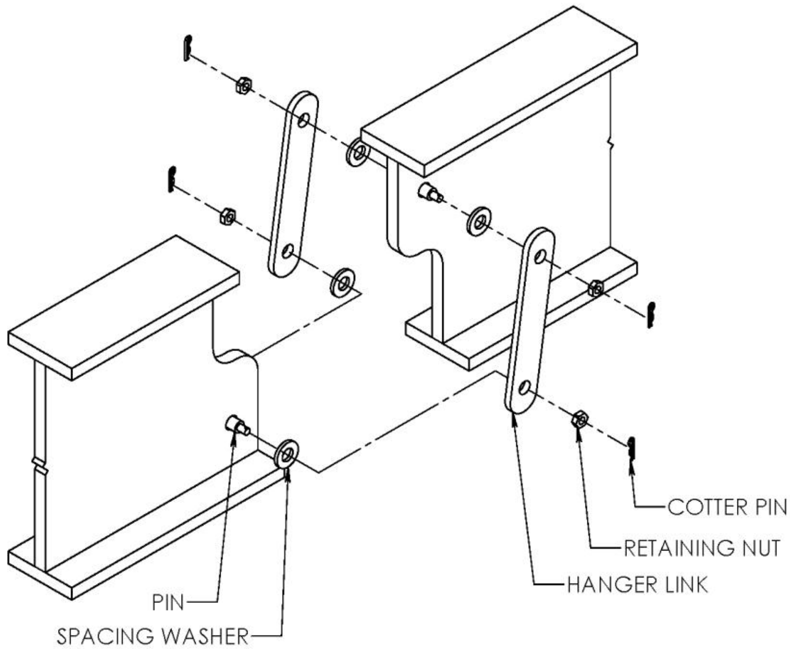


Figure 2.4.2.4.3.1. Pin and Hanger Hinge

2.4.2.4.3.2. Rotational Connections

A typical rotational hinge connection is shown in Figure 2.4.2.4.3.2. Rotational connections may be considered FCMs. Retaining nuts should be checked for cracks and to confirm retaining nuts are tight. Pins should be visually inspected for signs of corrosion. Because hinges are located at deck joints, leaking joints can promote corrosion in the hinge components, including pack rust between the pin plates and the web plate. Pin plates should be checked for pack rust that could apply an outward force to retaining nuts.

Pins for rotational connection assemblies shall be ultrasonic tested on a 60- to 72-month frequency.

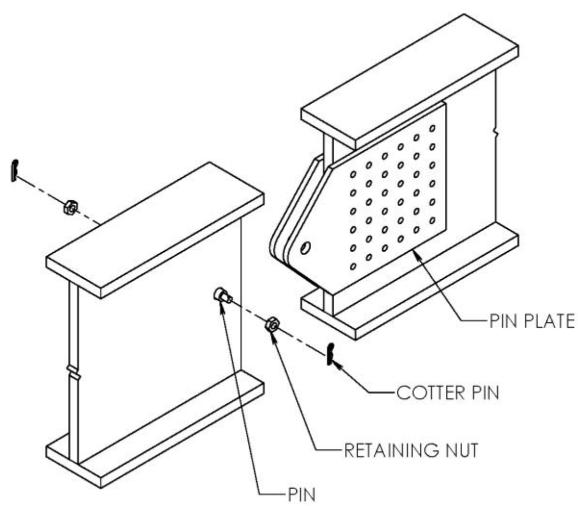


Figure 2.4.2.4.3.2. Rotational Hinge Connection

2.4.2.5 Other Structure Types

Many other superstructure types are less common on the Primary Highway System. The techniques used for inspecting these bridges do not vary greatly from what has been discussed previously. Unique aspects of some of the more common bridge types are discussed in the following sections.

2.4.2.5.1 Timber

Timber beams should be inspected for checks, splits, knots, rot, and damage. Any of these conditions should be documented on a sketch.

Knots in timber stringers can be detrimental to the stringers' capacity. The area around a knot should be closely examined for splits.

2.4.2.5.2 Trusses

Truss bridges typically have FCMs. The FCMs should be identified by OBS. The truss tension members and floorbeams spaced at 14 feet or more are the most common FCMs. Pins and hangers may also be FCMs if they exist on a truss bridge. Gusset plates are also considered FCMs.

2.4.2.5.3 Arches

An arch can be constructed with concrete or steel. Arches are designed to be mainly in compression but may experience tension under certain loadings.

A tied arch bridge has a main arch tied to a bottom chord at both ends of the arch. The bottom chord is in tension and is usually fracture critical.

2.4.2.5.4 Cable Supported Structures

The primary types of cable supported superstructures are cabled stayed and suspension bridges. Arch and tied arch bridges may also use cable members as suspenders to connect the deck framing system to the arch.

2.4.2.5.5 Rigid Frames

A rigid frame structure has the main superstructure girders integrally connected to the substructure to form a moment connection. These types of structures are less common and will be specifically identified in the bridge file.

2.4.2.6 Bearings

Bearings transfer the load from the superstructure to the substructure. They are designed to accommodate movement and/or rotation due to temperature and live load forces. There are four types of movement that could occur: 1) rotational, 2) longitudinal, 3) lateral, and 4) vertical. Vertical movement is normally due to earthquakes, which have a low probability of occurring in Iowa.

All bearings can accommodate rotational movement, but bearings are also designed to either accommodate or restrain longitudinal movement. Thus, bearings are defined on a plan set as either fixed or expansion. Fixed bearings accommodate rotation only, while expansion bearings accommodate rotation along with longitudinal movement. Special bearing types can accommodate lateral movement as well.

Typical bearing types are shown in Figures 2.4.2.6-1 through 2.4.2.6-5.

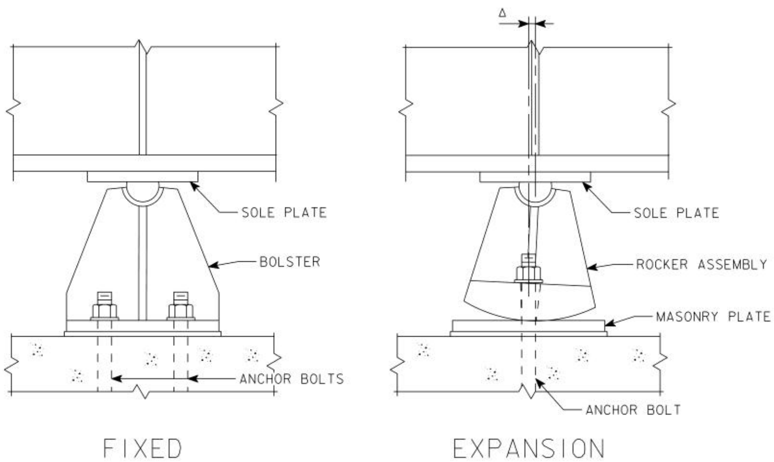


Figure 2.4.2.6-1. Steel Fixed Bolster and Steel Rocker Bearings

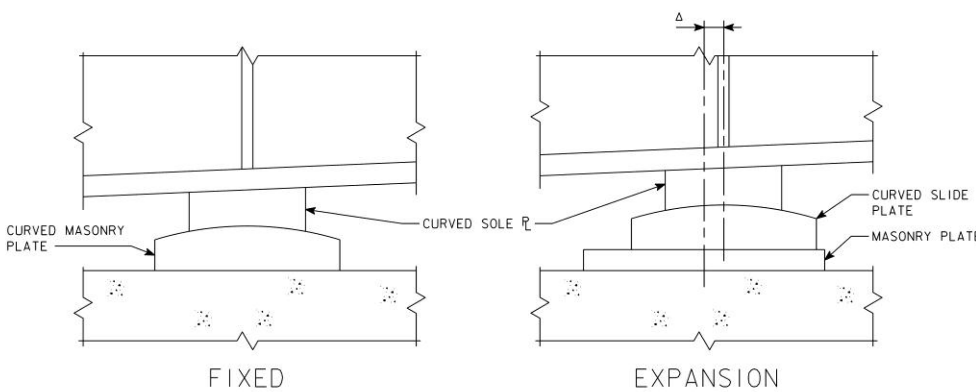


Figure 2.4.2.6-2. Steel Sliding Plate Bearings

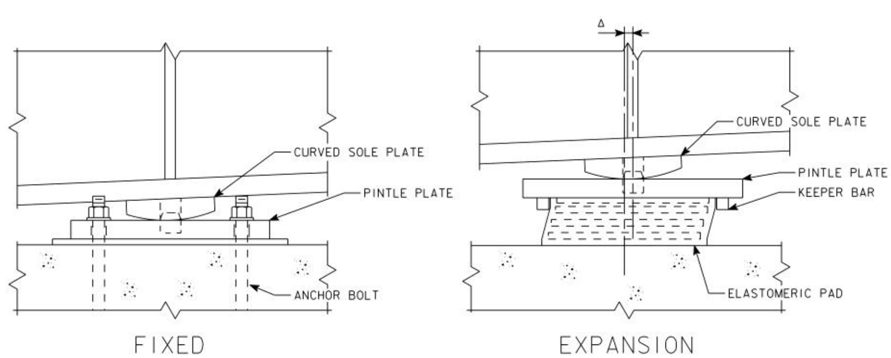


Figure 2.4.2.6-3. Pintle Plate & Pintle Plate with Elastomeric Pad Bearings

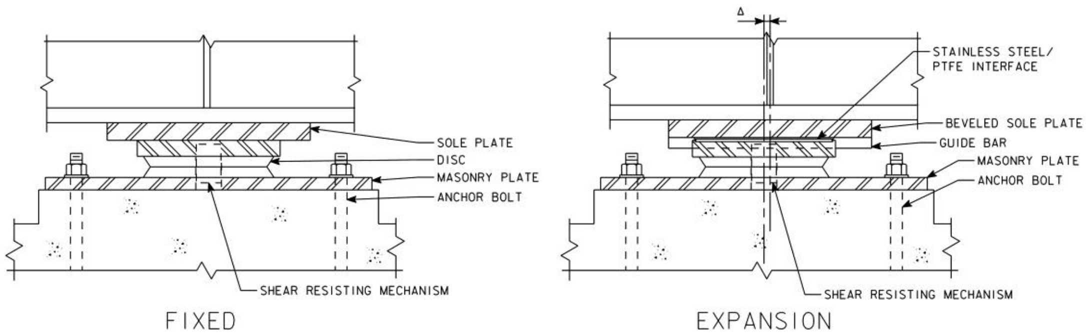


Figure 2.4.2.6-4. Disc Bearings

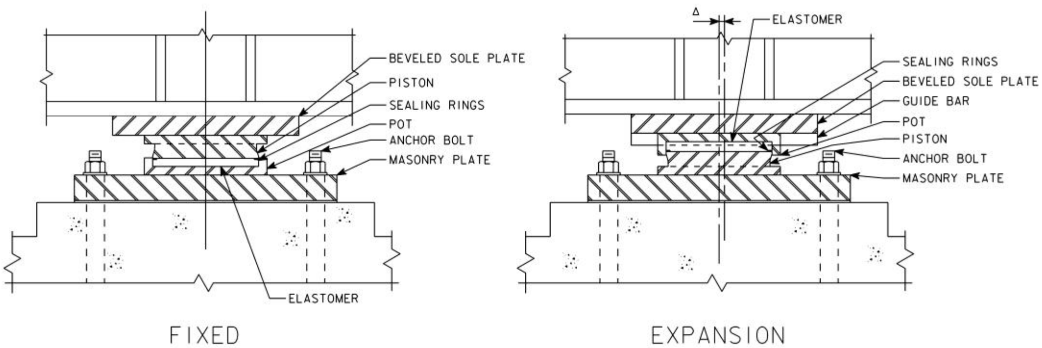


Figure 2.4.2.6-5. Pot Bearings

Expansion bearings are set at construction to a certain position according to the ambient temperature. These setting may or may not correspond to the temperature during the inspection. Movement should be generally to expansion during the summer months and to contraction during the winter months. When movement is seen that does not correspond to the temperatures of the season, measurement of the bearing setting and the temperature of the superstructure should be documented. Measurement locations for expansion bearings can be found in the figures of the bearing types shown above.

Any damage or deterioration of a bearing should be documented by sketches, photographs, or both. Pack rust that may be limiting the ability of the bearing to move properly should be noted. Bearings under deck joints are more susceptible to corrosion and pack rust because of joint leakage.

2.4.2.7 Coding NBI Item 59 (Superstructure Condition Rating)

The condition of bearings, joints, and paint system should not be included in the rating for NBI Item 59, Superstructure, except in extreme situations, but should be noted in the inspection report. On bridges where the deck is an integral part of the superstructure (such as concrete T-beams, where the deck is cast with the beams), the superstructure rating may be affected by the deck condition. If the deck is an integral part of the superstructure, the superstructure rating should not be higher than the deck rating. Both ratings should be the same for concrete slab bridges.

An NBI rating of 5 or less requires a comment on the reasons for this condition rating. A condition rating of 5 begins to affect the Sufficiency Rating negatively.

2.4.2.8 National Bridge Elements

The description of the NBE for superstructures can be found in the NBE manual prepared by OBS.

The NBE should include comments and inspection notes under each element as necessary. Comments and inspection notes should be included when there is a portion of the element in condition state 3 or 4.

2.4.2.9 Additional SIIMS Superstructure Data

The Superstructure section in SIIMS has several items not part of the NBI or NBE data. These items should be updated as necessary at each Routine or In-depth Inspection.

2.4.2.9.1 Additional Structure Detail Fields

Some bridges have unique features not captured within the standard structure type codes of the NBI. A field called "Additional Structure Details" has been created within SIIMS to document some of these special features. A drop-down menu of items is used to allow selection of a special feature if one exists. The drop-down menu includes:

1. Welded I Girder with Diaphragms (more than 2 girders) – Bridges with standard diaphragms between girder lines
2. Two-girder Welded I Girder with Stringers – Standard two-girder bridges with stringers and floorbeams
3. Two-girder Welded I Girder with Floorbeams – A two-girder bridge with floorbeams and no stringers
4. Welded I Girder with Floorbeams (more than 2 girders) – Multiple girders with floorbeams supporting the deck
5. Pony Truss – To specifically identify this type of truss bridge
6. Arch Deck with No Fill – A concrete arch structure with no fill material between the arch and the deck
7. Other – Any unique feature that would make the bridge necessary to include in a query

2.4.2.9.1.1. Beams/Girders

The Beams/Girders section in SIIMS will be eliminated once the new NBEs are implemented. The beam end deterioration can be documented by using the environments for beam and girder elements.

2.4.2.9.1.2. Diaphragms

The Diaphragms section in SIIMS is for documenting the type of diaphragms found on a bridge. A drop-down menu in SIIMS lists the choices of diaphragms to select from for end diaphragms and intermediate diaphragms. The choices are:

1. Concrete – Solid concrete reinforced with mild steel
2. Rolled Steel – A single rolled steel member, usually an I shape or channel shape
3. Steel Angles – Multiple steel angles usually in an X-frame or K-frame configuration
4. Miscellaneous – Any type not fitting the three other categories
5. None – No diaphragms present

2.4.2.9.1.3. Fracture Critical/Fatigue Prone /Fatigue Retrofit

The Fracture Critical/Fatigue Prone /Fatigue Retrofit section in SIIMS is for documenting whether a bridge has FCMs, Fatigue Vulnerable details, or if there has been a retrofit of a Fatigue Vulnerable detail. A “Yes” or “No” should be chosen from the drop-down menu for each of the three items. If “Yes” is chosen for any one of these features, the type of feature found on the bridge should be checked in the corresponding list. More than one item can be checked in any one list.

2.4.2.9.1.4. Fatigue Inspection History

A Fatigue Inspection is an inspection of the fatigue prone details of a steel member. This inspection is done during a Routine or In-depth Inspection.

A Fracture Critical bridge, with fatigue prone details, may require an Intermediate Fatigue Inspection at an interval between a Routine or In-depth Inspection. An Intermediate Fatigue Inspection is required when a Fracture Critical bridge has or has had fatigue cracks.

The Fatigue Inspection History section in SIIMS is for documenting the date of the last Fatigue Inspection and the date of the next Fatigue Inspection. Fatigue Inspections are scheduled on a 24- or 72-month basis. A bridge can be on a 72-month Fatigue Inspection frequency if there have never been more than two locations found with fatigue cracks, these fatigue cracks have been arrested, and the bridge is not Fracture Critical. When more than two locations have had fatigue cracks verified, the bridge’s fatigue-prone details must be inspected every 24 months. If the 72-month frequency is allowed, the check box designated as “Six Year Cycle” should be checked.

The number of locations with fatigue cracks shall be documented by entering the number of locations with the following:

1. Previous confirmed cracks – total number of locations with cracks found during previous inspections
2. New confirmed cracks – new cracks found during the current inspection
3. Cracks extended beyond holes – old cracks with ¾-inch-diameter crack arrest holes that did not stop the crack from extending past the hole
4. Confirmed cracks – the total number of crack locations currently found on the bridge regardless if they have had ¾-inch diameter arresting holes drilled or large hole retrofits

If all of the cracks have been arrested with ¾-inch diameter holes or larger hole retrofits, “Yes” should be selected from the drop-down for the question “Have holes been drilled at all cracks?”. Otherwise, “No” should be selected.

2.4.2.9.1.5. Pin and Hanger Inspections

To identify whether a Pin and Hanger assembly exists on the bridge, “Yes” or “No” should be selected from the drop-down menu. If there are Pin and Hanger assemblies on the bridge, the date of the last ultrasonic inspection and the date of the next ultrasonic inspection should be entered.

An ultrasonic inspection will be performed at a 60- to 72-month frequency. This inspection will be documented as an “Other” inspection type.

2.4.3 Substructure Inspection

Substructure members should be inspected for deterioration, as described below, due to specific material characteristics, as well as for signs of foundation settlement, rotation (tipping), lateral movement, overstress due to poorly functioning bridge bearings, scour, and undermining damage. During inspection for scour and undermining, areas surrounding the footings should be probed to find areas of loose backfill or areas where scour action has removed streambed material from around the footings. Footings not located in areas influenced by stream flow may also experience undermining from bridge drainage outletting near substructure foundations. High stress zones of substructure members should be examined for localized failure at bearing pedestals and high shear and flexural zones.

2.4.3.1 Abutments

Abutments are located at the ends of the bridge and support the superstructure at the transition between bridge and pavement. Abutments can be supported by spread footings or piles. An abutment may be integral, semi-integral, or stub type.

Spalling, scaling, and cracking in the abutment seat and backwall concrete should be noted and sketched.

Undermining of the abutment should be noted and sketched. Undermining extending under the abutment to the point where the approach fill may be washing out from under the abutment is significant. Investigation of a possible void under the approach pavement is necessary. A void should be reported to OBS immediately to determine if it affects the safety of the roadway. The District may need to be contacted in severe cases.

If undermining has exposed steel piles, the piles should be examined for section loss as is practical. Section loss at the interface between the pile and footing is the most common place for this to occur.

2.4.3.1.1 Integral Abutments

An integral abutment is connected to the superstructure in a way that makes the abutment flex with the expansion and contraction of the superstructure. This flexing will often displace soil and create a trough in front of the footing and a void under the approach pavement at the paving notch. These conditions are not detrimental to the structure. The void under the approach should be monitored to make sure it does not grow too large due to water erosion.

2.4.3.1.2 Semi-Integral Abutments

A semi-integral abutment can be a retrofit or an original design. Leaching of subsurface drainage from the approach fill occurring between the footing and the backwall may be present, which may indicate a non-functioning sub-drain.

2.4.3.1.3 Stub Abutments

The backwall should be examined for signs of crushing or cracking from deck pressure against the backwall. The joint opening should be measured between the deck and backwall on the underside of the joint. The joint opening on top of the backwall may not be comparable to the gap between the deck and backwall underneath the joint.

The bridge seat should be examined for spalling, scaling, and hollow areas. Spalling or scaling that has caused bearing loss must be measured and sketched.

2.4.3.2 Piers

There are many types of piers. They can be concrete, steel, or a combination of both. Steel pier caps can be fracture critical.

Piers should be examined for signs of atypical movement. Settlement of pier footings can cause tipping of the pier. Any unusual movement should be documented with a sketch and vertical alignment measurements.

2.4.3.2.1 Concrete Piers

Spalling, scaling, cracking, and hollow areas of concrete should be documented with sketches and written descriptions of significant deterioration. Cracking in high stress areas should be documented.

Flood debris against a pier should be documented. Flood debris can cause scour, which may lead to undermining of the pier footing.

2.4.3.2.2 Steel Bents

Steel bents should be checked for impact damage from flood debris. In addition, steel bent components and steel piles should be checked for fatigue cracking, pack rust, and section loss due to corrosion. Connections between primary vertical members and secondary bracing members should be checked for cracked welds, loose connections, or section loss at gusset plate connections.

2.4.3.2.3 Integral Steel Pier Caps

Integral steel pier caps should be checked for signs of overstress at high shear or flexural zones. For FCMs, an "arms length" inspection of all components and connections should be conducted.

2.4.3.3 Underwater Inspection of Substructures

Pier elements below the waterline are to be inspected by means of wading or probing at periods of low water.

Underwater Inspections are required when the low water depth is never below 2 feet. When the low water level is between 2 feet and 6 feet, Underwater Inspections are to be performed at a 48-month frequency, and NBI Items 92B and 93B, Underwater Inspection, must be filled in. Additional Underwater Inspection requirements include the following:

1. If the water depth at low water is not less than 6 feet, divers are required to perform the inspection of underwater portions of the substructure. The Underwater Inspection by divers should be coded as "Yes."
2. When the water depth is between 2 feet and 6 feet, wading and probing are used to inspect the portions of the substructure underwater. It is at the inspector's discretion whether a boat is used if the water level and current are too dangerous for wading.
3. The streambed should be documented during Underwater Inspections to the extent practical.

