Bridge Inspection Manual

Texas Department of Transportation

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Manual: *Bridge Inspection Manual*

Effective Date: August 23, 2013

Purpose

This manual provides guidance for bridge inspection personnel and helps ensure consistency in bridge inspection, rating, and evaluation.

Contents

This manual adds in Chapter 5 information regarding the procedures for changing off-system bridge load postings.

Contact

For more information regarding any portion of this manual, please contact the TxDOT Bridge Division.

Archives

Past manual notices are available in a pdf archive.

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Section 1 — About this Manual

Purpose

This manual provides guidance for bridge inspection personnel, provides a reference for consultants, and helps to ensure consistency in bridge inspection, rating, and evaluation.

Manual Revision History

Version	Publication Date	Summary of Changes
2001-1	December 2001	New manual.
2002-1	July 2002	Revision adding updated information on bridge load-posting changes and updating references to electronic forms.
2006-1	April 2006	Revision adding an index.
2012-1	August 2011	Minor editorial revisions to each chapter are not highlighted. Citations to the most current editions of reference materials have been updated but are not highlighted. Revisions to Chapter 2 updating the status of current relevant publications; updating Chapter 3 regarding the titles of current job series and consultant evaluation criteria; updating fracture critical inspection frequency in Chapter 4; updating information on bridge load-posting in Chapter 5; and adding Chapter 9 regarding the Quality Assurance/Quality Control (QA/QC) program.

Feedback

Direct any questions or comments on the content of the manual to the Director of the Bridge Division, Texas Department of Transportation.

Abbreviations

Throughout this manual, the period is omitted from abbreviations that are obvious to the engineering reader, such as "ft " for feet, "Fig " for Figure, "Ref " for Reference, and "lbs " for pounds. Only abbreviations that may be misinterpreted have the period, such as "in. " for inch or inches, and "No. " for number.

Capitalization

Throughout the manual many names of items, subjects, and processes are capitalized such as Special Inspection, Condition Rating, Bridge Records, etc. These are considered to be proper names and the convention conforms to the current AASHTO Manual for Condition Evaluation of Structures[1] and with other AASHTO and bridge-related engineering publications.

1. Manual for Condition Evaluation of Structures, AASHTO, 1994

Chapter 2 — History of Bridge Inspection

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Section 1 — Initial Reasons for Bridge Inspection

Beginning of Bridge Inspection

After World War II, Texas initiated an extensive road construction program. As a result, most emphasis was on new and economical construction, and for about two decades most highway departments gave little effort to bridge inspection or preventive maintenance.

In 1967, there was a sudden collapse of the Silver Bridge, a pin-connected link suspension bridge over the Ohio River at Point Pleasant, West Virginia, with loss of 46 lives. As a result, a 1968 federal act[1] initiated a national bridge inspection program that recognized the need for periodic and consistent bridge inspections. The first National Bridge Inspection Standards (NBIS) were developed in 1971.[2]

Another structure failure at the Mianus River Bridge in Connecticut in 1983 caused more concern related to fatigue and fracture-critical bridges. This failure and further research resulted in fracture-critical inspections to be mandated. In 1987, scour caused failure of the Schoharie Creek Bridge in New York. This failure resulted in the initiation of the underwater bridge inspection program.

The Bridge Inspector's Reference Manual[3] gives a more detailed history of bridge inspection on pages 1.1.1 through1.1.9.

First Texas Bridge Inspection Program

The first formal bridge inspection program in Texas began in 1975. The first Administrative Circular initiating the inspections was No. 60-75 issued in 1975[4]. It stated that all on-system bridges were to be inspected every two years and that a computerized inventory data file was to be maintained. The reporting of data was made to the Federal Highway Administration (FHWA) on required forms. Texas was the first state to develop a punch-card reporting scheme accepted by the FHWA and later mandated for all states.

1. Federal Highway Act of 1968.
2. National Bridge Inspection Standards (NBIS), FHWA, 1971.
3. Bridge Inspector's Reference Manual, FHWA, October, 2002, revised December, 2006.
4. Administrative Circular No. 60-75, TxDOT, 1975.