2.4.3.4 Coding NBI Item 60 (Substructure Condition Rating)

All substructure elements should be inspected for visible signs of distress including evidence of cracking, section loss, settlement, misalignment, scour, collision damage, and corrosion. The rating given by NBI Item 113, Scour Critical Bridges, may have a significant effect on NBI Item 60, Substructure, if scour has substantially affected the overall condition of the substructure. When NBI Item 113, Scour Critical

Bridges, is coded 2 or less on the SI&A form, NBI Item 60, Substructure, shall be coded 2 or less in accordance with Hydraulic Engineering Circular 18 (HEC-18), Section 10.3.2, Bridge Inspection, FHWA's Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges.

The substructure condition rating shall be made independent of the deck and superstructure. This item describes the physical condition of piers, abutments, piles, fenders, footings, or other components.

Integral-abutment wingwalls up to the first construction or expansion joint shall be included in the evaluation. For non-integral superstructure and substructure units, the substructure shall be considered as the portion below the bearings. For structures where the substructure and superstructure are integral, the substructure shall be considered as the portion below the superstructure.

An NBI rating of 5 or less requires a comment on the reasons for this condition rating. A condition rating of 5 begins to affect the Sufficiency Rating negatively.

2.4.3.5 National Bridge Elements

The description of the NBE for substructures can be found in the NBE manual prepared by OBS.

The NBE should include comments and inspection notes under each element as necessary. Comments and inspection notes should be included when there is a portion of the element in condition state 3 or 4.

2.4.3.6 SIIMS Pier Data

The Pier section in SIIMS is used to document the foundation type and the pier structure. The condition of individual piers is more easily documented by using this section. Bridges with more than two piers are difficult to document when multiple issues are found. Describing multiple issues for many piers in the NBE can be confusing. In this section, written documentation of the conditions found for each pier during the inspection can be included.

The number of piers should be selected from the drop-down menu. When the number of piers is chosen, areas will appear for each of the piers identified.

2.4.3.6.1 Foundation Type

The foundation description should be identified for each pier by using the most relevant type listed in the drop-down menu.

When the foundation is not visible, the foundation condition should be coded as unknown from the drop-down menu. When the foundation is visible, it should be rated as Good, Fair, or Poor. If a Poor condition is found, a description of the condition should be entered in the comment field.

Comments on the overall condition of the foundation should be entered when an individual foundation has deterioration not common among all the foundations of the bridge.

2.4.3.6.2 Pier Type

The pier description should be identified for each pier by using the most relevant type listed in the drop-down menu.

The pier condition should be coded as Good, Fair, or Poor. If a Poor condition is found, a description of the condition should be entered in the comment field.

Comments on the overall condition of the pier should be entered when an individual pier has deterioration not common among all the piers of the bridge.

2.4.3.7 Additional SIIMS Substructure Data

The Substructure section in SIIMS has several items not part of the NBI or NBE data. These items are to be updated as necessary at each Routine or In-depth Inspection.

2.4.3.7.1 Foundation

The foundation types for the near and far abutments should be identified by using the most relevant type from the drop-down menu under the Description heading.

If the foundation elements are not visible, the condition should be coded as unknown. When the foundation elements are visible, the condition should be coded as Good, Fair, or Poor. If a Poor condition is found, a description of the condition should be entered in the comment field.

2.4.3.7.2 Berm Protection

The berm types for the near and far abutments should be identified by using the most relevant type from the drop-down menu under the Description heading.

The condition should be evaluated as Good, Fair, or Poor. If a Poor condition is found, a description of the condition should be entered in the comment field.

2.4.4 Channel Inspection

Channels should be inspected for the physical condition associated with the flow of water through the bridge, such as stream stability, and the condition of the channel, riprap, slope protection, or stream control devices, including spur dikes. The inspector should be particularly concerned with visible signs of excessive water velocity, which may affect undermining of slope protection, erosion of banks, and realignment of the stream, which, in turn, may result in immediate or potential problems. Accumulation of drift and debris on the superstructure and substructure should be noted in the inspection report but shall not be included in the condition rating.

2.4.4.1 Coding NBI Item 61 (Channel Condition Rating)

The rating for NBI Item 61, Channel/Channel Protection, should reflect the general condition of the channel in relation to the following:

1. Bank vegetation – Vegetation protects the banks from erosion by normal water flow.
2. River control devices – Devices include spur dikes, jetties, retards, and other control systems.
3. Debris in channel restricting flow – Debris could cause scour to occur around substructure elements.
4. Trees and brush restricting the channel – Trees and brush could cause a restriction accelerating the flow and the potential for stream degradation or scour.
5. Degradation or aggradation of the streambed – Streambed elevations significantly different than the as-built condition may cause unexpected problems during high water events.
6. Channel movement away from the as-built condition – Channel movement may encroach on the substructure or approach pavement, causing undermining and potential failure of the bridge or roadway.

An NBI rating of 5 or less requires a comment on the reasons for this condition rating. A condition rating of 5 begins to affect the Sufficiency Rating negatively.

2.4.4.2 National Bridge Elements

The description of the NBE for Channel condition can be found in the NBE manual prepared by OBS.

The NBE should include comments and inspection notes under each element as necessary. Comments and inspection notes should be included when there is a portion of the element in condition state 3 or 4.

2.4.4.3 Additional SIIMS Channel Data

The Channel section in SIIMS has several items not part of the NBI or NBE data. These items should be updated as necessary at each Routine or In-depth Inspection.

2.4.4.3.1 Bank Protection

The type of bank protection present upstream and downstream, if any (spur dike, jetty, retard, other, or none), should be described.

The conditions of the protection devices should be described as follows:

1. Good – functioning and no damage to device
2. Fair – functioning but minor damage to device
3. Poor – not functioning properly due to damage to device
4. N/A - no bank protection device

2.4.4.3.2 Revetment

The type of revetment present, if any (riprap, concrete, other, or none), should be described.

The conditions of the revetment should be described as follows:

1. Good – functioning and no damage
2. Fair – functioning but minor damage
3. Poor – not functioning properly due to damage
4. Blank – no revetment present

2.4.4.3.3 NBI Item 113, Scour Critical Bridges

NBI Item 113 and the Scour Critical Classification are to be entered by the Hydraulic engineers only. If scour is found at the inspection, the inspection shall be routed to the hydraulic engineers for review before the report is finalized.

2.4.4.4 Underwater Inspection

Complete the following information for bridges that cross a waterway feature:

1. The “Underwater Inspection by Divers” should be coded as “Yes” when the low water depth is 6 feet or more. Enter “No” if divers are not required.
2. The streambed should be documented during Underwater Inspections to the extent practical. The “Streambed” should be coded “Yes” when it can be documented during the Underwater

Inspection. Enter "No" when the streambed cannot be documented during the Underwater Inspection.

3. The number of piers that require Underwater Inspection should be documented. Only piers in low water above 2 feet in depth are to be included. Enter "0" when there are no piers requiring Underwater Inspection.

2.4.4.5 Waterway Characteristics

The waterway characteristics document the elevations of the following:

- High water
- Current water
- Low water
- Pile tip
- Scour hole
- Plan streambed

Other information that should be documented includes the reference point of the elevation used and the length of the pile according to plan or pile log information.

2.4.4.6 Channel Cross Section

A channel cross section on the upstream side of the bridge is required to be a part of the bridge record. A standard Channel Cross Section form has been incorporated into SIIMS. Each bridge structure is required to have data points at the top of bank, toe of bank, thalweg, and each substructure unit. The Channel Cross Sections are updated in SIIMS every 4 years for natural waterways and every 10 years for drainage ditches controlled by a drainage district, unless conditions at the bridge warrant more frequent monitoring.

Although the Channel Cross Section is required in SIIMS, hand-drawn channel sketches may be uploaded to the report, or the standard Channel Cross Section form in SIIMS may be used to auto-generate a channel cross section sketch.

2.4.5 Culvert Inspection

A culvert with an opening greater than 20 feet as measured along the center of the roadway is considered a bridge-sized structure and is subject to NBIS requirements. Similarly, a grouping of culverts with a length greater than 20 feet as measured along the roadway centerline, and where the clear distance between openings is less than half the smaller contiguous opening, is considered a bridge-sized structure.

Culverts should be inspected for their overall condition, any approach roadway and embankment settlement, the condition of their end treatments (headwalls, parapets, and wingwalls), and the condition of their appurtenance structures (such as aprons, weirs, and energy dissipaters). The inside of a culvert should be inspected for any damage or deterioration. Weep holes should be checked to determine if they are functioning or if they are plugged. Joints should be checked for deterioration or spalls.

2.4.5.1 Concrete Headwalls

For concrete headwalls, the following items should be reviewed at each inspection:

1. Wall condition – wall tipping, cracking, and concrete scaling
2. Apron condition – concrete scaling, settlement, and cracking

3. Curtain wall – stream bottom elevation, piping of water under or around the curtain wall, and riprap present

2.4.5.2 Concrete Barrels

For concrete barrels, the following items should be reviewed at each inspection:

1. Wall condition – cracking, spalling, scaling, joint openings, and bulging
2. Slab condition – cracking, spalling, scaling, joint openings, and leaching
3. Floor condition – sediment depth, spalling, scaling, settlement, and heaving

2.4.5.3 Metal Culverts

For metal culverts, the following items should be reviewed at each inspection:

1. Corrosion – section loss
2. Erosion – potential piping around the culvert
3. Distortion – unusual defections or alignment
4. Connections – loose or missing bolts

2.4.5.4 Concrete Arches

For concrete arches, the following items should be reviewed at each inspection:

1. Footings – scour, cracking, spalling, and pile exposure
2. Arches – spalling, scaling, exposed reinforcing, conditions at the springline
3. Wingwalls – wall tipping, cracking, and concrete scaling
4. Fill – signs of settlement, sink holes, and pavement settlement

2.4.5.5 Fill Depth

The fill depth must be measured for all culvert types. This information is needed for dead load calculations used for the load rating. A sketch of the cross section of the culvert with the elevations of the fill at the parapets, roadway shoulders, and centerline of roadway should be made. The maximum fill depth should be documented on the sketch if it is different from the recommended elevation locations described.

2.4.5.6 Coding NBI Item 62 (Culvert Condition Rating)

The rating for NBI Item 62, Culvert, should evaluate the alignment, settlement, joints, structural condition, scour, and other elements associated with culverts. The rating code is intended to be an overall condition evaluation of the culvert. Integral wingwalls to the first construction or expansion joint shall be included in the evaluation.

An NBI rating of 5 or less requires a comment on the reasons for this condition rating. A condition rating of 5 begins to affect the Sufficiency Rating negatively.

2.4.5.7 National Bridge Elements

The description of the NBE for culverts can be found in the NBE manual prepared by OBS.

The NBE should include comments and inspection notes under each element as necessary. Comments and inspection notes should be included when there is a portion of the element in condition state 3 or 4.

2.4.5.8 Additional SIIMS Culvert Data

The Culvert section in SIIMS has items not part of the NBE or NBI data. These items should be updated as necessary at each Routine or In-depth Inspection.

2.4.5.8.1 Fill

There is a check box that must be checked when no fill is present over the top of the culvert. This identifies culverts for which the top of the slab is the driving surface of the roadway.

2.4.5.8.2 Revetment

The type of revetment present, if any (riprap, concrete, other, or none), should be described.

The overall condition of the revetment should be described as follows:

1. Good – functioning and no damage
2. Fair – functioning but minor damage
3. Poor – not functioning properly due to damage
4. Blank – no revetment present

If the condition is considered poor, a description of the condition should be entered into the comment field.

2.5 SIIMS DOCUMENTATION

2.5.1 About SIIMS

The Structure Inventory and Inspection Management System (SIIMS) is the single-source location for entering and reviewing condition information for all Iowa bridges, both State owned and locally owned. In order to use SIIMS and other applications hosted on State web servers, a user must first obtain a State of Iowa Enterprise A & A account I.D. and password. In addition, a user must be registered in SIIMS by completing a form for a Bridge Owner, Bridge Inspector, Bridge Load Rating Engineer, or Bridge Data Entry Personnel. Individuals who do not qualify for any of these levels of access must complete a form for Bridge Information. The various permission levels control the level of access provided within the system.

SIIMS has the ability to track all keystrokes made within the system based on the user. In this way, the software can determine the source of any information changed or edited within the system. For this reason, it is important a user does not share his/her user I.D. or password with anyone else.

The architecture of the SIIMS software includes several modules. There are two modules that will be used by most users: a Manager module and a Collector (or Inspector) module. The Manager module or Collector module are accessed through the main menu items listed at the top of the screen after initial log in. Access to items under the Manager or Collector modules is controlled by user permissions at the log in.

2.5.2 Manager Module Menu in SIIMS

The Manager module menu is geared toward Program Managers for bridge inspection programs at either the State or local level. Access to the Manager module menu is limited based on permissions granted. For example, the Program Manager for a local agency may be granted permission to access bridge inspection data only for bridges under his/her jurisdiction. Functions within the Manager module menu include queries to search for data and mapping options (for example, to display all bridges within a particular county). Through the menu, the user also has the ability to provide system reports used to support funding decisions for a local agency's bridge program.

2.5.3 Collector (Inspector) Module Menu in SIIMS

The Collector module menu allows an inspector to filter and view the bridge inspection report status, workflows and upcoming inspections. Access to the Collector module menu is limited based on permissions granted. For example, an inspector for a local agency will only be granted permission to access bridge inspection information for bridges under the jurisdiction of the given local agency. The Collector module menu allows inspectors to organize and view the bridges they are tasked with inspecting.

2.5.4 Creating Inspection Reports

New reports can be created and pending reports can be viewed or edited based on the status of the report. To create a new report, the inspector must navigate to the specific bridge needing inspection and click the Create Report button. When a user is creating a new report, historical information from the bridge file, such as the bridge plans, will automatically be associated to the bridge from information in the Central Database. In addition, when creating a report, the user must specify the report type (for example, Iowa Full State, Iowa Full County, Load Rating Report, or Iowa Other). Once the report type is chosen, the Inspection type can be selected from the list shown.

2.5.5 Bridge Descriptions in SIIMS

The Bridge Descriptions tab in SIIMS provides written descriptions of what an inspector should expect to see when arriving at a bridge. As such, the descriptions should be of the configuration of the bridge, not the condition of the bridge. The descriptions should include rough dates of when the bridge and bridge components were built, retrofitted, or repaired. If the date of a change to a bridge or bridge component is unknown, the description should indicate when the change was first recorded, such as: "Retrofitted rectangular concrete bridge rails were installed sometime prior to the 1991 inspection."

2.5.5.1 General Guidelines for Written Descriptions

In general, describe permanent and long-term features of the bridge, such as overlays, retrofitted barrier rails, beam replacements, paint, abutment backwall rebuilds, paving notch rebuilds, riprap installations, and articulated block mat installations. When describing a change, retrofit, or addition, include the year when the new feature was first included.

Conversely, do not list Design Numbers or FHWA Bridge Numbers in the descriptions. The descriptions are not intended to describe maintenance features, such as Portland cement patches to the deck or epoxy injection of the deck. In addition, they would not describe deterioration such as spalls or impact damage.

2.5.5.2 Descriptive Information Required for Sub-sections

2.5.5.2.1 Bridge Description

Describe the bridge size (length and width), the superstructure type, and the bridge location. The location information should describe the feature the bridge is crossing over, such as "…carrying Westbound I-80 over Mud Creek 1.5 miles west of US-65."

2.5.5.2.2 Waterway

Indicate the skew of the waterway in relation to the bridge and the direction of the skew (right-hand back or left-hand back). Describe the upstream channel characteristics related to the stream path.

2.5.5.2.3 Roadway Under Bridge

List the name of the route under the bridge. List the span(s) the route passes through as it goes under the bridge.

2.5.5.2.4 Substructure

Describe the type of abutments for the bridge. Describe the number of piers and the type(s) of piers. Describe which piers use fixed and which piers use expansion bearings.

2.5.5.2.5 Superstructure

Indicate the number of spans in the bridge. Describe the type of girder used. Describe any special features of the superstructure, such as fatigue vulnerability and list the details of the special features.

2.5.5.2.6 Culvert

Indicate the number of barrels for the culvert, and the height and width of each barrel. Indicate the skew of the culvert relative to the roadway and the direction of the skew (right-hand back or left-hand back). Describe the type of headwalls used (straight or flared).

2.5.5.2.7 Roadway

The description of the bridge roadway refers to the bridge deck. Describe the roadway material type. Include the type and year of installation of the overlay, if one exists.

2.5.5.2.8 Approaches

Describe the type of pavement used on the bridge approaches. If an overlay exists on the approach roadway, describe the type of overlay and the year it was installed. Describe any maintenance performed on the approach pavement.

2.5.6 NBI Calculations

Calculated fields, the Sufficiency Rating, and the classification for Structural/Functional Deficiency are recalculated and updated in SIIMS during entry of inspection data for a new inspection. The logic for the calculated appraisal ratings and the Sufficiency Rating can be reviewed in the NBI Calcs section in SIIMS. It is recommended that these ratings be recalculated by choosing “Recalculate NBI Ratings” in the NBI Calcs section of SIIMS before finalizing an inspection.

The data fields that are calculated in the NBI Calcs section in SIIMS are:

1. NBI Item 67, Structural Evaluation
2. NBI Item 68, Deck Geometry
3. NBI Item 69, Underclearances
4. Sufficiency Rating
5. Classification – Structurally Deficient or Functionally Obsolete

2.5.7 Photographs, Sketches, Plans, Documents, and Files

Photographs, sketches, plans, documents and files are attached under the Report Info - Pictures section in SIIMS. Almost any file type can be added to a bridge file. The type of document will determine whether the document should be attached with an inspection report or as part of the Bridge File. If a document relates to only a specific inspection, such as photographs and sketches, it should be attached to the “In

Progress" inspection report. When a document relates to the bridge, such as design plans or a scour plan of action, the document should be attached in the "Files" area on the Asset Details page.

Files attached as part of an inspection report must be attached before the inspection report is finalized. If a document or file is not attached before the inspection report is finalized, the report must be unapproved to attach the files and then reapproved.

Files can be attached in the Asset Details page at any time, whether an inspection is in progress or not. The description field for each document should include specific information about the subject of the document so anyone looking at the Bridge File will know what each document contains without having to open each document.

2.5.7.1 Required Photographs

For Routine Inspections, the following photographs are required:

1. Bridges
    a. Approaches, with and against the route direction
    b. Profile view
    c. Upstream and downstream views, when over water
    d. Both abutments (overall)
    e. Typical pier, including one of each type if there are multiple types
    f. Bottom of the deck overall to show girder type and configuration
    g. Top of deck overall
    h. All deck joints
    i. Guardrail overall
    j. Any condition that may warrant repair
2. Culverts
    a. Both inlet and outlet profiles
    b. Roadway above
    c. Upstream and downstream views
    d. Any condition that may warrant repair

In-depth Inspections should include all the required photographs for a Routine Inspection as well as photographs relating to the field notes on deteriorated or unique conditions. In addition, photographs of the posting signs should be included in the report. Structures with a condition rating coding of 4 or less for Deck (NBI Item 58), Superstructure (NBI Item 59), Substructure (NBI Item 60), Channel and Channel Protection (NBI Item 61), or Culvert (NBI Item 62) are required to have photographs of the deficiency, although it is good practice to photographically document any significant deficiency.

2.5.7.2 Photograph Annotation Convention

The description field for each photograph should include specific words so that photos of unique circumstances can be found in future queries. These key words do not have to be used in any specific order or consecutively. A query will look for any combination of these words in a description. Common key words that may be used to find photographs of a particular issue are shown in Figure 2.5.7.2.

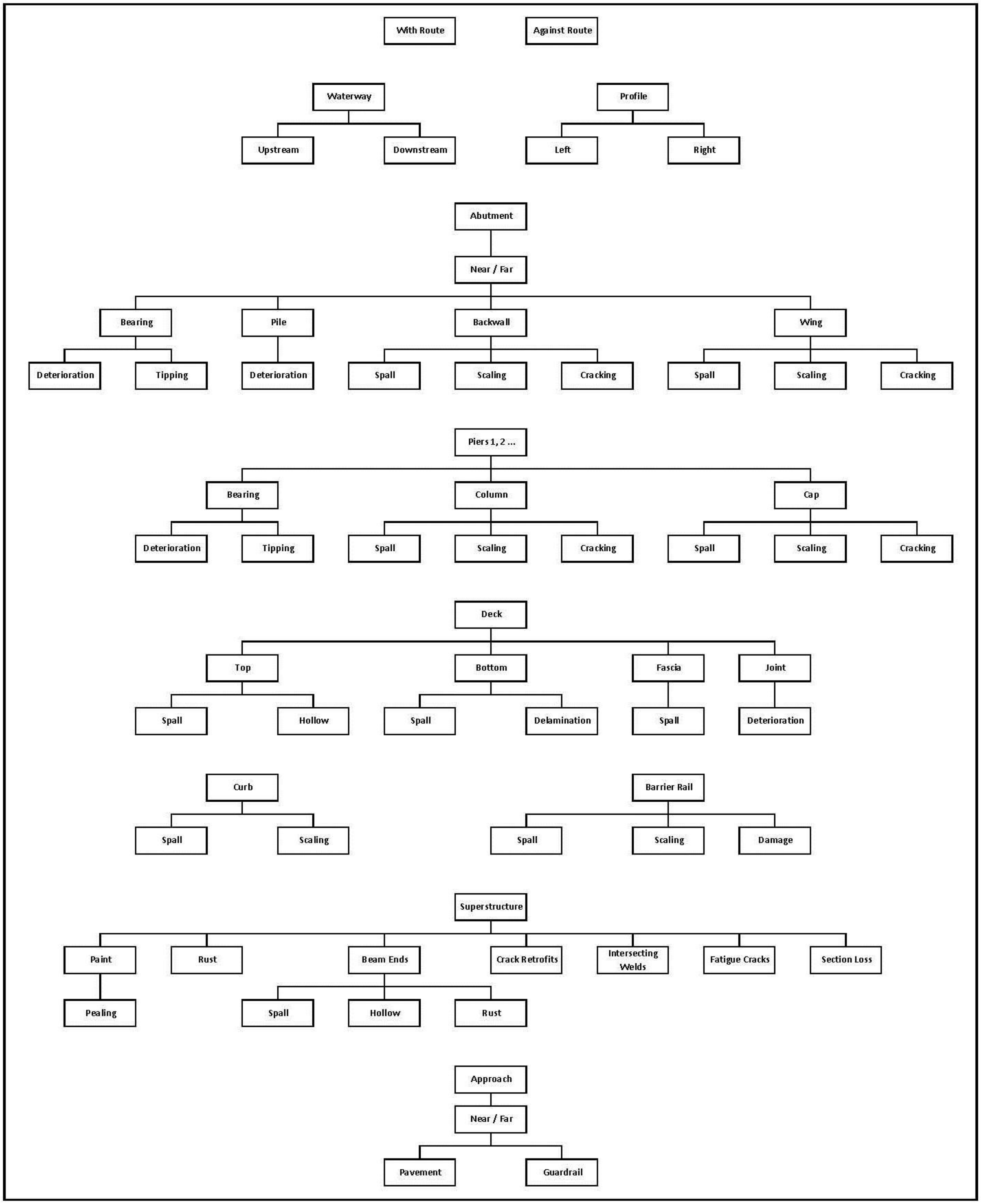


Figure 2.5.7.2. Common Photo Caption Key Words

2.5.7.3 Sketches

Sketches should be scanned into a single .pdf file before attaching them to an inspection report. If there is a large number of sketches to attach for a given bridge, the sketches can be grouped in logical pieces and attached as independent groups of sketches. When several groups of sketches are to be attached to an inspection report, each .pdf file should include a description identifying the type of sketches that are in each group. Logical groupings are:

- Profile
- Substructure
- Superstructure
- Deck

2.5.7.4 Plans

The original design plans as well as any repair or rehabilitation plans are to be attached to a bridge file in the Manager's module. Each plan set should be in a single file. If a bridge was built with staged construction, each stage can be attached individually. Each plan set should include a description of the details of the plans. The description should include the general work type and whether the plans are the "As-Built" set.

2.5.7.5 Other Documents

Any other documents relating to an inspection or the bridge in general can be attached under the following groupings:

1. Files – General documents: correspondence, material test reports, load test reports, etc.
2. Map – An aerial map
3. Load Ratings – Load Rating calculations
4. Scour – Scour calculations, Plans-of-Action, flood data, etc.
5. Fracture Critical Details – Documentation of the elements that are Fracture Critical as required by the NBIS
6. Channel Sections – Channel sketches showing changes in channel profile
7. Audio – Any audio or video recordings

2.5.8 Critical Findings

Reporting of Critical Findings is required under the NBIS. Critical Findings are structural or safety related deficiencies requiring immediate follow-up inspection or action. Typically, a Critical Finding requires bridge closure or lane closure. A form has been set up for documenting the finding and the follow-up actions. This form can be completed as part of a Routine or In-depth Inspection or as part of a separate Damage Inspection. The form should be completed as soon as possible from the time of the finding.

A complete description of the Critical Finding and the immediate action taken should be included in Part I of the form. Once the situation has been assessed, Part II of the form should be completed. Part II should include the proposed resolution of the Critical Finding and the time frame anticipated for completion.

The procedures to be used when issuing a Critical Findings Report are as follows:

1. The individual discovering the critical finding shall:
    a. Immediately report the finding to the Office of Bridges and Structures, who will notify maintenance personnel to close or restrict traffic on the bridge.
    b. Complete Part I of the Critical Findings Report within 48 hours of the finding.
2. The Office of Bridges and Structures shall:
    a. Take action to ensure the safety of the travelling public.
    b. Complete Part II of the Critical Findings Report within 5 days of the finding.
3. Before a closed bridge may be reopened to traffic, the following must be completed:
    a. A Professional Engineer, Licensed in the State of Iowa, shall approve any structural repairs.
    b. The bridge shall be load rated.
    c. The bridge shall be inspected by a Team Leader.

2.5.9 Load Rating Documentation

2.5.9.1 Load Rating Evaluation Form

The Load Rating Evaluation Form must be completed for every inspection. This form will determine if the existing load rating needs to be re-evaluated to determine if it is still valid or if a new load rating is needed. The name of the individual who completes the Load Rating Evaluation Form and the date he/she completes it must be entered at the top of the form.

All the questions on the form default to "No." If any one of the questions is changed to "Yes," a re-evaluation of the load rating or potentially a new load rating calculation will be required. After the evaluation form is completed, the Program Manager will make the request to have the load ratings re-evaluated or re-calculated based on the criteria on the Load Rating Evaluation Form.

2.5.9.2 Load Rating Bridge Report

The load rating must be completed by a Professional Engineer licensed in the State of Iowa. As noted above, the need for a load rating re-evaluation or a new load rating calculation is determined by filling out the Load Rating Evaluation Form.

If the load rating is re-evaluated and there is no reason found to update the load rating, the following fields on the Load Rating Bridge Report Tab need to be updated:

1. Report By: – indicates who performed the review
2. Date: – indicates the date the review was completed
3. Comment: – indicates the review did not require re-rating of the bridge

If the load rating is re-calculated and the ratings have changed, the entire Load Rating Bridge Report Tab must be updated. The Load Rating Bridge Report Tab can be generated by an unlicensed engineer, but a licensed engineer must put his/her name and license number at the bottom of the form. It is recommended the new calculations be attached to the inspection report before it is finalized. If the ratings are not completed before the inspection is finalized, a Load Rating Bridge Report should be created to update the ratings and attach the calculations.

2.5.10 Supplemental Inspection Information

The NBIS requires information on inspection equipment needs and maintenance history be maintained for all bridges. The Supplemental Inspection Information section in SIIMS provides a means to document this information. This section includes:

1. Special equipment requirements for inspection
2. Traffic control needs during inspection
3. Time requirements for inspection
4. Construction work history (design number, repair type, and year completed)

2.5.11 Maintenance, Repair, and Replacement

The Maintenance, Repair, and Replacement (MR&R) section in SIIMS is used to make recommendations for repair, rehabilitation, and replacement. The maintenance recommendations include all maintenance needs found during an inspection. These recommendations automatically transmit to the Records Management System (RMS) for the District bridge repair crews to manage. When a recommendation has been completed, deferred, submitted for contract work, or programmed, this information is transmitted back to SIIMS.

2.5.11.1 Maintenance Recommendations

When a recommendation is made, one of four check boxes must be checked to identify the type of recommendation. The four options are:

1. Corrective – The District must make the repair within 12 months or make provisions to have the work done by contract.
2. Preventive – Maintenance will prevent future deterioration. Deterioration is not causing a structural or safety issue at this time.
3. Monitor – The District must monitor the condition at an interval set by OBS or the District as appropriate.
4. From RMS – This recommendation was made by the bridge repair crew and transmitted to SIIMS from the RMS system.

A default type will be checked after the recommendation code is selected from the drop-down menu. This does not mean this is the only option for the recommendation. Some recommendation codes will display the Corrective and Preventive box checked. In this case, the severity of the condition should be used to determine which type of recommendation should be made. One of the boxes should be unchecked before the report is finalized.

Recommendations made during an inspection but not yet completed will come forward at future inspections. If a past recommendation has not been completed and is still necessary, the recommendation should be left as it is. A duplicate recommendation is not appropriate. If additional deterioration is found and the recommendation needs to change to a different code, then the recommendation status should be changed to “Cancelled” and a new recommendation added.

Recommendations previously completed serve as maintenance history. The NBIS requires a maintenance history be maintained for all bridges. In the past, the maintenance completed by District personnel was not tracked.

2.5.11.2 Available Maintenance Recommendation Codes

The Maintenance Recommendation Codes currently available for bridge work are shown in Table 2.5.11.2. The default text appearing with each recommendation can be altered to fit a specific situation. Recommendation codes 199, 299, 399, 499, and 599 are for situations not included in any of the available codes. The appropriate codes for Deck (199), Superstructure (299), Substructure (399), Channel (499), or Approach (599) work should be used. These codes can be used for Corrective, Preventive, or Monitoring situations.

Table 2.5.11.2. Maintenance Recommendation Codes

Code	Recommendation	Corrective/Preventive
100	Remove gravel from approaches	P
101	Remove gravel from snow & ice	P
103	Clean deck drains	C
104	Clean deck & drains	C
105	Remove loose concrete - Bottom of deck	C
110	Spall patch - Minor	P
111	Spall patch	C
112	Spall patch - Major	C
114	Deck deterioration - Possible failure	C
121	Recommend PCC overlay	C
132	Replace - Urgent	C
140	Inject w/ epoxy	P
141	Inject & patch spalls	C
142	Replace overlay	C
150	Repair or replace sliding plate joint	C
151	Repair crumb rubber joint	C
152	Repair or replace strip seal gland	C
160	Extend deck drains	C
161	Repair extensions	C
162	Seal concrete below drains	C
170	Paint steel handrail	C
171	Repair collision damage	C
172	Seal concrete handrail	P
199	Miscellaneous - Deck	C
200	Clean superstructure	P
212	Spot paint - Schedule	P
213	Complete paint - Consider	P
214	Complete paint - Schedule	C
215	Zone paint - Severe rusting	C
221	Possible cracks - Drill	C
223	Loosen diaphragm bolts	C
230	Tighten loose bolts	C
232	Replace missing bolts	C
234	Tighten & replace	C

Code	Recommendation	Corrective/Preventive
240	Repair - Spalls	C
241	Seal	C
249	Seal spalls	C
250	Repair spalls	C
251	Moisture - Seal	C
252	Cracks - Seal	C
260	Repair concrete diaphragms	C
261	Repair nicks & gouges	C
271	Repair collision damage	C
299	Miscellaneous - Superstructure	C
300	Clean bridge seats	P
301	Clean & paint bearings	P
302	Clean seats & paint bearings	P
303	Drain bridge seats	C
304	Re-set bearings	C
310	Repair near face & seat	C
311	Repair far face & seat	C
312	Repair both faces & seats	C
313	Repair near backwall	C
314	Repair far backwall	C
315	Repair both backwalls	C
320	Repair cap & bridge seat	C
321	Repair columns	C
322	Repair bridge seat & columns	C
340	Repair culvert walls	C
371	Repair collision damage	C
399	Miscellaneous - Substructure	C
400	Remove flood debris - Piers	P
401	Remove unbalanced fill - Piers	C
402	Cut off old pile in channel	P
403	Remove trees & brush	P
410	Repair erosion - Near berm	C
411	Repair erosion - Far berm	C
412	Repair erosion - Both berms	C
413	Repair erosion - Around near wing	C
414	Repair erosion - Around far wing	C
415	Repair erosion - Around all wings	C
416	Berm - Repair erosion - Near berm undermined	C
417	Berm - Repair erosion - Far berm undermined	C
418	Berm - Repair erosion - Both berms undermined	C
420	Repair degradation - Consider	P
421	Repair degradation - Schedule	C
422	Repair meander - Consider	P

Code	Recommendation	Corrective/Preventive
423	Repair meander - Schedule	C
430	Remove flood debris	P
431	Repair erosion at outlet	P
433	Clean out - Schedule	C
440	Seal cracks	P
441	Seal cracks & repair - Consider	C
442	Seal cracks & repair - Schedule	C
499	Miscellaneous - Channel	C
500	Re-cut near pressure relief joint	C
501	Re-cut far pressure relief joint	C
502	Re-cut both pressure relief joints	C
503	Install near pressure relief joint	C
504	Install far pressure relief joint	C
505	Install both pressure relief joints	C
510	Repair pavement - Near approach	C
511	Repair pavement - Far approach	C
512	Repair pavement - Both approaches	C
520	Repair shoulders - Near approach	C
521	Repair shoulders - Far approach	C
522	Repair shoulders - Both approaches	C
523	Repair near concrete panels	C
524	Repair far concrete panels	C
525	Repair all concrete panels	C
530	Guardrail repair near end	C
531	Guardrail repair far end	C
532	Guardrail repair both ends	C
571	Guardrail - repair collision damage	C
599	Miscellaneous - Approach	C

2.5.11.3 Program Recommendations

The Program Recommendations section in SIIMS is for work that cannot be done by District forces. This section can be populated by OBS inspection staff or District staff. There can be three separate recommendations for contract work at one time. Separate work items should be used when the work needed will not be performed by one contractor. An example of separate work items is painting, deck overlay, and riprap. In contrast to this, work items that can be performed by one contractor should all be included in one work item and comments should be made in the “Description of Work/Comments” listing the work needed. When there is more than one work item, an “Importance” should be selected to designate which work item is the highest priority among the work items designated for that bridge.

When entering a new Program Recommendation, include the preliminary cost estimate, the proposed date, whom the work is proposed by, and the priority of the work. This will place the bridge in the list to be evaluated at the annual District meeting with OBS. At the annual meeting, the project will be discussed and a determination of “Official Candidate” status, priority of work, and preliminary cost estimate will be made.

The Program Recommendation Items available are:

- Riprap
- Bridge Rehabilitation
- Bridge Removal
- Bridge Replacement
- Bridge Widening
- Bridge Approach Repair
- Bridge Deck Overlay
- Bridge Repair
- Bridge Rail Retrofit
- Bridge Painting
- Culvert Replacement
- Culvert Repair
- Culvert Extension
- Deck Patching with PC Concrete
- Bridge Cleaning/Washing
- Deck Joint Repair
- Bridge Slope Protection
- Permanent Scour Countermeasures
- Deck Patching with PC Concrete
- ‘Temporarily’ Repair Top of Abutment Backwall
- Replace Neoprene Expansion Joint Gland
- Rehab End of Prestressed Beam
- Replace Existing Joint w/ Strip Seal Joint
- Repair (not replace) Barrier Rail
- Repair Bridge Curb
- Repair Components of Modular Joint
- Replace Bridge Approach Pavement
- Replace Pavement Notch & Bridge Approach Pavement
- HMA Resurface Bridge Approach Pavement
- Patch Substructure Members
- Clean/Wash Deck & Unplug Drains

A Program Recommendation can be entered as part of an inspection report or by accessing the Bridge File through the Manager’s module in SIIMS. Program Recommendations are always active and are not necessarily associated with a specific inspection.

The “Need for Project Statement” is for the use of OBS. This statement will be used in the concept and is requested when the concept is being written. The “Need for Project Statement” should include specific information about the bridge, Structurally Deficient or Functionally Obsolete status, and reasons for needing the project.

Once a Project has been let to contract, the status of the proposed work item should be changed to “Completed.” The Assistant District Engineer should update the status after letting. The status can be updated to “Completed,” “Programmed,” “Cancelled,” or “Deferred” at any time.

2.5.12 Inspection Report

An inspection report is made up of several sections from the inspection input areas. Each inspection report should include all of the appropriate areas to create a final report. Not all sections need to be included in a given report, but may be needed for future inspections or as additional information after the inspection report is finalized. If a section is removed from the “Report Sections” screen, the section removed cannot be viewed or printed after the report is finalized. Sections that may be used in future reports should not be removed but can have the “Print” check box left blank. By leaving the “Print” check box blank, this section will not be included in the final report, but can be viewed and printed individually.

Sections of the inspection report that can be removed are areas that will never apply to the given bridge. If a structure is a culvert, the Deck, Superstructure, and Substructure sections will never be used and can be removed. The Culvert section can be removed from a structure that has a Deck, Superstructure, and Substructure. The Channel section can be removed when the bridge is over another roadway. The Pier section can be removed for a culvert or a single-span structure.

When an In-depth or Routine Inspection is performed, the sections outlined in Sections 2.5.12.2 and 2.5.12.3 of this manual should always be included in the report.

2.5.12.1 Error Check

The Error Check section should be reviewed before an inspection report is submitted for review and before it is finalized. The Error Check section will display the items in SIIMS that do not meet current QC or formatting guidelines. Each error must be corrected before the inspection report can be finalized. Some errors may be corrected automatically when the NBI calculations are manually recalculated.

Some common errors are:

- Field(s) left blank in the Load Rating Evaluation Form
- Comment field left blank when a condition rating is 5 or less
- SI&A data not completed

2.5.12.2 Typical Bridge Inspection Report Sections

A typical bridge inspection report should consist of the sections indicated below in the following order:

1. Cover
2. Table of Contents
3. Bridge Description
4. SI&A
5. Maintenance Recommendations (if recommendations exist)

6. Program Recommendations (if recommendations exist)
7. BrM
8. Deck
9. Superstructure
10. Substructure
11. Piers (if piers are present)
12. Channel (if channel is present)
13. Pictures
14. Sketches
15. Load Rating
16. Map

2.5.12.3 Typical Culvert Inspection Report Sections

A typical culvert inspection report should consist of the sections indicated below in the following order:

1. Cover
2. Table of Contents
3. Bridge Description
4. SI&A
5. Maintenance Recommendations (if recommendations exist)
6. Program Recommendations (if recommendations exist)
7. BrM
8. Culvert
9. Channel
10. Pictures
11. Sketches
12. Load Rating
13. Map

2.5.12.4 "Print" Check Box

The "Print" check box should be checked for all the required sections of an inspection report. Several of the additional sections, not required for a typical inspection report, should not be deleted from the report listing. The "Print" check box should be left unchecked so these sections do not appear in the final inspection report, but are available to view or print at a later date. These sections include:

- Channel Section
- Critical Finding
- Load Rating Evaluation
- Supplementary Inspection Information

- Special/Other Inspection (NBI)
- Special/Other Inspection (Non-NBI)
- Under Records

The final inspection report does not require printing or saving. The report can be viewed, printed, or e-mailed any time after the report is finalized. For all sections included in the final report, the box under the columns “Include in Table of Contents” and “Show Page Number” should be checked.

Documents created outside of SIIMS can be added to an inspection report. If a document that is not one of the standard documents in SIIMS would be a valuable item to include in a report, it can be added from the Report Sections window.

2.5.13 Inspection Information

The Inspection Information section in SIIMS includes information related to what, when, and how an inspection was completed. The date of the inspection(s) type performed is updated in this section. The inspection frequency can be updated as needed for any of the inspection types. The primary inspector’s name and anyone who assisted in the inspection are to be listed in the appropriate fields.

If an inspection was performed later than the required frequency due to unforeseen or unusual circumstances, an explanation of the “Unusual Circumstances” for exceeding the inspection frequency is required in the field provided. This will inform FHWA as to why an inspection could not be completed as scheduled. The month the inspection was originally required to be performed must remain the same for the following inspection. Therefore, the frequency for the next inspection should be adjusted to place the inspection back in the original month. For example, if a bridge was scheduled for inspection in March and could not be inspected until April, the frequency should be changed to 23 months to put the next inspection back to a March due date.

A general comments field is provided in this section for inspectors to provide information to the Program Manager or other inspectors about special issues related to the given bridge. This information is not included in any report section and is for internal use only.

2.6 SI&A DATA

The Structure Inventory and Appraisal (SI&A) is a compilation of NBI data submitted annually to FHWA. The SI&A does not contain all fields submitted to FHWA, and the SI&A format is not a standard form required by FHWA. Each state is able to format the form in any way it chooses. Iowa DOT’s format was developed to provide as much information as possible in an organized way on a single sheet.

The SI&A form in SIIMS contains information pulled from other SIIMS forms or external databases as well as data that must be entered directly on the SI&A form. Most of this information must be entered within 90 days of the bridge being opened to traffic. The fields on the SI&A form are defined as shown in FHWA’s Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation’s Bridges.

For bridges on the State and federal highway system, if errors are found in fields on the SI&A form that are not editable by the bridge inspector, OBS should be contacted to have the errors corrected.

2.7 UNDER RECORDS

The Under Records section in SIIMS pertains to a bridge crossing a roadway. The inventory route for the under record is the route under the bridge. The following four fields can be edited by the bridge inspector:

1. Item 19, Bypass Detour Length – This is the detour length if the route under the bridge were to be closed.
2. Item 47, Inventory Route Total Horizontal Clearance – This is the widest available clearance under the bridge on the inventory route of the under record.
3. Item 101, Parallel Structure Design – This item will be coded as “N – No parallel structure,” in most cases. If there are two bridges carrying the inventory route under a bridge, then this item should be coded “L – Left” or “R - Right.” In this case, there would be separate under records for each direction of the inventory route.
4. Item 102, Direction of Traffic – This item will be coded as “2-2-way traffic” in most cases. A bridge crossing a one-way ramp would be coded as “1-1-way traffic.”

A bridge will have multiple under records if more than one signed route goes under the bridge. Each route should have a separate under record. All four items listed above will have to be populated for each inventory route passing under the bridge.

CHAPTER 3
QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) FOR IOWA DOT PERSONNEL

3.1 SCOPE OF IOWA DOT BRIDGE INSPECTION QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The Iowa segment of the NBI is more than 25,000 bridges. Iowa DOT owns, inspects, and maintains more than 4,000 of these bridges in compliance with the NBIS.

More than 21,000 of the bridges in the Iowa NBI are owned, inspected, and maintained by counties, cities, and other public agencies. County and city bridge owners are referred to as Local Public Agencies (LPAs). Iowa Code 314.18 requires LPAs to be responsible for the safety inspection and evaluation of all highway bridges under their jurisdiction that are located on public roads in accordance with the NBIS. Iowa DOT published Instructional Memorandum (I.M.) 2.120 to assist LPAs in complying with the NBIS.

Private bridge owners are not subject to the NBIS and do not fall under Iowa DOT oversight. They are encouraged but not required to perform inspections that comply with the NBIS.

3.2 NBIS DEFINITION OF TERMS

The NBIS definitions of Quality Control and Quality Assurance are provided in the following sections.

3.2.1 Quality Control

Quality Control is defined as procedures intended to maintain the quality of a bridge inspection and load rating at or above a specified level.

3.2.2 Quality Assurance

Quality Assurance is defined as 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.