Section 2 — Primary References

Major Standards, Manuals, and Technical Advisories

Many standards, manuals, and technical advisories have been developed over the years related to bridge inspection. Most of these were issued by the American Association of State Highway Officials (AASHO), whose name was changed in 1973 to the American Association of State Highway and Transportation Officials (AASHTO), or by the FHWA. The major publications related to bridge inspection with their issue dates are:

- *AASHTO LRFD Bridge Design Specifications, 5th Edition* (2010)
- *AASHTO Manual for Bridge Evaluation, Second Edition* (2011)
- *AASHTO Guide Manual for Bridge Element Inspection, First Edition* (2011)
- *AASHTO Guide for Commonly Recognized Structural Elements* (1998)
- *AASHTO Manual for Condition Evaluation of Bridges* (1994)
- *AASHTO Manual for Maintenance Inspection of Bridges* (1974, 1978, 1983, and 1993)
- *AASHO Manual for Maintenance Inspection of Bridges* (1970)
- FHWA *Bridge Inspector's Reference Manual* (2002 and 2006)
- FHWA, *Bridge Inspector's Training Manual 90*, 1991
- FHWA Hydraulic Engineering Circular No. 18 (about 1988)
- FHWA "Scour at Bridges," a technical advisory (1988)
- FHWA *Inspection of Fracture Critical Bridge Members* (1986)
- FHWA *Bridge Inspector's Training Manual 70* (1979)
- FHWA *Culvert Inspection Manual* (about 1979)
- FHWA *The Bridge Inspector's Manual for Movable Bridges* (1977)
- FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* (1972, 1979, 1988, 1991, and 1995)
- FHWA *National Bridge Inspection Standards* (1971, 1979, and 1988)
- *Code of Federal Regulations*, 23 Highways Part 650, Subpart C - National Bridge Inspection Standards.

Hereinafter, references to AASHO will be called AASHTO for consistency.

Section 3 — AASHTO Inspection Manuals

1970 and 1974 AASHTO Manuals

The first AASHTO Manual issued in 1970[1] (the small grey book) and subsequently modified slightly in 1974[2] (the small green book) described the minimum information considered necessary for inspection, records, rating, and check of bridge load capacities. Primary subjects with their major items were:

Inspections

- Frequency of two years
- Waterway, debris, and channel profile observed
- Investigate evidence of scour and undercutting
- Deterioration of main structural members, deck, superstructure, and bents
- Fatigue details of steel girders to be considered (little guidance given)
- Abnormal cracking in concrete members
- Bridge railings to have only visual inspection, no strength requirements
- Trusses inspected for damage, bracing, condition of paint
- Timber structures to be inspected for decay, overloading

Records

- Written Structural Inventory and Appraisal (SI&A) sheet (little similarity to current SI&A sheet)
- Condition Ratings given as 9 to 0 as now, but little guidance on selection of ratings
- At least two photos to be taken
- All normal identifications, widths, clearances, etc. to be recorded
- Painting record to be kept
- Stress calculations to be kept
- All spans should be listed by length (this is not currently done except indirectly in the bridge plans)

Ratings

1. Manual for Maintenance Inspection of Bridges, AASHTO, 1970.
2. Manual for Maintenance Inspection of Bridges, AASHTO, 1974.

- Operating and Inventory Ratings to be H- or HS-equivalents
- Calculations in accordance with current AASHTO bridge specifications
- Higher safety factor allowed for heavily traveled routes
- Dimensions from as-built or field measurements if necessary
- Pictorial posting signs recommended (not used by Texas at that time)

Load Capacity of Bridges

- Consider two lanes loaded with rating trucks if bridge is 18-ft clear or wider
- Allow fewer lanes if warranted by judgment of Engineer
- "Train" of lighter-weight trucks to be considered, spaced at 30-ft headway when at H-12 or less
- Load distribution and allowable stresses as given by AASHTO Bridge Specifications
- Sample calculations given in Appendix B of AASHTO Manual
- Unique nomographs for live load rating in Appendix B
- Load Factor Rating introduced as an acceptable method

1978 AASHTO Manual

The third AASHTO Manual was issued in 1978[1] (the small yellow book), and it included all the same information and requirements as the first two AASHTO Manuals, with some re-ordering of contents. In addition, the following major additions and modifications were made as compared to the 1974 AASHTO Manual:

Records

- Recommendations modified for repair, maintenance, and posting

Load Ratings

- Definition of Inventory Rating changed to omit the equivalency to the original design load
- Typical load and speed posting signs omitted and reference made to the *Manual for Uniform Traffic Control Devices*[2] (MUTCD)

Load Capacity of Bridges

- The "Secant Formula" was added for steel column strength calculations (this formula is believed to be out-of-date and should not be used by a rater)