3.3 ROLE OF SIIMS

Iowa DOT implemented SIIMS in May 2010. SIIMS is a software package used to update the bridge records of Iowa's portion of the NBI. The user interface is a password-protected website allowing Iowa DOT and LPA bridge inspectors to manage inspections and document findings in a standardized reporting format.

SIIMS is the foundation of the Iowa DOT quality control program. The software presents standard collection screens for data entry, schedules inspections, and performs integrity checks at each stage of the approval process. These quality control measures are in place to obtain consistent inspection data from multiple inspectors, which is necessary if proper resource planning is to occur across the State.

3.4 QUALITY CONTROL

3.4.1 Inspection Scheduling

Inspection dates and inspection frequencies are entered in SIIMS for all NBI structures. Multiple inspection types, such as Fracture Critical or Underwater Inspections, may be entered and scheduled for separate dates, years, and frequencies.

SIIMS can forecast upcoming inspections and provide maps of bridge locations.

When the date of an inspection passes without the creation of an inspection report, SIIMS will automatically notify the bridge owner and Program Manager via e-mail if a report is not created by the time the inspection is 1 month, 3 months, and 6 months past due.

If an inspection report was created but remains unapproved, SIIMS will automatically notify the bridge owner and Program Manager via e-mail when the inspection report is 3 months and 6 months past the inspection date.

If an inspection report is not created or the report remains unapproved 6 months after the inspection date, SIIMS will automatically notify the bridge owner and Program Manager via e-mail and request an aggressive, short-term plan to correct this deficiency.

3.4.2 Data Collection

When an inspection report is created in SIIMS, a series of web pages are populated with the NBI information available for the structure. SIIMS promotes consistent NBI data collection by standardizing the data entry based on the following:

1. The inspector reviews each NBI entry and updates the data to reflect his/her inspection findings.
2. Each report includes a Load Rating Evaluation Form the inspector must complete before SIIMS will allow the inspection report to be approved.

Each report has an Error Check page to alert the inspector to entries missing or varying from an expected format.

3.4.3 Inspection Report Approval

The last step in the data entry process for an inspection report is requesting approval. When an inspector submits a report for approval, the error check software in SIIMS will review the report fields. If data entry errors are found, such as Item 92A (Fracture Critical Details) is coded “Yes” but no Fracture Critical Inspection date is entered, an Error Check page will appear, and the report will not be approved until the errors are resolved.

When the error check software finds entries that do not match the data stored in the SIIMS database, the inspector will be asked if the new data should overwrite the existing data or if the existing data should remain. The inspector must choose whether to use the report values or central database values before SIIMS will allow the report to be approved. Some data may be uneditable because it is data maintained by the Iowa DOT. If the data is uneditable and appears to be incorrect or in question, contact the Office of Research and Analytics to correct or clarify the data discrepancy.

Iowa DOT inspectors submit each report to the Quality Control team for content review and approval. A member of the Quality Control team reads each report to check the following:

1. The fields used for data entry are appropriate for the type of structure being inspected.
2. The written descriptions convey mental images of field conditions consistent with the photographs and sketches of deterioration.
3. The descriptions, photographs, and sketches provide sufficient information for a person not able to physically visit the bridge to make judgments about maintenance activities or structural repairs.

If the member of the Quality Control team finds the report fails these checks, the Quality Control team member may either make the necessary corrections or return the report to the inspector for completion. If the Quality Control team member decides the report is complete, he/she must then decide to take one of three actions based on the findings in the report:

1. Approve the report without making maintenance recommendations
2. Approve the report with maintenance recommendations
3. Forward the report for further review to:
    a. Engineering review
    b. Scour review
    c. Load Rating review

The following criteria should be used to determine when to forward the inspection report to Engineering Review:

1. A condition rating decreased to a 4 or below.
2. An NBE has a combined total of more than 10% in condition state 3 and/or 4.
3. A BME has a combined total of more than 15% in condition state 3 and/or 4
4. Any issue the Quality Control team finds questionable.

The following criteria should be used to determine when to forward the inspection report to Preliminary Bridge Design for Scour Review:

1. The structure is a scour susceptible bridge.
2. Scour is found during the current inspection.
3. Severe channel movement is present that is threatening a bridge substructure element.
4. Any condition the Quality Control team finds questionable.

The following criteria should be used to determine when to forward the inspection report to Load Rating review:

1. There is collision damage to beams since the last inspection with:
    a. exposed strand(s) in prestressed beams;
    b. gouges, tears, or bends in steel beams; or
    c. unrepaired previous collision damage.
2. There is more than 1/16 inch new section loss in steel beams and any additional section loss at an old area.
3. There is new or additional bearing area loss.

4. There is a new deck, new deck overlay, new barrier rails, or bridge widening since the last inspection.
5. There are damaged sign trusses attached to bridges (attachments with exposed anchor bolts, cracks in truss members, truss members with significant section loss).
6. Strengthening of load carrying members has been performed since the last inspection.
7. There are special, posted, or detour bridges.
8. There are wood piling problems (hollow or rotten areas, major splits).
9. The structure is a new bridge.
10. There is movement of substructure units.
11. There is significant concrete deterioration of prestressed beam ends, pier caps and columns, if not previously reported.
12. There is post tensioning of prestressed concrete beam bridges.
13. There is post tensioned retrofit of steel and concrete bridges.

Engineer review or Load Rating review includes reviewing the entire inspection and making recommendations for repair. Recommendations for program work, when needed, should also be completed during an engineer's review. When the review is complete, the engineer will approve the final report.

A Scour review will only review the need for repair of the waterway. When the Scour review is complete, the report will be sent back to the Quality Control team for finalization or further engineer review.

3.4.4 Training

The NBIS requires periodic bridge inspection refresher training for Program Managers and Team Leaders in Part 650.313(g). Iowa DOT has defined periodic as being every 5 years. All State and LPA bridge inspection personnel are required to complete the Bridge Inspection Refresher Training Course every 5 years following the completion of the Safety Inspection of In-Service Bridges Training Course.

The SIIMS system contains an individual's qualifications as a team leader. When an individual's refresher training or professional license is within 6 months of expiring, a notice will appear each time the user logs into SIIMS. This notice will show the date(s) of expiration.

3.5 QUALITY ASSURANCE

The terms quality control and quality assurance are not interchangeable. The NBIS defines quality control as a tool and quality assurance as an evaluation of that tool. SIIMS has built-in quality controls guiding inspectors through data collection and standardize data entry in order to obtain consistent inspection data from multiple inspectors.

Quality assurance is a review of the inspection data to provide the following:

1. An evaluation of how well the quality control tools in SIIMS are delivering consistent inspection data
2. Identification of where the data are not consistent so the quality control tools can be corrected or modified

Iowa DOT employs six inspection teams to perform NBI inspections complying with the NBIS. The supervisor of the inspection teams performs a formal quality assurance review of two teams annually using the criteria described in the following sections.

3.5.1 Team Selection

Two inspection teams are reviewed annually. The six teams are selected in the following 3-year cycle:

- Year 1 = Teams 1 and 4
- Year 2 = Teams 2 and 5
- Year 3 = Teams 3 and 6

3.5.2 Bridge Selection

Four bridges assigned to a team are selected for review, but the bridges should not be selected at random. The bridges should be scheduled for inspection during the calendar year of the review. The age and sufficiency rating should be considered to avoid selecting bridges that are too new to have notable deterioration. The type (SI&A item 43) of the four structures selected must include the following:

1. 402, Steel Continuous Multi-Beam
2. 502, Prestressed Concrete Multi-Beam
3. 201, Concrete Continuous Slab
4. 219, Concrete Continuous Culvert

The size and complexity of the structures should be similar to a number of other bridges of the same type the team inspects.

3.5.3 Quality Assurance Inspections

The supervisor will inspect the selected bridges using an Independent Oversight Model (IOM), which is a quality assurance review generating a bridge inspection independent and without the knowledge of the team under review. The supervisor should review previous inspection reports and plans, prepare sketches, take digital photographs, rate NBI items, complete Bridge Element condition states, and describe deterioration as if he/she were performing the biennial NBI inspection.

3.5.4 Tolerance Thresholds

The supervisor will compare the IOM inspections to the NBI inspection reports the team submits and prepare a summary of any differences between the reports. Specifically, the supervisor should look for consistency in NBI ratings, Bridge Element condition states, sketches, and photographs using the following thresholds established to define if data are in-tolerance or out-of-tolerance:

NBI Tolerances:

1. NBI condition/appraisal ratings are within +/- 1 of the IOM ratings.
2. Subjective NBI lengths (field measurements that may be difficult to exactly duplicate, such as vertical clearances) are within +/- 0.2 feet or +/- 3 inches.
3. Non-subjective NBI lengths (obtained from bridge plans that should not vary, such as the longest span) are within +/- 0.1 feet or +/- 2 inches.

4. Non-subjective NBI quantities (obtained from bridge plans that should not vary, such as the number of spans) are within +/- 0 quantity.
5. Non-subjective NBI descriptive codes (obtained from bridge plans that should not vary, such the type of wearing surface) are within +/- 0.

AASHTO Bridge Elements:

1. Each Bridge Element included in the inspection team's NBI report that does not apply to the bridge should be counted as out-of-tolerance.
2. Each failure to include a Bridge Element in the inspection team's NBI report that does apply to the bridge should be counted as out-of-tolerance.

Condition States for AASHTO Bridge Elements:

1. Bridge Elements where condition state quantities are reported in feet: +/- 10 feet
2. Bridge Elements where condition state quantities are reported in square feet: +/- 25 square feet
3. Bridge Elements where condition state quantities are reported in each: +/- 1

3.5.5 Scoring

Each report will receive a score of up to 100 points. The report score is the sum of points awarded in the following four categories:

1. Condition/Appraisal Ratings = 25 points
2. SI&A Data Items = 25 points
3. AASHTO Bridge Elements = 25 points
4. Supporting Documentation = 25 points

3.5.5.1 Condition/Appraisal Ratings

The supervisor will compare the inspection team's NBI ratings for SI&A items 58 – 62 and 72 to the IOM inspection. The six items will be counted as either in-tolerance or out-of-tolerance. A score will be calculated as follows:

N = number of out-of-tolerance items

Score = (1 - N / 6) * 25 pts.

3.5.5.2 SI&A Data Items

The supervisor will compare the inspection team's values for SI&A items 10, 27, 28, 32 – 36, 41 – 56, and 106 – 108 to the IOM inspection. The 37 values for these items will be counted as either in-tolerance or out-of-tolerance. A score will be calculated as follows:

N = number of out-of-tolerance items

Score = (1 - N / 37) * 25 pts.

3.5.5.3 AASHTO Bridge Elements

The supervisor will count the number of Bridge Elements that are either in-tolerance or out-of-tolerance. A score will be calculated as follows:

N = number of out-of-tolerance elements

T = total number of elements in the IOM inspection

Score = (1 - N / T) * 25 pts.

3.5.5.4 Supporting Documentation

The supervisor will score the inspection team’s photographs; photo descriptions; sketches; Bridge Element text descriptions; and proper use of grammar, capitalization, and sentence structure. Each criterion is worth up to 5 points. An overall score for Supporting Documentation will be calculated by summing the scores for the five aforementioned criteria. Each criterion score shall be based on the following model:

5 = Excellent documentation

4

3 = Minimum acceptable effort

2

1 = Completely unacceptable effort

Points 4 and 2 are to be used where the documentation is judged to fall between the 5, 3, and 1 point scores.

The example provided in Figure 3.5.5.4-1 is intended to provide a scoring guide for Supporting Documentation, but the reviewer must use judgment to decide if the inspection team’s documentation more closely aligns with the excellent or unacceptable end of the rating scale.

Figure 3.5.5.4-2 is a summary scoring sheet for the entire Quality Assurance Review.

Maint. Number: ________________ NBI 90 Date: ____________FHWA Number: ___________

Photographs	
5	Photo or series of photos tells story of deterioration without explanation.
4	
3	All photos are in focus and well lit.
2	
1	Two or more photos are out of focus, blurry, or poorly lit.

Photo Descriptions	
5	Descriptions identify location, orientation of viewer, and/or purpose of photo.
4	
3	Descriptions identify location and/or subject.
2	
1	Two or more photos are not labeled or label is inaccurate.

Sketches	
5	Sketches show deterioration with quantitative information such as dates, dimensions, and numbers.
4	
3	Sketches are legible, initialed, and dated.
2	
1	Two or more sketches are not dated, not initialed, have illegible writing, or are too faint to read.

Bridge Element Text Descriptions	
5	Text descriptions provide context or history of deterioration.
4	
3	Text descriptions are consistent and support the reported condition states.
2	
1	One or more elements have quantities in condition states 2, 3, or 4 without a written description explaining why the condition state is not 1.

Grammar, Capitalization, and Sentence Structure	
5	Text descriptions include concise descriptive sentences that convey a mental image consistent with the photographs and sketches and provide a context.
4	
3	Text descriptions include descriptive sentences that convey a mental image consistent with the photographs and sketches, and may have extra words or wordy descriptions.
2	
1	Text descriptions include run-on sentences, misspellings, or missing punctuation.

Figure 3.5.5.4-1. Supporting Document Review Scoring Guide

Maint. Number: _______________ NBI 90 Date: _____________
FHWA Number: _______________ Total:_____________

<u>Condition/Appraisal Ratings</u> The supervisor will compare the inspection team's NBI ratings for SI&A items 58 – 62 and 72 to the IOM inspection. The six items will be counted as either in-tolerance or out-of-tolerance. A score will be calculated as follows: N = number of out-of-tolerance items Score = (1 - N / 6) * 25 pts.	N	
	Score	
<u>SI&A Data Items</u> The supervisor will compare the inspection team's values for SI&A items 10, 27, 28, 32 – 36, 41 – 56, and 106 – 108 to the IOM inspection. The 37 values for these items will be counted as either in-tolerance or out-of-tolerance. A score will be calculated as follows: N = number of out-of-tolerance items Score = (1 - N / 37) * 25 pts.	N	
	Score	
<u>AASHTO Bridge Elements</u> The supervisor will count the number of Bridge Elements that are either in-tolerance or out-of-tolerance. A score will be calculated as follows: N = number of out-of-tolerance elements T = total number of elements in the IOM inspection Score = (1 - N / T) * 25 pts.	N	
	T	
	Score	
<u>Supporting Documentation</u> The supervisor will score the inspection team's photographs; photo descriptions; sketches; Bridge Element text descriptions; and proper use of grammar, capitalization, and sentence structure using the five scoring criteria tables in Appendix A. Each criterion is worth up to 5 points. An overall score will be calculated by summing the scores for the five criteria.	Photographs	
	Photo Descriptions	
	Sketches	
	Bridge Element Text Descriptions	
	Grammar, Capitalization, and Sentence Structure	
	Score	

Figure 3.5.5.4-2 Summary Score for Quality Assurance Review

3.5.6 Close-out Meeting

The supervisor will schedule a meeting with the inspection teams to review the findings from the IOM inspections and the scores of the team inspections. The meeting should be a constructive discussion to identify gaps in training, training topics that should be repeated or emphasized, expectations that should be revised or clarified, and possible changes to SIIMS.

CHAPTER 4
CONDITION EVALUATION OF BRIDGES
FOR LOCAL PUBLIC AGENCIES

Refer to Iowa DOT I.M. 2.120 for guidelines and procedures for LPAs to assist them in complying with the NBIS.

4.1 INSPECTION PLANNING

4.1.1 Reviewing Past Inspection Reports, SIIMS Data, Existing Bridge Plans, and Bridge Repair Plans

The first step in preparing for any bridge inspection is to gather information regarding the existing bridge so the inspector is educated with regard to the configuration and type of bridge as well as its documented history. This is important so the number of inspection personnel and type of equipment and tools, including non-destructive testing equipment, needed to perform the inspection can be determined. If as-built plans and/or plans of any repairs or rehabilitation projects are available, they should be reviewed to help the inspector gain an understanding of the bridge configuration and structure type as well as to allow the inspector to plan ahead for the access constraints that might affect how the bridge will be inspected. Typically, if existing plans are available, they would be included as part of the bridge's record within the SIIMS database. Another helpful resource is any available shop drawings produced by the contractor or the contractor's fabricators at the time the bridge was originally built or rehabilitated.

In addition to existing plans and shop drawings, the bridge record within SIIMS should also contain past inspection reports for the bridge. Reviewing these past reports not only helps the inspector identify problem areas of the bridge previously documented, but they may also document the progression of damage or deterioration over the course of multiple inspections, thus allowing the inspector to identify trends or problem areas worsening over time. The inspection reports should also include past photographs and field sketches documenting the condition of the bridge.

4.1.2 Determining Required Inspection Documentation and Preparing Needed Sketches

In reviewing the available information for the bridge, the inspector will begin to develop an understanding of the bridge. In preparation for the upcoming bridge inspection, it may be necessary to prepare sketches or tables in advance to be used for documenting current conditions to be more efficient in the field and to more clearly record crucial inspection findings. For example, prior to going into the field for the bridge inspection, a table may be prepared to record bearing and expansion joint movement data, or sketches may be prepared for use in recording crack locations and sizes for the underside surface of the bridge deck or for individual piers or abutments.

4.1.3 Arranging for Access and Other Inspection Equipment

A critical component of any bridge inspection preparation is determining how the bridge components will be accessed during the inspection. In addition, depending on the nature of the bridge components, such as whether the bridge includes fracture critical components requiring arms-length access, the access requirements may require more rigorous planning.

Depending on the size of the bridge and its height above ground level, inspection access could be as simple as ground-level observations. More often than not, ladders, a UBIV, a manlift, or even rope access techniques may be necessary to properly access key bridge components. However, developing an access plan requires careful consideration of the components to be inspected; the topography and features crossed by the bridge that might limit access options; any load restrictions on the bridge; the geometry of the bridge and its sidewalks, bridge rails, and fencing; and a review of whether certain access methods may provide a cost advantage by saving time and labor even at the expense of the equipment costs or rental.

If it is determined that a manlift or UBIV is required to access the bridge components for inspection, advance planning is required to either schedule the equipment, if owned by the LPA, or to determine availability and rent the equipment from an outside source. A variety of UBIV options are available that allow the vehicle reach and the number of rotating turrets to be tailored to the specific constraints of the bridge to be inspected. This may be especially critical for truss bridges, where the ability to maneuver the boom of a UBIV through and between truss members may be dependent on the configuration of the UBIV.

4.1.4 Arranging for Advanced Bridge Washing

It is important that bridge components are free of debris, animal nesting materials, and bird droppings to allow the most efficient use of the inspection team's time in the field. Therefore, coordinating with LPA bridge maintenance personnel in advance of the bridge inspection is important to ensure required bridge cleaning activities are completed before the inspection team arrives at the bridge site. Inspections scheduled during winter months may not allow advanced bridge washing due to freezing conditions. Additionally, some environmental regulations may limit periods when active nests of migratory birds, such as swallows, may be removed.

4.1.5 Executing Any Required Agency Notifications and Permits

Many bridges cross facilities requiring advance notification or permits with other agencies. Bridges over navigable waterways such as the Mississippi and Missouri rivers will require advance notice to the U.S. Coast Guard so barge operators can be advised of the inspection activities, especially if the inspection will require the mechanical arms of a UBIV to be extended below the superstructure of a bridge where it could conflict with barge traffic.

Similarly, bridges over railroads will require notification of the railroads so a UBIV does not conflict with active train traffic. In addition, the use of a railroad flagger will be required to control train movement during bridge inspection activities. If railroad right-of-way must be crossed or used to provide bridge access, the bridge inspector must have a railroad flagger present, and a right-of-access permit may need to be obtained. The railroad must be notified far enough in advance to allow them time to schedule a flagger for the inspection and to obtain the access permit.

If there are any critical utilities mounted on the bridge or crossing the bridge that could cause safety concerns (for example, an overhead high voltage line that needs to be de-energized to avoid conflict with the mechanical arm of a UBIV), advance coordination with the utility may be needed.

4.1.6 Adjusting Work Schedules

As practicable, but still maintaining NBIS compliance with required inspection frequencies, bridge inspections should be performed when weather conditions will have minimal impact on workflow. If possible, inspections for bridges over rivers and streams should be periodically scheduled during low-flow months to allow the best view of components above the waterline. For the most effective inspections, periods of extreme temperature or high winds should be avoided.

The Team Leader should also use his or her best judgment to determine if inspection activities should be suspended due to changing weather conditions. For example, potential exposure to lightning, particularly when working on steel bridges, could be justification for suspending inspection operations to ensure crew safety.

4.2 CONDITION EVALUATION OF NATIONAL BRIDGE INVENTORY (NBI) ITEMS

4.2.1 Appraisal Evaluations

A number of NBI items for bridges are inspected and evaluated for comparison to acceptable standards. For example, various components of bridge approach guardrail are to be inspected to determine if they meet currently accepted standards. Although deterioration or damage should be noted as part of the inspection report, the actual appraisal evaluation of the particular component is based only on whether the configuration and geometry of the component meets current standards.

4.2.1.1 Waterway Adequacy

Waterway Adequacy (NBI Item 71) calls for the inspector's appraisal evaluation of the waterway adequacy; therefore, this item appraises the waterway opening with respect to the passage of flow through the bridge. Appraisal ratings take into account the functional classification of the roadway, the expected frequency of overtopping, and potential traffic delays as a result of overtopping. Table 4.2.1.1 summarizes appropriate appraisal evaluation values for Waterway Adequacy (NBI Item 71).

Table 4.2.1.1. Appraisal Values for Waterway Adequacy

Functional Classification			Description
Principal Arterials – Interstates, Freeways, or Expressways	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local Roads	
Code			
N	N	N	Bridge not over a waterway.
9	9	9	Bridge deck and roadway approaches above flood water elevations (high water). Chances of overtopping remote.
8	8	8	Bridge deck above roadway approaches. Slight chance of overtopping roadway approaches.
6	6	7	Slight chance of overtopping bridge deck and roadway approaches.
4	5	6	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with insignificant traffic delays.
3	4	5	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with significant traffic delays.

Functional Classification			Description
Principal Arterials – Interstates, Freeways, or Expressways	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local Roads	
Code			
2	3	4	Occasional overtopping of bridge deck and roadway approaches with significant traffic delays.
2	2	3	Frequent overtopping of bridge deck and roadway approaches with significant traffic delays.
2	2	2	Occasional or frequent overtopping of bridge deck and roadway approaches with severe traffic delays.
0	0	0	Bridge closed.

4.2.1.2 Approach Roadway Alignment

Approach Roadway Alignment (NBI Item 72) calls for the inspector's appraisal evaluation of the approach roadway alignment; therefore, this item identifies bridges which do not function properly or adequately due to the alignment of the approaches. It is not intended the approach roadway alignment be compared to current standards but rather to the existing highway alignment; therefore, this appraisal differs from other appraisal evaluations. The basic criterion is how the bridge approach alignment relates to the general highway alignment for the section of highway on which the bridge is located. The approach roadway alignment will be rated intolerable (a code of 3 or less) only if horizontal or vertical curvature requires substantial reduction in operating speed from that on the highway section. A very minor reduction in speed will be rated a code of 6, and when a speed reduction is not required, the appraisal code will be an 8. Additional codes may be selected between these general values.

4.2.1.3 Traffic Safety Features (Bridge Railing and Approach Guardrail)

Traffic Safety Features (NBI Item 36) calls for appraisal evaluations of a number of traffic safety features associated with the bridge railing and approach guardrail. Although collision damage and deterioration of the components evaluated in Traffic Safety Features (NBI Item 36) should be noted in the inspection report, the appraisal evaluations for the following items should evaluate only whether they meet current design standards:

- Bridge Railings (NBI Item 36A) – Materials for bridge railing can be concrete, metal, timber, or a combination thereof. Bridge railing should provide a smooth, continuous face of rail on the traffic face, with posts (if applicable) set back from the face of the rail. Structural continuity of the rail members, including anchorages, is essential. The railing system shall be able to resist the applied loads at all locations. Careful attention must be given to the treatment of the railing at the bridge ends. Exposed rail ends, posts, and sharp changes in the geometry of the railing should be rated a zero. The heights of bridge railing shall be measured relative to the reference surface, which shall be the top of roadway, top of future overlay (if future resurfacing is anticipated), or the top of curb (if the curb projection is greater than 9 inches from the traffic face of railing). Bridge railings and traffic portions of combination railing shall not be less than 2 feet 3 inches from the top of the reference surface. Parapets designed with sloping faces intended to allow the vehicles to ride up on them at low contact angles shall be at least 2 feet 8 inches in height. For traffic railings, the maximum clear opening below the bottom rail shall not exceed 17 inches, and the maximum opening between succeeding rails shall not exceed 15 inches. Effective November 20, 2009, the AASHTO Manual for Assessing Safety Hardware defines the standards for approved bridge railing and establishes six test levels for bridge railing based on speed and type of facility.

- Transitions (NBI Item 36B) – The transition section, which extends from the approach guardrail to the bridge railing, acts to stiffen the flexible guardrail as it connects to the rigid bridge railing and it must be firmly attached to the bridge railing. The gradual stiffening of the guardrail system could be done by decreasing the post spacing, increasing the post size, embedding the posts in concrete bases, increasing the guardrail depth (W-beam to Thrie-beam), or a combination of these methods. The ends of curbs and safety walks need to be gradually tapered out or shielded.
- Approach Guardrail (NBI Item 36C) – The approach guardrail must be of adequate length and have the structural qualities to shield motorists from the hazards at the bridge site in addition to being capable of safely redirecting an impacting vehicle without snagging or pocketing an impacting vehicle. Consecutive sections of overlapping guardrail shall be configured with overlaps facing away from the traffic direction. Guardrail shall have a nominal height of at least 27 inches above the reference surface (with a $\pm$ tolerance of 2-inches).
- Approach Guardrail Ends (NBI Item 36D) – The ends of approach guardrail should be flared, buried, shielded (by means of an impact attenuator), or made to break away. If the end of an approach guardrail is buried, it must extend outside the lateral clear zone limits before turning down so as not to launch an errant vehicle.

The three possible codes that may be entered for each of the Traffic Safety Features (NBI Items 36A – 36D) are shown in Table 4.2.1.3

Table 4.2.1.3. Appraisal Values for Traffic Safety Features

Code	Description
0	Inspected feature does not meet currently acceptable standards for safety, or a safety feature is required and none is provided.
1	Inspected feature meets currently acceptable standards.
N	Not applicable, or a safety feature is not required.

4.2.2 General Condition Rating Codes

Condition ratings are used to describe the existing physical state of bridge components as compared to their original as-built conditions. In order to promote uniformity between bridge inspectors, the condition codes used to rate bridge components should characterize the overall condition of the entire component being rated and are not intended to rate localized defects or nominally occurring instances of deterioration or disrepair. Correct assignment of a condition code must, therefore, consider both the severity of the deterioration or disrepair and the extent to which it is widespread through the component being rated. If there are localized defects, the bridge owner should be notified (by means of the inspection report) with recommendations for possible repair, rehabilitation, or retrofits.

The load carrying capacity of the component is not to be used in evaluating condition items. The fact that a bridge was designed for less than the current legal loads, and that the bridge may even be posted, should have no influence on the condition ratings.

The Deck (NBI Item 58), Superstructure (NBI Item 59), Substructure (NBI Item 60), Channel and Channel Protection (NBI Item 61), and Culvert (NBI Item 62) are the items used to describe the general condition ratings of bridges and culverts and are to be updated after each inspection cycle. Therefore, the condition of these items provides a simple snapshot of the current overall condition of a bridge or culvert.

Descriptive conditions used within the text of an inspection report or descriptive labels used in the comment fields for SIIMS should correlate to the numerical rankings described below for NBI Items 58, 59, 60, and 61 based on the deficiencies found for the individual components. The guidelines presented in Table 4.2.2 should be used to group the descriptive conditions for the various components.

Table 4.2.2. Grouping of Descriptive Conditions

Code	Descriptive Condition	Description
7, 8, 9	GOOD	Component defects are limited to only minor problems.
5, 6	FAIR	Structural capacity of the component is not affected by minor deterioration, section loss, spalling, cracking, or other deficiency.
0, 1, 2, 3, 4	POOR	Structural capacity of the component is affected or jeopardized by significant deterioration, section loss, spalling, cracking, or other deficiency.

4.2.2.1 Deck (NBI Item 58), Superstructure (NBI Item 59), and Substructure (NBI Item 60)

The general condition ratings shown in Table 4.2.2.1 shall be used as a guide in evaluating the Deck (NBI Item 58), Superstructure (NBI Item 59), and Substructure (NBI Item 60).

Table 4.2.2.1. General Condition Ratings for Deck, Superstructure, and Substructure

Code	Description
N	NOT APPLICABLE
9	EXCELLENT CONDITION
8	VERY GOOD CONDITION – No problems noted.
7	GOOD CONDITION – Some minor problems.
6	SATISFACTORY CONDITION – Structural elements show some minor deterioration.
5	FAIR CONDITION – All primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.
4	POOR CONDITION – Advanced section loss, deterioration, spalling, or scour.
3	SERIOUS CONDITION – Loss of section, deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present.
2	CRITICAL CONDITION – Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present, or scour may have removed substructure support. Unless closely monitored, it may be necessary to close the bridge until corrective action is taken.
1	IMMINENT FAILURE CONDITION – Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic, but corrective action may put it back in light service.
0	FAILED CONDITION – Out of service; beyond corrective action.

4.2.2.2 Channel and Channel Protection (NBI Item 61)

The general condition ratings shown in Table 4.2.2.2 shall be used as a guide in evaluating Channel and Channel Protection (NBI Item 61).

Table 4.2.2.2. General Condition Ratings for Channel and Channel Protection

Code	Description
N	Not applicable. Use when bridge is not over a waterway (channel).
9	There are no noticeable or noteworthy deficiencies that affect the condition of the channel.
8	Banks are protected or well vegetated. River control devices such as spur dikes and embankment protection are not required or are in a stable condition.
7	Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel have minor amounts of drift.
6	Bank is beginning to slump. River control devices and embankment protection have widespread minor damage. There is minor streambed movement evident. Debris is restricting the channel slightly.
5	Bank protection is being eroded. River control devices and/or embankment have major damage. Trees and brush restrict the channel.
4	Bank and embankment protection is severely undermined. River control devices have severe damage. Large deposits of debris are in the channel.
3	Bank protection has failed. River control devices have been destroyed. Streambed aggradation, degradation, or lateral movement has changed the channel to now threaten the bridge and/or approach roadway.
2	The channel has changed to the extent the bridge is near a state of collapse.
1	Bridge is closed because of channel failure. Corrective action may put it back in light service.
0	Bridge is closed because of channel failure. Replacement is necessary.

4.2.2.3 Culvert (NBI Item 62)

The general condition ratings shown in Table 4.2.2.3 shall be used as a guide in evaluating a Culvert (NBI Item 62).

Table 4.2.2.3. General Condition Ratings for Culvert

Code	Description
N	Not applicable. Used if structure is not a culvert.
9	No deficiencies.
8	No noticeable or noteworthy deficiencies that affect the condition of the culvert. Insignificant scrape marks caused by drift.
7	Shrinkage cracks, light scaling, and insignificant spalling that 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.

Code	Description
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 that 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 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 is closed. Corrective action may put it back in light service.
0	Bridge is closed. Replacement is necessary.

4.3 SIIMS

4.3.1 About SIIMS

The Structure Inventory and Inspection Management System (SIIMS) is the single-source location for entering and reviewing condition information for all Iowa bridges, both State owned and locally owned. In order to use SIIMS and other applications hosted on State web servers, a user must first obtain a State of Iowa Enterprise A & A account I.D. and password. In addition, a user must be registered in SIIMS by completing a form for a Bridge Owner, Bridge Inspector, Bridge Load Rating Engineer, or Bridge Data Entry Personnel. Individuals who do not qualify for any of these levels of access must complete a form for Bridge Information. The various permission levels control the level of access provided within the system.

SIIMS has the ability to track all keystrokes made within the system based on the user. In this way, the software can determine the source of any information changed or edited within the system. For this reason, it is important a user does not share his/her user I.D. or password with anyone else.

The architecture of the SIIMS software includes several modules. There are two modules that will be used by most users: a Manager module and a Collector (or Inspector) module. The Manager module or Collector module are accessed through the main menu items listed at the top of the screen after initial log in. Access to items under the Manager or Collector modules is controlled by user permissions at the log in.

4.3.2 Manager Module Menu in SIIMS

The Manager's module is geared toward Program Managers for bridge inspection programs at either the State or local level. Access to the Manager module menu is limited based on permissions granted. For example, the Program Manager for a local agency may be granted permission to access bridge inspection data only for bridges under his/her jurisdiction. Functions within the Manager's module of the software include queries to search for data, photographs, or descriptions in inspection reports for which the manager may have permission. It also includes mapping options (for example, to display all bridges within a particular county), and it has the ability to provide system reports used to support funding decisions for a local agency's bridge program.

4.3.3 Collector (Inspector) Module Menu in SIIMS

The Collector module menu allows an inspector to filter and view the bridge inspection report status, workflows and upcoming inspections. Access to the Collector module menu is limited based on permissions granted. For example, an inspector for a local agency will only be granted permission to access bridge inspection information for bridges under the jurisdiction of the given local agency. The Collector module menu allows inspectors to organize and view the bridges they are tasked with inspecting.

4.3.4 Bridge File

Bridge owners are required to maintain a complete, accurate, and current record of each bridge under their jurisdiction, either electronically or hard copy, in accordance with the AASHTO Manual for Bridge Evaluation. The components of a complete bridge record are listed in the AASHTO Manual for Bridge Evaluation. Many of the items listed will be included in SIIMS for each bridge. Bridge owners are encouraged to include electronic copies of as many of these items in SIIMS as practicable. See I.M. 2.120 for details on required items for a Bridge File.

4.4 FIELD DATA ITEMS IN SIIMS

For LPA bridges not located on the NHS, element-level reporting of condition states for bridge components is not required by the NBIS. As a result, LPAs should evaluate the various field data using a condition evaluation scale similar to the values shown in Table 4.2.2.1 for Deck, Superstructure, and Substructure components; Table 4.2.2.2 for Channel and Channel Protection components; or Table 4.2.2.3 for Culvert components.

4.4.1 Deck Inspection

Concrete decks should be inspected for cracking, spalling, potholes, efflorescence, leaching, delamination, exposed reinforcing steel, and full or partial depth failures. If the concrete deck consists of partial- or full-depth pretensioned panels, it should also be inspected for failures at the pretension and post-tension anchor zones, failures of grout-fill joints between panels, and failures of bearing edges along supporting beams.

Steel grid decks should be inspected for corrosion, broken welds, broken or damaged bearing bars or cross bars, and section loss.

Timber decks should be inspected for splits; checks; broken planks; crushing; excessive wear; rot; and loose, broken, or missing fasteners.

The overall condition rating of the Deck (NBI Item 58) shall be coded as shown in Table 4.2.2.1. For culverts or other structures without a deck, such as a corrugated metal structural plate arch bridge, code N (not applicable) should be used for NBI Item 58. Decks integral with the superstructure, such as for a cast-in-place box girder bridge or a concrete T-beam bridge, shall be rated for the deck only, and the superstructure condition of the integral deck-type bridge should not influence the deck rating. Deck field notes are to be maintained in the remarks field of the items described below or in the General Comments field.

4.4.1.1 Wearing Surface

Wearing surfaces for protecting bridge decks may include flexible materials such as asphaltic concrete, semi-rigid materials such as an epoxy concrete overlay, or rigid materials such as a low slump concrete overlay. The wearing surface should be inspected for spalls, delaminations, patched areas, potholes, cracks, and overall effectiveness. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the wearing surface; the condition should be coded "N" if there is no wearing surface.

4.4.1.2 Deck – Structural Condition

The structural condition of concrete decks should be inspected for cracking, spalling, potholes, Rust staining, efflorescence, leaching, delamination, exposed reinforcing steel, and full or partial depth failures. Evidence of deterioration to reinforcing steel should be examined closely to determine its extent. The extent of spalling and delamination can be determined by hammer sounding, chain dragging, or rotary percussion sounding. Hollow sounding areas should be mapped and recorded. Any rutting or wear that may result in reduced skid resistance should be noted. The underside of the deck should be examined for indications of efflorescence or water passing through cracks. Any loose concrete that could fall on vehicles or pedestrians should be removed.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall structural condition of the deck.

4.4.1.3 Curbs

Concrete curb sections, including concrete barrier rails, should be examined for cracking, spalling, delamination, impact damage, overall condition, and alignment. Cracking in the face of curbs or barrier rails could result from shrinkage cracking, reflective cracking at barrier rail vertical reinforcing, or structural cracking. Any exposed or corroding reinforcing steel should be documented. Precast concrete parapet or barrier rail elements should be checked for evidence of active water leakage between the parapet and deck causing corrosion and potential failure of anchorages.

Timber wheel guards, including riser blocks, should be checked for splits, checks, and decay. In addition, wheel guards should be checked to determine if they are bolted securely in place.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the curbs; the condition should be coded "N" if there are no curbs.

4.4.1.4 Median

Raised concrete medians often are non-structural toppings to the bridge deck but may show signs of deterioration, such as cracking, scaling, spalling or impact damage from snow plows. Raised medians that are structural deck elements intended to support vehicle loads should be evaluated for their load carrying capabilities. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the median; the condition should be coded "N" if there is no median.

4.4.1.5 Sidewalks

Concrete sidewalks should be examined for cracking, scaling, spalling, potholes, or delamination. Sidewalks should be evaluated for compliance with requirements of the Americans with Disabilities Act with respect to accessibility compliance and safety items such as tripping hazards, potential for ponding of water or ice, and condition of walking surface. A condition rating (0 – 9) should be assigned on the

Field Data Collection Form in SIIMS to describe the overall condition of the sidewalks; the condition should be coded "N" if there are no sidewalks.

4.4.1.6 Railings

Bridge railings should be evaluated for their condition and for their adequacy of geometry and structural capacity. The face of railing exposed to traffic shall be smooth and continuous. The inspector should be familiar with the railing requirements of the bridge owner. Metal railings should be inspected for corrosion damage, loose or broken components, and impact damage. Connections should be inspected for loose or missing bolts or rivets and for broken welds. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the railings; the condition should be coded "N" if there are no railings.

4.4.1.7 Paint

For painted railing components, the coating should be examined for chalking, fading, or peeling. The condition of the paint coating should be documented. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the paint coating; the condition should be coded "N" if there is no paint coating on the rails.

4.4.1.8 Drains

The inspector should determine if drains are functioning properly, ideally under wet weather conditions. Any clogged drain scuppers, missing drain grates, or water ponding should be noted. Drains and downspout piping connections should be examined to confirm connections are intact and water is being properly discharged away from the structure. Any corrosion or holes in downspout piping should be noted. In addition, any erosion or undermining at drain outfalls should be noted. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the drains; the condition should be coded "N" if there are no drains.

4.4.1.9 Utility Connections

Utility connections and supports should be examined for proper function under expansion and contraction. Any discontinuities in conduit, exposed wiring, or missing junction box covers should be noted. The inspector should be aware of the type of utilities present on a bridge and the nature of the hazards present during inspection.

Utilities are frequently retrofitted on bridges, and the nature of the retrofit should be inspected for the presence of improper welding techniques or welds to tension members, which may create fatigue-sensitive conditions. Any utility deficiencies should be reported promptly since the bridge inspector may be the first person to report a utility failure and the utility owner may not be aware of a problem. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the utility connections; the condition should be coded "N" if there are no utilities.

4.4.1.10 Joint Leakage

The inspector should note drainage leaking through open joints, cracks, or spalls in the curbs, parapets, or other elements where leakage is not intended. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the degree of joint leakage; the condition should be coded "N" if this item does not apply.

4.4.1.11 Expansion Joints and Devices

It is good practice to measure and record joint openings between identifiable locations so the opening width can be checked during future inspections to establish a record of joint movement over time. The ambient temperature and the time of day for the measurement should be documented. The inspector should look for proper joint alignment, the condition of any joint glands or seals (if present), and evidence of spalls in the slab edges adjacent to joint armoring. In addition, the inspector should listen for audible sounds of joint damage under traffic loading. Joints should be inspected from the bridge deck and from below to determine the condition of joint supports and to detect leakage. Where drainage troughs are provided under open joints, the inspector should check for build-up of debris in troughs that could prevent proper drainage or impede joint movement.

Sealed joints such as strip seals should be inspected for debris in the neoprene glands, tears, and separation of the gland from the steel extrusions. For bolt-down reinforced elastomeric joints, the inspector should check for missing anchor bolt covers, broken anchor bolts, separation of joint elements, and audible sound of loose panels under traffic. The undersides of modular joints should be inspected for evidence of weld cracking between support bars and joint extrusions, as well as for equal movement gaps between adjacent extrusions.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the expansion joints and devices; the condition should be coded “N” if there are no expansion joints or devices.

4.4.2 Superstructure Inspection

Superstructure members should be inspected for signs of distress, which may include horizontal or vertical displacement of components affecting structure stability, excessive deflection, cracking, deterioration, section loss, collision damage, or overload damage.

An overall condition rating of the Superstructure (NBI Item 59) shall be provided as shown in Table 4.2.2.1. Code “N” should be used for all culverts. On bridges where the deck is an integral part of the superstructure (such as concrete T-beams, where the deck is cast with the beams), the superstructure rating may be affected by the deck condition. If the deck is an integral part of the superstructure, the superstructure rating should not be higher than the deck rating. Both ratings should be the same for concrete slab bridges.

The condition of bearings, joints, and paint system should not be included in superstructure condition rating except in extreme situations, but should be noted in the remarks. FCMs should receive careful attention since their failure could lead to collapse of a span or the bridge.

Superstructure field notes are to be maintained in the remarks field of the items described below or in the General Comments field.

4.4.2.1 Bearing Devices

Bridge bearings transmit the superstructure loads to the substructure elements and allow for rotation at fixed bearings, and rotation and movement at expansion bearings. Steel components of bearings should be checked for corrosion that would limit or restrain intended movements. Elastomeric bearings should be checked for abnormal flattening or shear deformation, bulging, or splitting. High load/multi-rotation bearings, such as pot bearings and disc bearings, should also be checked for proper seating of components with respect to each other; weld cracks; and wear, binding, and deterioration of guide bars. In addition, bearings should be checked for proper alignment and orientation for the ambient temperature, loose or broken anchor bolts, any movement of components under heavy truck load (which may indicate an uplift condition), and excessive dirt or debris that could restrict movement. Bearing pedestals should be checked for concrete spalling that could indicate high edge loading conditions.

When inspecting expansion bearings, it is good practice to document the positions of the bearings by measuring either the offset from a neutral position or the angle of inclination from plumb so it can be determined if the bearings are working properly with respect to thermal bridge movements (see Figures 4.4.2.1-1 through 4.4.2.1-5). When documenting the position of the bearings, it is important to note the temperature at which the measurements were taken to indicate if the temperature is above or below the neutral temperature, and the time of day to indicate whether the temperature is rising or falling.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the bearings; the condition should be coded "N" if there are no bearings.