1. Manual for Maintenance Inspection of Bridges, AASHTO, 1978.
2. "Scour at Bridges," Technical Advisory, FHWA, 1988.

- Allowable Inventory Rating stresses listed for A36, A572, A441, and other steel types
- Increased allowable bearing stresses on rivets and bolts

1983 AASHTO Manual

The fourth AASHTO Manual was issued in 1983 in loose-leaf form[1] (the large yellow book) and contained essentially the same requirements as the first three AASHTO Manuals. The Records and Ratings requirements were essentially unchanged from the 1978 AASHTO Manual. The following list summarizes the major additions and modifications since the 1978 AASHTO Manual:

Load Capacity of Bridges

- Allowable Inventory Rating stresses became more detailed
- Allowable bearing stresses on rivets and bolts for Operating Ratings was again increased to be consistent with the increases made in 1974 for Inventory Rating
- Allowable Inventory stresses for A7 bolts and rivets clarified
- Allowable Operating Rating stresses for high-strength bolts detailed for all conditions
- Comparative chart for fastener bearing stresses added
- Maximum Operating Rating concrete stresses in bending clarified

AASHTO Interim Specifications

The AASHTO Interim Specifications[2] of 1984 through 1990 included some re-ordering and editing of various sections of the 1983 AASHTO Manual. In addition, there were significant changes and additions were made in certain sections. These changes are summarized as follows:

- In 1984 the inspection frequency could be increased to more than two years for certain types of bridges if properly documented. An example in Texas is reinforced concrete box culverts.
- In 1984 the two lanes of live loading for roadways between 18 to 20 feet was clarified. For roadways over 20 feet in width, the spacing between trucks became 4.0 feet, which is the same as the AASHTO bridge specifications.[3] This corrected a long time disparity between the bridge specifications and the AASHTO Manual.
- In 1986 there was a major change in the qualification of inspection personnel required that the individual in charge must be a Registered Professional Engineer. Prior to this time, the individual in charge could be qualified by experience.
- In 1986 scour was specifically identified as an item requiring more intense inspection.

1. Manual for Maintenance Inspection of Bridges, AASHTO, 1983.
2. "Interim Specifications for Bridges," AASHTO, 1984, 1986, 1987, 1988, 1989, 1990.
3. Standard Specifications for Highway Bridges, AASHTO, 1994.

- In 1986 nonredundant structures were identified as requiring the initiation of special inspection procedures.
- In 1986 concrete bridges with no plans were allowed to be rated by simple physical inspection and evaluation by a qualified engineer.
- In 1987 underwater inspection was identified as an important inspection requirement. This was a direct result of the failure of the Schoharie Creek Bridge in New York in April 1987, which also resulted in a 1988 FHWA technical advisory.[1]
- In 1987 hangers and pins were identified as features to be properly inspected.
- In 1987 new sections entitled Evaluation and Limiting Vehicle Weights were added. Higher safety factors could be considered for structures with large volumes of traffic. In addition, the agency responsible for maintenance of a structure could use stress levels higher than Inventory Ratings to post a bridge if inspection levels exceeded the minimum.
- In 1987 speed postings were allowed in certain cases to reduce impact loads and thus reduce the need for lowering weight limits. This procedure is not believed to have been applied to any structures in Texas, either on- or off-system.
- In 1988 the requirement that all inspections be done by a Registered Professional Engineer was re-interpreted to allow an inspection team leader to be qualified by experience. However, the person in responsible charge must be an Engineer.
- In 1988 emphasis was placed on underwater inspection of pilings, particularly those exposed to salt water or salt spray, and any foundation member in contact with brackish or chemically contaminated waters.
- In 1989 the minimum weight limit for posting was clarified to be three tons at the Operating Rating stress level. Texas' minimum capacity for bridges to remain open is HS-3 instead of 3 tons.
- In 1989 a new Appendix B was added that described the five basic Inspection Types:
  - inventory
  - routine
  - damage
  - in-depth
  - interim
- The categories and description of each Inspection Type were relatively broad. However, clarifications were made that the first Inventory Inspection was to determine all the Structure Inventory and Appraisal data required by the FHWA and that Routine Inspections were defined as those done at regularly scheduled intervals.
- In 1990 only minor editorial changes were made.

1. "Scour at Bridges," Technical Advisory, FHWA, 1988.