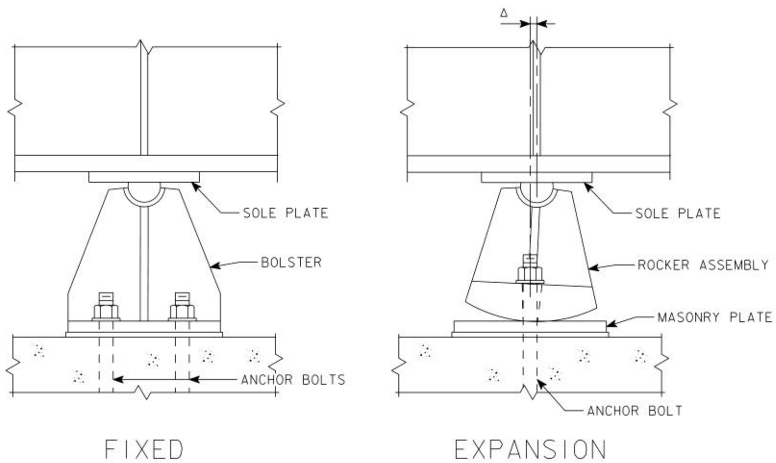


Figure 4.4.2.1-1. Steel Fixed Bolster and Steel Rocker Bearings

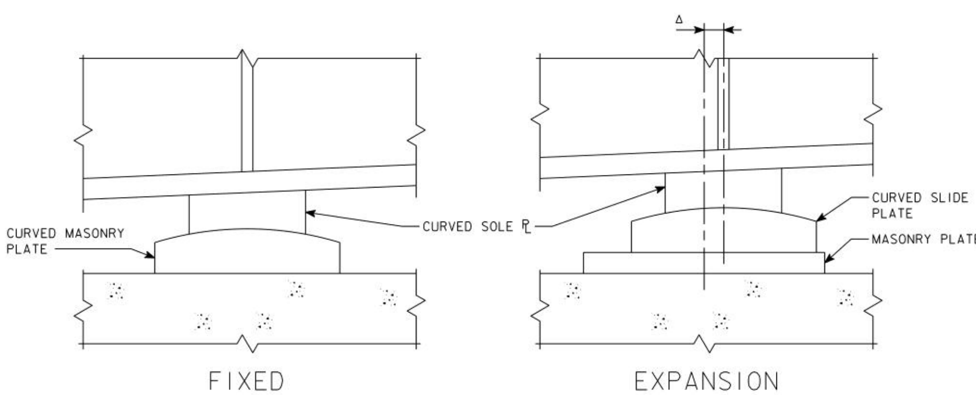


Figure 4.4.2.1-2. Steel Sliding Plate Bearings

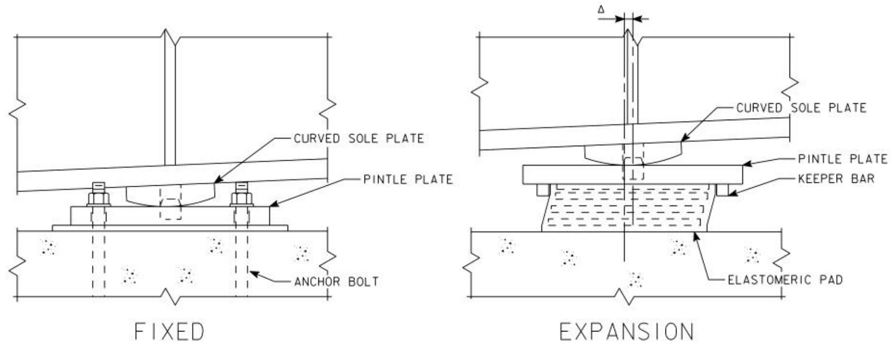


Figure 4.4.2.1-3. Pintle Plate & Pintle Plate with Elastomeric Pad Bearings

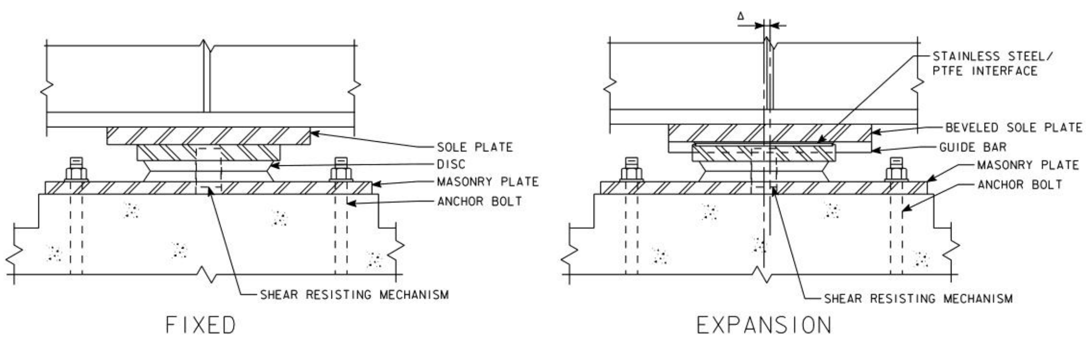


Figure 4.4.2.1-4. Disc Bearings

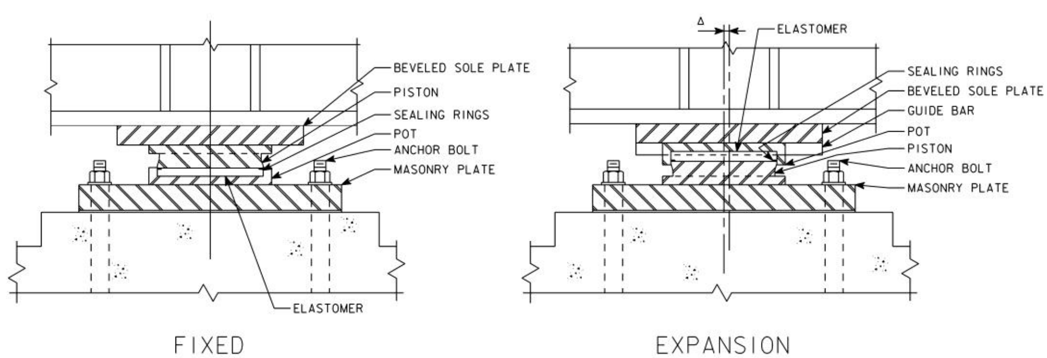


Figure 4.4.2.1-5. Pot Bearings

4.4.2.2 Stringers

For steel stringers, inspection should include checking for paint failure, corrosion, section loss, evidence of fatigue or fracture, evidence of overload, and connection damage. At areas of section loss, a D-meter or calipers should be used to determine the thickness of steel remaining. For stringer connections where the stringer is connected to a floorbeam or other element with clip angle connections, the clip angle connections should be examined, especially where the connections may be subject to deterioration from leaking expansion joints above the connection. For stringers resting on the top flange of floorbeams, the anchor bolts connecting the stringer to the floorbeam should be checked to determine whether they are intact.

For concrete stringers, typical defects to check for include scaling, delamination, spalling, cracking, and honeycombing. With most of these defects, the damage to the concrete may, in turn, cause deterioration and loss of section to the accompanying reinforcing steel. Exposed reinforcing steel should be measured to determine the section remaining. High shear stress areas should be checked near supports for diagonal shear cracking and near midspan areas for flexure cracks oriented perpendicular to the tension flange.

When inspecting timber stringers, the inspector should visually inspect for checks, shakes, knots, splitting, crushing, decay, insect attack, natural defects, fire damage, overstress, or delamination (for Glulam members). Physical testing typically includes sounding with a hammer to determine areas of decay or rot, penetration tests with a pick, or core drilling to determine limits and extents of rot. In addition, fastener locations should be checked where the protective barrier created by preservative treatment is compromised.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the stringers; the condition should be coded “N” if there are no stringers.

4.4.2.2.1 Lateral Support

The load capacity for stringers supporting a steel, timber, or concrete deck may be controlled by the unbraced length of the compression flange for the stringer. If plans are not available, the inspector should document whether the stringers are braced at support locations, note the spacing of intermediate lateral supports (if provided), and document the depth of the lateral bracing members with respect to the overall depth of the stringer. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the stringer lateral supports; the condition should be coded “N” if there is no lateral support.

4.4.2.3 Girders/Beams

Inspection of steel, concrete, and timber girders/beams would focus on the same features as described for stringers as noted in Section 4.4.2.2. In contrast to steel stringers, which often consist of rolled sections, steel girders/beams are more likely to be built-up welded or riveted members. Therefore, the inspection of steel girders/beams would require more emphasis on the connecting welds and rivets of these built-up members as well as fatigue cracks, which may initiate near weld terminations or other stress risers. In addition, for built-up riveted members, there is a higher tendency for pack rust to form between individual components of the built-up members. Girder and beam members are also more likely to incur impact damage; therefore, this type of deterioration should be documented during the inspection.

For steel bridges, if only two primary girder/beam members are present per span, the bridge lacks load path redundancy. These members would be considered FCMs. FCMs require inspection from an “arms-length” distance.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the girders/beams; the condition should be coded “N” if there are no girders/beams.

4.4.2.3.1 Lateral Support

The load capacity for girders supporting a steel, timber, or concrete deck may be controlled by the unbraced length of the compression flange for the girder. If plans are not available, the inspector should document whether the girders are braced at support locations, note the spacing of intermediate lateral supports (if provided), and document the depth of the lateral bracing members with respect to the overall depth of the girder.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the lateral supports for girders/beams; the condition should be coded "N" if there is no lateral support.

4.4.2.4 Floorbeams

Inspection of steel, concrete, and timber floorbeams would focus on the same features as described for stringers as noted in Section 4.4.2.2. In contrast to steel stringers, which often consist of rolled sections, steel floorbeams are more likely to be built-up welded or riveted members. Therefore, the inspection of steel floorbeams would require more emphasis on the connecting welds and rivets of these built-up members. Also with built-up riveted members, there is a higher tendency for pack rust to form between individual components of the built-up members.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the floorbeams; the condition should be coded "N" if there are no floorbeams.

4.4.2.4.1 Lateral Support

The load capacity for floorbeams may be controlled by the unbraced length of the compression flange for the floorbeam. If plans are not available, the inspector should document whether the floorbeams are braced at intermediate locations between supports by stringers. If the top flange of a floor beam is in contact with the deck, it is considered fully braced.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the lateral supports for floorbeams; the condition should be coded "N" if there is no lateral support.

4.4.2.5 Trusses – General

Trusses consist of members acting primarily in tension or compression. Steel compression members should be examined to confirm they are straight, with no bows or kinks, so as not to introduce eccentric loading into the members. In addition, connections should be checked to ensure that they are intact. Steel tension members in trusses are generally FCMs as are gusset plates; therefore, they shall be inspected at "arms length." The inspector should carefully check weld locations, material flaws, changes in member cross section, or other potential stress risers in tension members that could initiate the formation of a crack. Looped rod tension members and eyebars should be closely examined for cracking in the loop or eyebar areas. For these members made up of multiple loop rods or eyebars, the inspector should check to ensure that all components equally share the tensile load. For pin-connected trusses, the inspector should check the condition of pins and ensure that nuts and spacers are in place. In addition, the inspector should check for broken, loose, or missing rivets, bolts, or nuts. Gusset plates should be inspected for signs of distortion from overload. The paint condition, corrosion, and section loss of members, particularly riveted built-up members that may trap moisture between connected components, should be documented. At areas of section loss, the thickness of members should be measured with calipers or a D-meter to determine the thickness remaining.

For timber trusses, timber members should be inspected for checks, splits, cracks, insect damage, and decay. The inspector should carefully check joints for decay where there are contact surfaces where moisture can be trapped or enter around holes for bolts or truss rods. The inspector should check for evidence of crushing at ends of compression members. At end panel joints, where the timber members may come in contact with the ground or trap dirt and debris, the inspector should check for decay and rot. In addition, the inspector should check connections for loose, broken, or missing bolts or nuts. For covered bridges, roofs and sides should be investigated to ensure they are protecting structural members from the elements. Any fire hazards, which need to be corrected to safeguard the structure, should be reported.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the truss; the condition should be coded "N" if this field does not apply.

4.4.2.5.1 Portals

Portal bracing members between lines of trusses are usually the members with the most restrictive vertical clearance. These members should be checked for impact damage. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the portal members; the condition should be coded "N" if there are no portals.

4.4.2.5.2 Bracing

All upper and lower bracing members should be checked for damage and to observe if they are properly adjusted and functioning correctly; lateral and sway bracing should be observed under live load to confirm proper function. Connection gusset plates for lateral and sway bracing members may easily trap the nesting material of birds or other debris, thus retaining moisture and promoting corrosion and section loss. The condition of connections and any section loss of rivets, bolts, gusset plates or structural members should be documented. Connection plates of lateral bracing and sway bracing should be checked for fatigue cracking due to wind or live load induced vibration. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the truss bracing; the condition should be coded "N" if there is no truss bracing.

4.4.2.6 Paint

The paint coating of steel members should be inspected for chalking, peeling, and overall effectiveness. Generally, chalking is the first indication that the paint system is beginning to fail. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the paint; the condition should be coded "N" if there are no painted members.

4.4.2.7 Rivets or Bolts

Rivets and bolts should be examined to document loose, broken, or missing rivets, bolts, or nuts. In heavily corroded areas, the loss of rivet or bolt heads due to corrosion should be documented. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of rivets and bolts; the condition should be coded "N" if there are no rivets or bolts.

4.4.2.8 Welds – Cracks

Particularly in tensile zones of members or for members fully in tension, welds should be examined for cracks or poor workmanship. Tack welds, temporary fit-up welds, and field welds in tension members should be carefully examined. The inspector should check for instances of intersecting welds in tensile zones, which could provide stress risers. Weld cracks found in tension zones may require nondestructive testing methods, such as dye penetrant testing or magnetic particle testing, to determine the termination point of the crack. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of welds; the condition should be coded "N" if there are no welds.

4.4.2.9 Steel Corrosion

Corroded steel members may require removal of rust build-up by hammering or scraping to determine extents of section loss. The inspector should document if rust corrosion is surface corrosion only, rust with section loss, or pack rust. In addition, the inspector should document the locations of defects and the extent of rust, and should measure the remaining steel thickness. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall severity of steel corrosion; the condition should be coded "N" if this data field does not apply.

4.4.2.10 Timber Decay

Inspection for timber decay should include physical testing, typically by hammer sounding or penetration tests with a pick or core drill, to determine extents of sound timber cross section remaining. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall severity and extent of timber decay; the condition should be coded "N" if this data field does not apply.

4.4.2.11 Concrete Cracking

Documentation of concrete cracking should include a description of the crack location, width of crack, and length of crack. Feeler gauges or wallet-sized transparent cards with various crack width comparison gauges are available for estimating crack widths. The inspector should note the location and nature of the crack, such as whether the crack is a diagonal crack radiating upward toward midspan from a support location (shear crack) or if it is a crack beginning at and oriented perpendicular to the tension side of the member near midspan (positive moment flexure crack). A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall severity and extent of the concrete cracking; the condition should be coded "N" if this data field does not apply.

4.4.2.12 Collision Damage

All vehicular collision damage or flood debris impact to superstructure members should be noted. In addition, the extents of damage, particularly deterioration that could affect the public safety or the load carrying capacity of the bridge, should be documented. This might include severed prestressing strands of concrete beams, torn bottom flanges of steel beans, or torn elements of truss members. Documentation should be supplemented with nondestructive testing, if required, to determine the remaining usable section properties of damaged members. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall severity and degree of collision damage; the condition should be coded "N" if this data field does not apply.

4.4.2.13 Deflection Under Load

Excessive superstructure deflection under load could indicate failure of a critical member. The inspector should sight along barrier rails of the bridge or check bridge expansion joints to observe for unusual deflection of the bridge superstructure or possible substructure settlement. In addition, the inspector should watch for localized deflection of members, which could indicate a connection failure. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall extent of deflection under load.

4.4.2.14 Alignment of Members

The inspector should watch for misalignment of members that could be caused by an overload condition or localized failure. Gusset plates should be checked for distortion or misalignment. A condition rating

(0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of member alignment.

4.4.2.15 Vibration Under Load

Although all bridges will tend to vibrate to some degree, the inspector should take note of excessive vibrations under load. In addition, the inspector should listen for audible rattles or banging of members that could be indicative of damaged or loose members, such as lateral bracing, expansion joints, or bearings not in full contact with structural members. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall extent of vibration under load.

4.4.3 Substructure Inspection

All substructure elements should be inspected for visible signs of distress, including evidence of cracking, section loss, settlement, misalignment, scour, collision damage, overload conditions, and corrosion. Integral abutment wingwalls to the first construction or expansion joint shall be included in the evaluation for abutments. For non-integral superstructure and substructure units, the substructure shall be considered the portion below the bearings. For structures where the substructure and superstructure are integral, the substructure shall be considered as the portion below the superstructure.

An overall condition rating of the Substructure (NBI Item 60) shall be provided as shown in Table 4.2.2.1. Code “N” should be used for all culverts. The substructure condition rating should be made independent of the condition ratings for the deck and superstructure.

For scour critical bridges, the scour conditions may substantially affect the overall condition of the substructure. When NBI Item 113, Scour Critical Bridges, is coded 2 or less, the Substructure rating (NBI item 60) must be coded with the same value as NBI Item 113.

Substructure field notes are to be maintained in the remarks field of the items described below or in the General Comments field.

4.4.3.1 Abutments

4.4.3.1.1 Caps

The horizontal surfaces on the tops of the beam seats are particularly vulnerable to deterioration due to the road debris and chloride-laden runoff that may be deposited on the cap from open or failed expansion joints. For concrete abutments, cracking, spalling, and corrosion of reinforcing steel in the concrete cap should be documented. Areas around bridge bearings should be checked for spalls or cracks from the concentrated bearing loads. For timber abutment caps, the inspector should look for rot and decay of the timber cap in addition to any splits, checks, or shakes. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the abutment caps; the condition should be coded “N” if there are no caps.

4.4.3.1.2 Wings

The inspector should check for lateral movement of the wingwalls (rotation, bulging, sliding, or shifting) as well as settlement. Such movements may cause cracking in concrete wingwalls, broken timber wingwall planks, buckled steel sheet pile, or distress at the interface with the abutment cap and backwall. Wingwall movement or settlement may also be caused by stream scour. Ends of wingwalls should be checked for erosion damage, which may allow for roadway runoff to be trapped behind the wingwalls and create saturated soil conditions increasing the soil loads on wingwalls. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the abutment wings; the condition should be coded “N” if there are no wings.

4.4.3.1.3 Backwall

The backwall should be examined for signs of crushing or cracking from deck pressure against the backwall. The inspector should also check abutment backwalls for rotation or bulging from unbalanced earth loads. For concrete backwalls, the inspector should look for cracks, spalling, or efflorescence stains. In addition, the tops of concrete backwalls should be examined for scaling and concrete deterioration from chloride-laden bridge runoff and mechanical action of approach slab rotation. For timber plank backwalls, the inspector should look for broken or split planks, and for steel sheet pile backwalls, the inspector should look for buckled sheet piles. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the abutment backwalls; the condition should be coded “N” if there are no backwalls.

4.4.3.1.4 Footing

Abutment footings should be investigated for evidence of scour or undercutting. The inspector should document if the ground line has been scoured or eroded below the bottoms of the footings. The areas around spread footings should be probed for scour holes, and footings should be observed for signs of settlement. Cracks or spalling in concrete footings should be documented. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the abutment footings; the condition should be coded “N” if there are no footings or the footings are not visible.

4.4.3.1.5 Piles

The inspector should document if piles are exposed below the bottom of the abutment footing. Piles should be checked for damage from flood debris. The inspector should document the vertical alignment of piles if excessive unbalanced soil load at abutment or scour has caused the abutment to rotate or slide. For steel piles showing signs of corrosion loss, the thickness of pile flanges and web should be measured to determine the thickness of steel remaining. Timber piles should be sounded with a hammer and probe as necessary to detect and measure for rot or decay, especially in zones alternately wet and dry. Cracks or spalls in concrete piles should be noted. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the abutment piles; the condition should be coded “N” if there are no piles or the piles are not visible.

4.4.3.1.6 Erosion

Particularly for bridges on dirt or gravel roads in which no approach slabs are provided, the approach roadway adjacent to the bridge backwall and wingwalls should be examined for erosion holes or signs of settlement that may indicate loss of soil behind the abutment. Ends and exposed faces of wingwalls should be checked for erosion where bridge or side ditch runoff could cause erosion problems around the abutment. Abutments should be examined for distress due to stream erosion. The inspector should check for erosion near abutments where deck drains outlet onto the bridge berms. The condition of scour and erosion countermeasures such as channel armoring or riprap adjacent to the abutment or wingwalls should be documented. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition with respect to abutment erosion.

4.4.3.1.7 Settlement

Footing settlement from scour or undercutting is discussed in Section 4.4.3.1.4, above. The inspector should check for localized settlement of abutment due to erosion from roadway side ditches or outlets from bridge scuppers. Settlement, particularly for abutments on spread footings, could also be caused by overload conditions. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition with respect to abutment settlement; the condition should be coded “N” if there is no settlement noted.

4.4.3.2 Piles or Bents

4.4.3.2.1 Caps

For piers located under bridge expansion joints, pier caps are particularly vulnerable to deterioration due to the road debris and chloride-laden runoff that may be deposited on the cap from open or failed expansion joints. For concrete pier caps, cracking, spalling, and corrosion of reinforcing steel should be documented. Areas around bridge bearings should be checked for spalls or cracks from the concentrated bearing loads. For timber pier caps, the inspector should look for crushing at beam bearing areas, rot, decay of the timber cap, and any splits, checks, or shakes. Steel bent caps should be checked for corrosion loss. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the pier caps; the condition should be coded “N” if there are no caps.

4.4.3.2.2 Columns

Pier columns should be checked for lateral movement or tilt that could be caused by unbalanced soil loads or locked-up bearing devices. The inspector should document cracks, spalls, and corrosion of reinforcing steel for concrete pier columns, especially columns under bridge expansion joints, columns exposed to bridge scupper outlets or columns exposed to salt spray from adjacent roadways. For steel columns, the inspector should document any corrosion and measure for section loss as required. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the pier columns; the condition should be coded “N” if there are no piers.

4.4.3.2.3 Footings

If pier footings are exposed, concrete footings should be checked for cracks, spalls, or corrosion of reinforcing steel. Footings should be checked for signs of settlement. Exposed pier footings could also be indicative of unexpected scour or erosion. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the pier footings; the condition should be coded “N” if there are no footings or the footings are not visible.

4.4.3.2.4 Piles

The inspector should document if piles are exposed below the bottom of the pier footing. For pile bents, piles should be checked for damage from flood debris or deterioration at the waterline. The inspector should document the vertical alignment of pile bents if unbalanced soil load at pier or scour has caused the pier to rotate or tilt. For steel piles showing signs of corrosion loss, the thickness of pile flanges and web should be measured to determine the thickness of steel remaining. Timber piles should be sounded with a hammer and probe as necessary to detect and measure for rot or decay, especially in zones alternately wet and dry. Cracks or spalls in concrete piles should be noted. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the pier piles; the condition should be coded “N” if there are no piles or the piles are not visible.

4.4.3.2.5 Scour

For piers located in water, evaluation for effects of scour may need to be performed by means of an Underwater Inspection. Underwater Inspection should probe and use tactile methods to determine extents of scour holes adjacent to the pier footing. Underwater Inspection should also check for the scour effects on concrete footings by noting any loss of cement paste or spalls discovered below the water line.

For piers exposed to scour only during high water events, inspections should be scheduled during low flow events, if possible, to document the condition of scour countermeasures or any scour effects on the pier.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of scour at the piers; the condition should be coded "N" if this field does not apply.

4.4.3.2.6 Settlement

The inspector should sight along bridge rails to detect any settlement at pier locations. For suspected settlement conditions, the suspected pier should be further investigated to determine the cause and extents of settlement. For suspected settlement, the inspector should consider mounting a survey target on the top of the pier to allow monitoring of the pier settlement over time. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition with respect to pier settlement.

4.4.3.3 Concrete Cracking

Documentation of concrete cracking for substructure members should include a description of the crack location, width of crack, and length of crack. Feeler gauges or wallet-sized transparent cards with various crack width comparison gauges are available for estimating crack widths. For abutment or pier caps, the inspector should note the location and nature of the crack, such as whether the crack is a diagonal crack radiating upward toward midspan from a support or column location (shear crack) or if it is a crack beginning at and extending perpendicular to the tension side of the cap near midspan (positive moment flexure crack). A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall severity with respect to concrete cracking; the condition should be coded "N" if this data field does not apply.

4.4.3.4 Steel Corrosion

Corroded steel members may require removal of rust build-up by hammering or scraping to determine extents of section loss. The inspector should document if rust corrosion is surface corrosion only, rust with section loss, or pack rust. In addition, the inspector should document the location of defects and the extent of rust, and should measure the remaining steel thickness. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall severity of steel corrosion; the condition should be coded "N" if this data field does not apply.

4.4.3.5 Timber Decay

Inspection for timber decay should include physical testing, typically by hammer sounding or penetration tests with a pick or core drill, to determine extents of sound timber cross section remaining. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall severity with respect to timber decay; the condition should be coded "N" if this data field does not apply.

4.4.3.6 Debris on Seats

Particularly under open or leaking bridge joints, road debris may build up on abutment and pier beam seats and cap beams. Build-up of pigeon nesting material or excrement can also obscure the clear view of cap elements and hinder inspection procedures. All such types of debris have a tendency to hold moisture and promote concrete deterioration, corrosion of steel, and decay of timber members. Prior to initiating inspection operations, bridge cleaning efforts should be initiated by maintenance crews to allow for the most efficient use of the inspector's time and allow for a thorough inspection. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall severity with respect to debris on the seats; the condition should be coded "N" if this data field does not apply.

4.4.3.7 Paint

The paint coating of steel substructure members should be inspected for chalking, peeling, and overall effectiveness. Generally chalking is the first indication that the paint system is beginning to fail. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the paint coating; the condition should be coded "N" if there are no painted members.

4.4.3.8 Collision Damage

Bridge substructure members located adjacent to active roadways may encounter collision damage from an errant vehicle. Damaged members should be thoroughly checked, and impact damage such as concrete spalls or cracks and bent or cracked steel members should be documented. Immediate action should be taken if public safety is in question or if there is a question regarding substructure stability. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall severity of the collision damage; the condition should be coded "N" if there is no collision damage.

4.4.4 Culvert Inspection

A culvert with an opening greater than 20 feet as measured along the center of the roadway is considered a bridge-sized structure and is subject to NBIS requirements. Similarly, a grouping of culverts with a length greater than 20 feet as measured along the roadway centerline, and where the clear distance between openings is less than half the smaller contiguous opening, is considered a bridge-sized structure.

Culverts should be inspected for their overall condition, any approach roadway and embankment settlement, the condition of their end treatments (headwalls, parapets, and wingwalls), and the condition of their appurtenance structures (such as aprons, weirs, and energy dissipaters). The inside of a culvert should be inspected for any damage or deterioration. Weep holes should be checked to determine if they are functioning or if they are plugged. Joints should be checked for deterioration or spalls.

An overall condition rating of the Culvert (NBI Item 62) shall be provided as shown in Table 4.2.2.3. Culverts should be evaluated with respect to their alignment, settlement, joints, structural condition, scour, and other elements associated with culverts. The rating code is intended to be an overall condition evaluation of the culvert. Integral wingwalls to the first construction or expansion joint shall be included in the evaluation.

Culvert field notes are to be maintained in the remarks field of the items described below or in the General Comments field.

4.4.4.1 Barrel

The inspector should sight along the length of the culvert barrel to look for signs of settlement. The roadway embankment should also be viewed for signs of settlement, erosion or settlement of side slopes, pavement cracking, or pavement patching indicative of embankment settlement. Joints within the culvert should be checked for differential movement, infiltration of water, or exfiltration into the surrounding supporting soils. The inspector should check for loss of filler material or sealers at joints.

4.4.4.1.1 Concrete

For concrete box culverts, sidewalls, the top slab, and the base slab should be inspected for abrasion, cracking, or spalling of concrete surfaces, as well as for honeycombing of concrete and exposed reinforcing steel. Deteriorated areas should be sounded to determine the extents of delamination. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the culvert concrete; the condition should be coded “N” if the culvert has no concrete elements.

For concrete arch culverts, the arch area near the spring line should be inspected for abrasion, cracking, or spalling, as well as honeycombing of concrete and exposed reinforcing steel.

4.4.4.1.2 Steel

For steel culverts, any flattening of the top or sides of the metal elements or any shape distortions from the original as-built conditions should be noted. The inspector should check the base of Corrugated Metal Plate (CMP) structures for differential settlement or undermining. In addition, the inspector should check along the length of the CMP for misalignment of plate elements, leakage at seams and dents, or local defects. Finally, the inspector should check for cracks and distortions, especially at bolt locations. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the steel components; the condition should be coded “N” if there are no steel components.

4.4.4.1.3 Timber

Timber culverts should be inspected for checks, splits, shakes, fungus decay, rot, deflection, and loose fasteners. Gaps between adjoining members that are leaking fill material should be noted. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of timber components; the condition should be coded “N” if there are no timber components.

4.4.4.2 Headwall

Headwalls may be constructed with concrete, steel, or timber. Inspect for the typical deterioration damage of the material type used.

At concrete headwalls, the inspector should check for indications of movement, rotation or settlement of wingwalls, and separation or rotation of wingwalls from the main barrel.

For metal structures that do not have concrete headwalls, the inspector should check for any upward displacement at the inlet. For inlet or outlet ends mitered into the embankment slope, the inspector should check for evidence of edges folding inward.

For timber headwalls, the inspector should look for checks, splits, shakes, fungus decay, rot, deflection and loose fasteners. Gaps between adjoining members that are leaking fill material should be noted.

A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the headwalls; the condition should be coded “N” if there are no headwalls.

4.4.4.3 Cut-off Wall

The downstream cut-off wall should be checked for potential scour behind the wall in the upstream direction. The depth and limits of scour near the cutoff wall should be determined by probing with a rod. The inspector should watch for signs of piping along the outside face of the culvert walls or below the base slab. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the cut-off walls; the condition should be coded “N” if there are no cut-off walls or they are not visible.

4.4.4.4 Adequacy

The inspection should include an evaluation of whether the size of the culvert adequately addresses the hydraulic demand. The inspector should look for high water marks as well as whether there are signs piping occurring along the outside of the culvert walls. In addition, the inspector should look for signs of erosion at the inlet end of the culvert or overtopping of the culvert. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall culvert hydraulic adequacy.

4.4.4.5 Debris

The inspector should check for accumulation of debris, particularly at the inlet end of the culvert, which could block the entrance. In addition, the inspector should check for silting in of the culvert barrel. The inspector should note whether brush, trees, or debris are interfering with proper flow through the culvert. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall severity of debris accumulation.

4.4.5 Channel and Channel Protection

When examining the channel and channel protection, inspectors should observe the adequacy of the waterway opening under the structure or approaching culvert inlet to determine if the waterway is unobstructed and affords free flow of water. Obstructions such as debris or growth may contribute to scour and may be a potential fire hazard to the structure. Sand and gravel bars deposited in the channel may direct stream flow in such a manner as to cause harmful scour at piers or abutments. In addition, the inspector should be particularly concerned with visible signs of excessive water velocity, which may affect undermining of slope protection, erosion of banks, and realignment of the stream, which, in turn, may result in immediate or potential problems.

The surrounding area should also be observed to determine if the bridge and approaches are causing problems, such as flooding due to inadequate openings of the structure or skew of the piers or abutments, or if erosion of banks or levees is resulting from improper protection.

An overall condition rating of the Channel and Channel Protection (NBI Item 61) shall be provided as shown in Table 4.2.2.2. This condition rating should take into account stream bank stability, stream bank protection systems, river control devices, streambed movement, and whether there is debris in the channel that could affect the hydraulic opening. Accumulation of drift and debris on the superstructure, substructure, or culvert inlet should be noted in the inspection report but shall not be included in the condition rating.

Channel and Channel Protection field notes are to be maintained in the remarks field of the items described below or in the General Comments field.

4.4.5.1 Channel Scour

Scour can generally be categorized into three types. General scour involves channel bed degradation along a considerable distance of the channel and would typically occur whether or not the bridge structure was present. Contraction scour is the lowering of the streambed under the structure resulting from the acceleration of the stream flow due to a reduced waterway opening at the bridge. Local scour is the lowering of the streambed adjacent to an obstruction in the streambed, such as a pier foundation.

The inspector should check for timber debris in the channel or added vegetation that could contribute to contraction scour. In addition, ice jams, excessive riprap, sedimentation, an excessive number of piers in the channel, and inadequate bridge length can all contribute to contraction scour. Probing around pier and abutment locations should be employed to determine the depth and extents of scour holes. In addition, although scour holes could silt back in, probing would indicate the difference in compaction of natural soils and soils deposited following scour activities.

A condition rating (0 – 9) should be assigned on the Field Data Channel Collection Form in SIIMS to describe the overall severity of the channel scour.

4.4.5.2 Embankment Erosion

Lateral stream migration is the relocation of the stream channel over time due to lateral scour of the embankments. The inspector should note the angle of attack of the natural stream with respect to the bridge opening, which may be a contributing source of embankment erosion. In addition, the inspector should note bank sloughing and undercutting by the stream action. Left unchecked, early stages of lateral stream migration can lead to channel misalignment, where the stream flow now impacts one of the bridge abutments or flows under a bridge at a skew angle incompatible with the span opening(s). A condition rating (0 – 9) should be assigned on the Field Data Channel Collection Form in SIIMS to describe the overall severity of embankment erosion.

4.4.5.3 Drift

Drift and debris accumulations against the upstream side of piers partially blocking the hydraulic opening should be recorded. Debris build-up can cause unintended contraction scour or local scour. In addition, drift build-up can present a fire hazard to the bridge. A condition rating (0 – 9) should be assigned on the Field Data Channel Collection Form in SIIMS to describe the overall severity of the drift build-up with respect to its potential to create a scour or a fire hazard.

4.4.5.4 Vegetation

Excessive vegetation or tree growth along a channel’s banks can also lead to contraction scour. In contrast, grass and other light vegetation along stream banks can promote bank stability and help prevent sloughing. A condition rating (0 – 9) should be assigned on the Field Data Channel Collection Form in SIIMS to describe the overall bank stability with respect to vegetation growth.

4.4.5.5 Channel Change

As noted in Section 4.4.5.2, as stream embankments scour over time, lateral stream migration can occur. Overtopping of stream meanders during flood events could also cause stream cutting and a channel change. Channel cross sections should be reviewed over subsequent inspection cycles to identify appropriate countermeasures that may be needed to promote stability of the bridge opening. A condition rating (0 – 9) should be assigned on the Field Data Channel Collection Form in SIIMS to describe the overall channel stability with respect to channel change.

4.4.5.6 Fender System

Fender systems or dolphins are used to protect bridge substructures from unintended impact by floating debris or maneuvering vessels. Fenders are typically a protective unit or cover around a pier or the face of an abutment and are frequently attached to the substructure. Dolphins are generally a stand-alone unit placed upstream or downstream from a pier.

Piles should be inspected for fenders or dolphins in a manner similar to inspection of bridge substructure components. Steel frame members, cables, and connections should be inspected for corrosion, impact damage, and abrasion from vessel or debris impact. Timber piles and fender components should be inspected for decay, insect damage, marine organisms, impact, and structural damage; connections and cables should be checked for corrosion. Concrete components should be checked for spalling, cracking, corrosion of reinforcing steel, and damage or abrasion from debris or vessel impact. Auxiliary components such as rubber rub rails should be checked for damage and connection damage. Any hydraulic components should be checked to ensure that they are working correctly. In addition, navigation lighting and beacons should be checked for broken or missing lenses, proper light function, and damage to connections, wiring, and conduit.

A condition rating (0 – 9) should be assigned on the Field Data Channel Collection Form in SIIMS to describe the overall condition of the fender systems; the condition should be coded "N" if there are no fenders or dolphins.

4.4.5.7 Spur Dikes and Jetties

Spur dikes and jetties are river control structures designed to modify the flow of the river to help control lateral streambed movement. Spur dikes are often placed on the outside of a river bend to protect the stream bank by slowing velocities and inducing sediment deposition. The overall effectiveness of spur dikes and jetties should be evaluated from the standpoint of whether they are functioning as intended to protect the bridge. A condition rating (0 – 9) should be assigned on the Field Data Channel Collection Form in SIIMS to describe the overall condition of the spur dikes and jetties; the condition should be coded "N" if there are no spur dikes or jetties.

4.4.5.8 Riprap

Riprap and other armoring types of countermeasures are not intended to alter the stream's flow significantly but are designed to reduce the hydraulic stresses from design flood events. Riprap is often used to protect piers and abutments from contraction or local scour. The inspector should evaluate riprap for proper placement and whether it is functioning as intended to protect the stream banks. A condition rating (0 – 9) should be assigned on the Field Data Channel Collection Form in SIIMS to describe the overall effectiveness of the riprap; the condition should be coded "N" if there is no riprap.

4.4.5.9 Adequacy of Opening

The inspector should check the adequacy of the overall waterway opening. Specifically, the inspector should check for high water marks and should look for signs of contraction scour, lateral stream migration, or embankment sloughing that may indicate whether the opening size is inadequate. A condition rating (0 - 9) should be assigned on the Field Data Channel Collection Form in SIIMS to describe the overall adequacy of the hydraulic opening.

4.4.5.10 Scour Critical Bridge

A scour analysis shall be made by a hydraulic/geotechnical/structural engineer according to FHWA scour analysis guidelines. NBI Item 113 shall be coded according to the findings of the scour analysis or scour conditions observed at the bridge site. When Item 113 is coded 2 or less, the Substructure Condition Rating (Item 60) must be coded to match Item 113.

A bridge that is found to be Scour Critical must have a Plan of Action (POA) developed. The POA includes a specific plan for monitoring, inspecting, or closing a Scour Critical bridge during or after a flood event. A POA is required when NBI Item 113 is coded 0, 1, 2 or 3. A field in SIIMS identifying that a POA has or has not been implemented must be filled in with a "Yes" or "No." The analysis method must also be documented in SIIMS. Check boxes for Level A, B, or C analyses are provided in SIIMS to identify the type of analysis performed. One or more analysis types may be checked. The analysis documentation and POA must be uploaded into SIIMS.

4.4.5.11 Unknown Foundations

A bridge with an unknown foundation must be analyzed for potential risk of failure during a flood event. There are two levels of analysis that can be performed. Check boxes for Level A and B analyses are provided in SIIMS to identify the type of analysis performed. Both check boxes may be checked when the Level A assessment identifies risk level as Moderate or High. The risk level shall also be entered in SIIMS. In SIIMS, it must be documented that a POA has or has not been implemented. Enter "Yes" or "No" in the corresponding field identifying whether a POA has been implemented. The analysis documentation and a POA must be uploaded into SIIMS.

4.4.6 Bridge Data

4.4.6.1 Load Posting Table

If the bridge is load restricted, the inspector should verify whether the posted limits in the field match the recommended limits. The actual tonnage shown on the signs in the field are to be entered in the table. Remarks should be made to clarify the load limits or explain any discrepancies.

4.4.6.2 Signing

The inspector should verify that other required regulatory signs are properly posted at the correct height, are not obstructed by vegetation, and are clear and legible. These signs may include reduced speed limit signs, restricted vertical clearance signs, narrow bridge signs, bridge closure signs, and lateral delineators. A rating of Good, Fair, or Poor should be used to document the legibility and visibility of the signs. For applicable signs at the bridge site, comments on the legibility and visibility of the signs should be made on the Field Data Collection Form in SIIMS.

4.4.6.3 Approaches

4.4.6.3.1 Concrete Approaches

The inspector should check the approach pavement condition for cracking, settlement, unevenness, or roughness. Joints between approach pavement and abutment should be examined to verify they do not leak and provide adequate movement for bridge thermal expansion. The inspector should check that roadway approach drainage does not pond on shoulders and does not erode approach fills or areas at ends of wingwalls. In addition, the inspector should verify approach roadway drainage is directed away from the bridge. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the approach slabs; the condition should be coded "N" if there are no approach slabs.

4.4.6.3.2 Relief Joints

The inspector should check pavement relief joints in the bridge approaches for proper function to determine if they are properly accommodating thermal movement. The inspector should check for road debris or other factors that might inhibit movement at pressure relief joints. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of pressure relief joints; the condition should be coded "N" if there are no pressure relief joints.

4.4.6.3.3 Guardrail

Guardrail and all guardrail components, including transition sections at bridge rail and guardrail end treatments, should be checked for conformance to current standards. The inspector should check guardrail installation height and the condition of guardrail for impact damage, cracks, rust, and secure connections. Posts should be firmly embedded in the ground, and laterally displaced posts should be reported. Wood posts should be checked for rot or insect damage. If impact attenuator devices are used, the inspector should check for evidence of damage due to impact and that energy absorbing components have not ruptured; the inspector should also check that cable anchorages are secure and undamaged. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of the approach guardrail; the condition should be coded “N” if there is no approach guardrail. In addition, NBI Items 36A through 36D must be coded as shown in Table 4.3.1.3 to document whether the bridge rail, guardrail transitions, approach guardrail, and guardrail end treatments meet currently accepted standards.

4.4.6.3.4 Embankment

The approach embankment should be checked for steepness, signs of excessive erosion, settlement, and undermining of pavement, shoulders, or guardrail. A condition rating (0 – 9) should be assigned on the Field Data Collection Form in SIIMS to describe the overall condition of approach roadway embankments.

4.5 ADDITIONAL SIIMS DOCUMENTATION

4.5.1.1 Photographs, Sketches, Plans, Documents, and Files

Photographs, sketches, plans, documents and files are attached under the Report Info - Pictures section in SIIMS. Almost any file type can be added to a bridge file. The type of document will determine whether the document should be attached with an inspection report or as part of the Bridge File. If a document relates to only a specific inspection, such as photographs and sketches, it should be attached to the inspection report. When a document relates to the bridge, such as design plans or a scour plan of action, the document should be attached in the “Files” area on the Asset Details page.

Files attached as part of an inspection report must be attached before the inspection report is finalized. If a document or file is not attached before the inspection report is finalized, the report must be unapproved to attach the files and then reapproved.

Files can be attached in the “Files” area on the Asset Details page at any time, whether an inspection is in progress or not. The description field for each document should include specific information about the subject of the document so anyone looking at the Bridge File will know what each document contains without having to open each document.

4.5.1.2 Load Rating Evaluation Form

The Load Rating Evaluation Form must be completed for every inspection. This form will determine if the existing load rating needs to be re-evaluated to determine if it is still valid or if new load rating is needed. The name of the individual who completes the Load Rating Evaluation Form and the date he/she completes it must be entered at the top of the form.

If any one of the questions is changed from the default to “Yes,” a re-evaluation of the load rating or potentially a new load rating calculation will be required. After the evaluation form is completed, the Program Manager will make the request to have the load ratings re-evaluated or re-calculated based on the criteria on the Load Rating Evaluation Form.

4.5.1.3 Load Rating Report

The load rating must be completed by a Professional Engineer licensed in the State of Iowa. As noted above, the need for a load rating re-evaluation or a new load rating calculation is determined by filling out the Load Rating Evaluation Form.

If the load rating is re-evaluated and there is no reason found to update the load rating, the following fields on the Load Rating Bridge Report Tab need to be updated:

1. Report By: – indicates who performed the review
2. Date: – indicates the date the review was completed
3. Comment: – indicates the review did not require re-rating of the bridge

If the load rating is re-calculated and the ratings have changed, the entire Load Rating Bridge Report Tab must be updated. The Load Rating Bridge Report Tab can be generated by an unlicensed engineer, but a licensed engineer must put his/her name and license number at the bottom of the form. It is recommended the new calculations be attached to the inspection report before it is finalized. If the ratings are not completed before the inspection is finalized, a Load Rating Bridge Report should be created to update the ratings and attach the calculations.

4.5.1.4 Critical Findings

The purpose of the Critical Findings Report in SIIMS is to ensure serious bridge damage or defects are reported, that the necessary notifications are made to the bridge owner by the Program Manager or Team Leader, and proper and timely action is taken to ensure the safety of the travelling public. This process alerts the bridge owner so damage or deterioration can be repaired in a proper and timely manner and ensures damage and repairs are documented.

The procedures to be used for LPAs when issuing a Critical Findings Report are as follows:

1. The individual discovering the critical finding shall:
    a. Immediately report the finding to the responsible local official, who may notify law enforcement or maintenance personnel to close the bridge.
    b. Complete Part I of the Critical Findings Report within 48 hours of the finding.
2. The responsible local official shall:
    a. Take action to ensure the safety of the traveling public.
    b. Complete Part II of the Critical Findings Report within 5 days of the finding.
3. Before a closed bridge may be reopened to traffic, the following must be completed:
    a. A Professional Engineer, licensed in the State of Iowa, shall approve any structural repairs.
    b. The bridge shall be load rated.
    c. The bridge shall be inspected by a Team Leader.

4.5.1.5 Channel Section

A channel cross section on the upstream side of the bridge is required to be a part of the bridge record. A standard Channel Cross Section form has been incorporated into SIIMS. Each bridge structure is required to have a data point at the top of bank, toe of bank, thalweg, and each substructure unit. The Channel Cross Sections are to be updated in SIIMS every 4 years for natural waterways and every10 years for drainage ditches controlled by a drainage district unless conditions at the bridge warrant more frequent monitoring.

The Channel Cross Section is required in SIIMS. Hand-drawn channel sketches may be uploaded to the report or the standard Channel Cross Section form in SIIMS may be used to auto-generate a channel cross section sketch.

4.5.1.6 NBI Calculations

Calculated fields, the Sufficiency Rating, and the classification for Structural/Functional Deficiency are recalculated and updated in SIIMS during entry of inspection data for a new inspection. The logic for the calculated appraisal ratings and the Sufficiency Rating can be reviewed in the NBI Calcs section in SIIMS. It is recommended that these ratings be recalculated by choosing "Recalculate NBI Ratings" in the NBI Calcs section of SIIMS before finalizing an inspection.

The data fields that are calculated in the NBI Calcs section in SIIMS are:

1. NBI Item 67, Structural Evaluation
2. NBI Item 68, Deck Geometry
3. NBI Item 69, Underclearances
4. Sufficiency Rating
5. Classification – Structurally Deficient or Functionally Obsolete

4.5.1.7 Supplemental Inspection Information

The NBIS requires information on inspection equipment needs and maintenance history be maintained for all bridges. The Supplemental Inspection Information section in SIIMS provides a means to document this information. This section includes:

1. Special equipment requirements for inspection
2. Traffic control needs during inspection
3. Time requirements for inspection
4. Fracture Criticality and fatigue vulnerability

4.6 REPORTING OF SPECIAL ITEMS

4.6.1 Fatigue-Prone Details

Fatigue-prone details consist of, but are not limited to, the following:

- Welded cover plates, particularly the end terminations
- Web gap area at diaphragm stiffeners when out-of-plane bending is possible
- Welded gusset plate connections to girder webs, flanges or truss members
- Weld terminations of longitudinal stiffeners
- Coped areas in a floorbeam or cross beam
- Tack welds in tension areas
- Intersecting welds

Fatigue is the tendency of a member to fail at a stress level below yield stress when subjected to cyclical loadings. Fatigue-prone details require additional attention. If fatigue cracks or fractures are noted, non-destructive testing methods, such as dye penetrant testing or magnetic particle testing, may be required to determine the extents of cracks in steel members. Ultrasonic methods are typically used to test pin members for defects. Thickness gauges (D-Meters) or calipers can be used to determine the thickness of steel remaining for a particular member.

Triaxial constraint is a 3-dimensional stress state that reduces the ductility of a material. Under triaxial constraint, steel is unable to deform, and brittle fracture can occur under service conditions where ductile behavior is normally expected. Due to the nature of these unique conditions, the chance for member failure is greater for these conditions and they warrant added emphasis during inspection. Finally, the ability of inspectors to recognize conditions of triaxial constraint is important to guard against brittle failure.

AASHTO prioritizes fatigue details into categories from A (least critical) to E' (most critical). The inspector shall be familiar with the various fatigue categories and be able to classify the categories encountered in the field to determine the seriousness of the detail. Fatigue-prone details should be identified and noted in the inspection report so that the details can be monitored for cracks in subsequent inspections.

4.6.2 Fracture Critical Elements

FCMs are steel members in tension or with a tension element, whose failure would be expected to cause a partial or full collapse of the bridge. The NBIS requires FCMs to be inspected at "arms length."

Steel floorbeams are considered fracture critical when:

1. The connections to main girders are considered flexible or hinged;
2. There are no stringers;
3. The stringers are configured as simple spans; or
4. The stringers are continuous and the floorbeam spacing is greater than 14 feet.

4.6.2.1 FCM Pre-inspection Preparation

Prior to inspecting a bridge with known FCMs, the following procedures should be used in preparation for the inspection:

1. Review the FCM locations as identified in the bridge file.
2. Identify all fatigue-prone details requiring a hands-on inspection.
3. Determine what documentation will be needed as part of this inspection.
4. Determine the workflow needed and access requirements for inspecting the FCMs in the most efficient manner.
5. Discuss the workflow with all the members of the inspection team so they understand their roll in the inspection. It is recommended the workflow be documented and kept in the bridge file.
6. Assess the equipment needs to perform this inspection. This will include lighting adequate to identify small defects. It is recommended to keep a list of the equipment needed for the inspection in the bridge file.
7. Make arrangements to have the superstructure washed if debris, bird nests, or bird droppings inhibit proper inspection of important areas.
8. Make arrangements to have the necessary access equipment available for the inspection.
9. Verify who shall be notified if a potentially serious condition is found.

4.6.2.2 Requirements During FCM Inspection

During an FCM inspection, the following procedures should be used:

1. Perform a hands-on inspection to visually inspect the FCMs for deterioration, defects, damage, and cracks. Perform a hands-on inspection of all fatigue-prone details. A hands-on inspection is defined as the inspector being able to touch all surfaces of the tension carrying regions of FCMs.
2. Clean suspect locations for better visual assessment, and use appropriate non-destructive testing methods to verify potential crack locations and member thickness in deteriorated areas.
3. Photograph and sketch locations where deficiencies are found. Include appropriate dimensions and perspectives on all sketches. Close-up photographs should be taken before and after any cleaning, paint removal, or testing. Include a photograph of the general location so others can understand exactly where close-up photographs were taken.
4. The Fracture Critical Member Locations and Conditions form (Attachment K or L in I.M. 2.120) is required to be completed for each fracture critical bridge.
5. If a serious defect is found, notify the appropriate personnel immediately to determine what actions are necessary.

4.7 MAINTENANCE, REPAIR, AND REPLACEMENT (MR&R)

4.7.1 Recommendations

The Maintenance, Repair and Replacement (MR&R) section of SIIMS is used to make recommendations for repair, rehabilitation and replacement. Defects not repaired could affect the functionality of the bridge, its load carrying capacity, or the safety of the public. In addition, if repairs are not made, the defect could lead to added deficiencies that could be avoided through proactive repair. The inspector shall make recommendations for repair and shall include recommended time frames for completing the repairs (for example, within 1 month, during the next bridge maintenance cycle, or prior to the next routine inspection) in order to convey the urgency of repairing the defect and to aid the bridge owner in prioritizing the repair. The bridge owner will need to evaluate the recommendations for repair and evaluate the suggested time frames with respect to the costs of the repairs and the available funding in the bridge repair program. Repair recommendations may require a follow-on In-depth Inspection of the defects to support the development of repair plans and a cost estimate.

When a recommendation is made, one of three check boxes must be checked to identify the type of recommendation. The three options are:

1. Corrective – Defects that should be repaired as soon as practicable because the condition of the bridge is affected.
2. Preventive – Maintenance will prevent future deterioration. Deterioration is not causing a structural or safety issue at this time.
3. Monitor – The Local Agency must monitor the condition at an appropriate interval.

A default type will be checked after the recommendation code is selected from the drop-down menu. This does not mean this is the only option for the recommendation. Some recommendation codes will display the Corrective and Preventive box checked. In this case, the severity of the condition should be used to determine which type of recommendation should be made. One of the boxes should be unchecked before the report is finalized.

Recommendations made during an inspection but not yet completed will come forward at future inspections. If a past recommendation has not been completed and is still necessary, the recommendation should be left as it is. A duplicate recommendation is not appropriate. If additional deterioration is found and the recommendation needs to change to a different code, then the recommendation status should be changed to “Cancelled” and a new recommendation added.

Recommendations previously completed serve as maintenance history. The NBIS requires a maintenance history be maintained for all bridges.

4.7.1.1 Available Recommendation Codes

The Maintenance Recommendation Codes currently available for bridge work are shown in Table 4.7.1.1. The default text appearing with each recommendation can be altered to fit a specific situation. Recommendation codes 199, 299, 399, 499, and 599 are for situations not included in any of the available codes. The appropriate codes for Deck (199), Superstructure (299), Substructure (399), Channel (499), or Approach (599) work should be used. These codes can be used for Corrective, Preventive, or Monitoring situations.

Table 4.7.1.1. Maintenance Recommendation Codes

Code	Recommendation	Corrective/Preventive
100	Remove gravel from approaches	P
101	Remove gravel from snow & ice	P
103	Clean deck drains	C
104	Clean deck & drains	C
105	Remove loose concrete - Bottom of deck	C
110	Spall patch - Minor	P
111	Spall patch	C
112	Spall patch - Major	C
114	Deck deterioration - Possible failure	C
121	Recommend PCC overlay	C
132	Replace - Urgent	C
140	Inject w/ epoxy	P
141	Inject & patch spalls	C
142	Replace overlay	C
150	Repair or replace sliding plate joint	C
151	Repair crumb rubber joint	C
152	Repair or replace strip seal gland	C
160	Extend deck drains	C
161	Repair extensions	C
162	Seal concrete below drains	C
170	Paint steel handrail	C
171	Repair collision damage	C
172	Seal concrete handrail	P
199	Miscellaneous - Deck	C
200	Clean superstructure	P
212	Spot paint - Schedule	P
213	Complete paint - Consider	P

Code	Recommendation	Corrective/Preventive
214	Complete paint - Schedule	C
215	Zone paint - Severe rusting	C
221	Possible cracks - Drill	C
223	Loosen diaphragm bolts	C
230	Tighten loose bolts	C
232	Replace missing bolts	C
234	Tighten & replace	C
240	Repair - Spalls	C
241	Seal	C
249	Seal spalls	C
250	Repair spalls	C
251	Moisture - Seal	C
252	Cracks - Seal	C
260	Repair concrete diaphragms	C
261	Repair nicks & gouges	C
271	Repair collision damage	C
299	Miscellaneous - Superstructure	C
300	Clean bridge seats	P
301	Clean & paint bearings	P
302	Clean seats & paint bearings	P
303	Drain bridge seats	C
304	Re-set bearings	C
310	Repair near face & seat	C
311	Repair far face & seat	C
312	Repair both faces & seats	C
313	Repair near backwall	C
314	Repair far backwall	C
315	Repair both backwalls	C
320	Repair cap & bridge seat	C
321	Repair columns	C
322	Repair bridge seat & columns	C
340	Repair culvert walls	C
371	Repair collision damage	C
399	Miscellaneous - Substructure	C
400	Remove flood debris - Piers	P
401	Remove unbalanced fill - Piers	C
402	Cut off old pile in channel	P
403	Remove trees & brush	P
410	Repair erosion - Near berm	C
411	Repair erosion - Far berm	C
412	Repair erosion - Both berms	C
413	Repair erosion - Around near wing	C
414	Repair erosion - Around far wing	C

Code	Recommendation	Corrective/Preventive
415	Repair erosion - Around all wings	C
416	Berm - Repair erosion - Near berm undermined	C
417	Berm - Repair erosion - Far berm undermined	C
418	Berm - Repair erosion - Both berms undermined	C
420	Repair degradation - Consider	P
421	Repair degradation - Schedule	C
422	Repair meander - Consider	P
423	Repair meander - Schedule	C
430	Remove flood debris	P
431	Repair erosion at outlet	P
433	Clean out - Schedule	C
440	Seal cracks	P
441	Seal cracks & repair - Consider	C
442	Seal cracks & repair - Schedule	C
499	Miscellaneous - Channel	C
500	Re-cut near pressure relief joint	C
501	Re-cut far pressure relief joint	C
502	Re-cut both pressure relief joints	C
503	Install near pressure relief joint	C
504	Install far pressure relief joint	C
505	Install both pressure relief joints	C
510	Repair pavement - Near approach	C
511	Repair pavement - Far approach	C
512	Repair pavement - Both approaches	C
520	Repair shoulders - Near approach	C
521	Repair shoulders - Far approach	C
522	Repair shoulders - Both approaches	C
523	Repair near concrete panels	C
524	Repair far concrete panels	C
525	Repair all concrete panels	C
530	Guardrail repair near end	C
531	Guardrail repair far end	C
532	Guardrail repair both ends	C
571	Guardrail - repair collision damage	C
599	Miscellaneous - Approach	C

4.7.2 Cost Estimates

If, through past experience, the bridge inspector has knowledge of similar repairs performed for other bridges, the inspector should provide an approximate cost estimate corresponding to the repairs recommended.

CHAPTER 5
QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) FOR LOCAL PUBLIC AGENCIES

5.1 SCOPE OF LOCAL PUBLIC AGENCYQUALITY ASSURANCE/QUALITY CONTROL PROGRAM

Of the more than 25,000 bridges in Iowa that are in the NBI, approximately 21,000 of the bridges are owned, inspected, and maintained by counties, cities, and other public agencies. County and city bridge owners are referred to as Local Public Agencies (LPAs). Iowa Code 314.18 requires LPAs to be responsible for the safety inspection and evaluation of all highway bridges under their jurisdiction that are located on public roads, in accordance with the NBIS. Iowa DOT published I.M. 2.120 to assist LPAs in complying with the NBIS.

Private bridge owners are not subject to the NBIS and do not fall under Iowa DOT oversight. They are encouraged but not required to perform inspections that comply with the NBIS.

5.2 NBIS DEFINITION OF TERMS

The NBIS definitions of Quality Control and Quality Assurance are provided in the following sections.

5.2.1 Quality Control

Quality Control is defined as procedures intended to maintain the quality of a bridge inspection and load rating at or above a specified level.

5.2.2 Quality Assurance

Quality Assurance is defined as 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.

5.3 ROLE OF SIIMS

Iowa DOT implemented SIIMS in May 2010. SIIMS is a software package used to update the bridge records of Iowa’s portion of the NBI. The user interface is a password-protected website allowing Iowa DOT and LPA bridge inspectors to manage inspections and document findings in a standardized reporting format.

SIIMS is the foundation of the Iowa DOT quality control program. The software presents standard collection screens for data entry, schedules inspections, and performs integrity checks at each stage of the approval process. These quality control measures are in place to obtain consistent inspection data from multiple inspectors, which is necessary if proper resource planning is to occur across the State.

5.4 QUALITY CONTROL

5.4.1 Inspection Scheduling

Inspection dates and inspection frequencies are entered in SIIMS for all NBI structures. Multiple inspection types, such as Fracture Critical or Underwater Inspections, may be entered and scheduled for separate dates, years, and frequencies.

SIIMS can forecast upcoming inspections and provide maps of bridge locations.

When the date of an inspection passes without the creation of an inspection report, SIIMS will automatically notify the bridge owner and Program Manager via e-mail if a report is not created by the time the inspection is 1 month, 3 months, and 6 months past due.

If an inspection report was created but remains unapproved, SIIMS will automatically notify the bridge owner and Program Manager via e-mail when the inspection report is 3 months and 6 months past the inspection date.

If an inspection report is not created or the report remains unapproved 6 months after the inspection date, SIIMS will automatically notify the bridge owner and Program Manager via e-mail and request an aggressive, short-term plan to correct this deficiency.

5.4.2 LPA Compliance

For LPAs with NBIS compliance issues, the LPA will be directed to complete one of the following actions:

1. Complete all the actions necessary to resolve the compliance deficiencies.
2. Submit an aggressive, short-term plan to correct the deficiencies for FHWA approval.

Iowa DOT will issue two notifications to the LPA. First, Iowa DOT will issue a 60-day notification to the LPA that failure to correct the NBIS errors will result in the LPA being assessed as non-compliant with the NBIS. At the end of the 60 days, Iowa DOT will issue a 30-day second advanced notification recommending that FHWA not approve future Federal-aid projects for the noted LPA.

For LPAs that have not corrected the NBIS deficiencies or have not carried out a short term plan to correct the NBIS deficiencies within 90 days from the date of the first notification, Iowa DOT will notify FHWA of the recommended local governmental entities that should have their Federal-aid project funding suspended.

For those LPAs that submit a short-term plan, Iowa DOT shall review the plan to ensure the LPA necessarily corrected deficiencies in a reasonable time frame and, if it does, Iowa DOT will recommend its approval to FHWA. Additionally, Iowa DOT shall evaluate the progress made by the LPA to complete the short-term corrective plan in accordance with the approved timeline. Iowa DOT shall notify FHWA when the LPA has failed to make sufficient progress or failed to complete its short-term plan by the approved timelines. Additionally, in the case of failure to make sufficient progress or complete its short-term plan by the approved timelines, Iowa DOT shall issue a 30-day advanced notification recommending that FHWA not approve future Federal-aid projects for the noted LPA.

5.4.3 Data Collection

When an inspection report is created in SIIMS, a series of web pages are populated with the NBI information available for the structure. SIIMS promotes consistent NBI data collection by standardizing the data entry based on the following:

1. The inspector reviews each NBI entry and updates the data to reflect his/her inspection findings.
2. Each report includes a Load Rating Evaluation Form the inspector must complete before SIIMS will allow the inspection report to be approved.

Each report has an Error Check page alerting the inspector to entries that are missing or varying from an expected format.

5.4.4 Inspection Report Approval

The last step in the data entry process for an inspection report is requesting approval. When an inspector submits a report for approval, the error check software in SIIMS will review the report fields. If data entry errors are found, such as Item 92A (Fracture Critical Details) is coded “Yes” but no Fracture Critical inspection date is entered, an Error Check page will appear, and the report will not be approved until the errors are resolved.

When the error check software finds entries that do not match the data stored in the SIIMS database, the inspector will be asked if the new data should overwrite the existing data or if the existing data should remain. The inspector must choose whether to use the report values or central database values before SIIMS will allow the report to be approved. Some data may be uneditable because it is data maintained by the Iowa DOT. If the data is uneditable and appears to be incorrect or in question, contact the Office of Research and Analytics to correct or clarify the data discrepancy.

LPA inspectors perform their own quality control review of the report content. SIIMS is programmed to check for data entry errors, but decisions about maintenance activities or structural repairs are made by the LPA inspector or Program Manager.

5.4.5 Training

The NBIS requires periodic bridge inspection refresher training for Program Managers and Team Leaders in Part 650.313(g). Iowa DOT has defined periodic as being every 5 years. All State and LPA bridge inspection personnel are required to complete the Bridge Inspection Refresher Training Course every 5 years following the completion of the Safety Inspection of In-Service Bridges Training Course.

The SIIMS system contains an individual’s qualifications as a team leader. When an individual’s refresher training or professional license is within 6 months of expiring, a notice will appear each time the user logs into SIIMS. This notice will show the date(s) of expiration.

5.5 QUALITY ASSURANCE

The terms quality control and quality assurance are not interchangeable. The NBIS defines quality control as a tool and quality assurance as an evaluation of that tool. SIIMS has built-in quality controls that guide inspectors through data collection and standardize data entry in order to obtain consistent inspection data from multiple inspectors.

Quality assurance is a review of the inspection data to provide the following:

1. An evaluation of how well the quality control tools in SIIMS are delivering consistent inspection data
2. Identification of where the data are not consistent so the quality control tools can be corrected or modified

5.5.1 Review of LPA Bridge Records

Iowa DOT I.M. 2.120 states the Iowa DOT shall annually review a random sample of LPA bridge records to determine if they contain the following minimum (as applicable) items:

1. Bridge Plans
2. Repair Plans
3. Photographs
4. Scour Evaluation Data
5. Channel Cross Section
6. Local Agency Field Data Collection Form
7. Structure Inventory and Appraisal (SI&A) Forms
8. Load Rating Calculations
9. Load Rating Evaluation Form
10. Critical Findings
11. Critical Features List
12. Special Inspection Equipment List

5.5.2 LPA Team Leader Reviews

The LPA Program Manager (the individual in charge of the LPA inspection program) is required to conduct a Team Leader review every 4 years. The review includes the following:

1. An independent party review by a Professional Engineer licensed in the State of Iowa and qualified as a Team Leader.
2. A field review of inspection data for 10 bridges inspected during the past 12 months. The bridges selected shall include, but are not limited to, the following:
   a. Predominant bridge types inspected
   b. Bridges with lower sufficiency ratings
   c. Bridges with Deck (NBI Item 58), Superstructure (NBI Item 59), Substructure (NBI Item 60), Culvert (NBI Item 62), or Posting (NBI Item 70) rated 4 or less (if applicable to the bridges inspected by the Team Leader)
3. The Reviewer accompanies the Team Leader under review during the inspection of 2 of the 10 selected bridges.
4. A Quality Assurance Field Review Worksheet completed for each bridge inspected. The Quality Assurance Field Review Worksheet is available in IM 2.120.
5. Verification of the information provided by an individual to obtain access to SIIMS as a Team Leader.

6. Documentation that the Team Leader has completed the Bridge Inspector Refresher Training Course and, if needed, Fracture Critical Inspection Techniques for Steel Bridges Training Course.

The findings of the Team Leader reviews are reported to the Iowa DOT. If there are negative findings regarding the Team Leader, the report shall include corrective recommendations, or actions taken, to resolve those findings.

5.5.3 Load Rating Engineer Reviews

Load Rating Engineer reviews will be conducted by the Office of Bridges and Structures utilizing SIIMS in conjunction with on-site field reviews as part of the Iowa DOT's annual oversight of the LPA's program.