1994 Rewrite of AASHTO Manual

The AASHTO Manual was in the process of a complete rewrite during the period of about 1989 to 1992 under a research contract through the National Cooperative Highway Research Program (NCHRP). Since the rewrite was anticipated to be first presented to the AASHTO Bridge Committee in about 1991, no major changes were made to the 1983 loose-leaf version of the AASHTO Manual in 1991 or 1992. However, the rewrite was not completed for review until 1993. In 1994, AASHTO adopted the revised version (loose-leaf, dark blue) of the AASHTO Manual, which is now called the *AASHTO Manual for Condition Evaluation of Bridges*[1].

Major additions and changes since the 1983 AASHTO Manual are:

Records:

- Total bridge width is to be recorded. Prior to this time, the total was implied by the summation of the deck width, sidewalk or curb width, and railing type.
- Critical features such as special details, scour susceptibility, fatigue-prone details, etc. are now to be recorded.
- Flood records are to be kept if known. This information is not entered in the Coding Guide but should be kept in the Bridge Folder described in Chapter 8.

Inspections:

- Qualifications of the Inspection Program Manager are changed again to allow the person to be qualified by experience. The qualifications are listed the same as first introduced in 1983. The changes of 1986 and 1988, which did not allow qualification by experience, were therefore rescinded. This conforms to State and Federal Regulations, which allow qualification by experience.
- Qualifications of the Inspection Program Manager are modified to allow the person to be qualified by experience. This conforms to state and federal regulations, which are summarized in Appendix A: State and Federal Regulations and allow qualification by experience.
- Qualifications for Inspection Team Leader allow training to be based on a National Institute for Certification in Engineering Technologies (NICET) Level III or IV certification in Bridge Safety Inspection.
- The five basic Inspection Types are now called:
  - Initial,
  - Routine
  - Damage
  - In-depth
  - Special.

1. Manual for Condition Evaluation of Bridges, AASHTO, 1994.

- The categories and description of each Inspection Type are essentially the same as described for the 1983 AASHTO Manual as modified by the 1989 Interim.
- Detailed sections are added on methods of inspection including equipment, safety, advance planning, and preparation for inspections.
- Sections are added to describe inspection procedures, including organized and systematic field notes and procedures.
- Emphasis is placed on obtaining uniformity in condition ratings by different field inspection teams by developing an objective system of evaluation and training.
- New emphasis is placed on inspection of substructures including susceptibility to earthquake damage. There are no areas in Texas with bridges considered to be susceptible to earthquake forces except for a small portion of the El Paso district.
- More emphasis is placed on various types of substructure inspection.
- Detailed inspection recommendations are given for each of the various types of bridge superstructure including new superstructure types such as cable-stayed and prestressed concrete segmental bridges and new component types such as prestressed deck panels.
- Fracture-critical members are to be properly identified.
- More detail is required on description of timber components.
- Greater detail is added on inspection of trusses.

Material Testing:

- Extensive new material is added on field testing of materials for concrete, steel, and timber including reference to the various newer methods such as acoustic emission for steel and pull-off and thermographic tests for concrete.
- Sampling techniques are described in detail.
- Interpretation and evaluation of field and laboratory material tests is discussed.

Non-Destructive Load Testing:

- This is a new section in the AASHTO Manual. However, very little useful information on actual load testing procedures is given.
- Methods of determining equivalent standard ratings from load tests are complex and costly, and are not used at the present time in Texas.

Ratings:

- The rating section of the AASHTO Manual is much more extensive than corresponding sections in previous editions.
- The description of the safety factors for the Load Factor Rating method are similar to the factors in the new AASHTO Load and Resistance Factor Design (LRFD) Specifications.[1]

- The AASHTO Manual stated when a redundant bridge has details not available from plans, then a physical inspection and evaluation may be sufficient to approximate the ratings. An interpretation on applying this criterion to redundant bridges will be presented in Chapter 5, Ratings and Load Posting.
- Structural grade of reinforcing steel is listed separately in the Load Factor Method of rating but is combined with all the older unknown grades for the Allowable Stress Rating Methods. Texas allowed the use of structural grade of reinforcing until about 1962 which was described in the TxDOT Construction Specifications of 1951 and 1962. This will be discussed in more detail in Chapter 5, Ratings and Load Posting.
- The AASHTO Manual now contains detailed examples of allowable stress, load factor, and load and resistance factor (LRFR) ratings for a simple-span, I-beam structure and for a simple-span, concrete structure. An example of an allowable stress rating is also given for a simple-span timber structure.
- An expanded index of subjects is now included in the AASHTO Manual.

Current Status of AASHTO Manual

The Manual for Bridge Evaluation, First Edition (MBE) was adopted by the AASHTO Highways Subcommittee on Bridges and Structures in 2005. The MBE combines the *Manual for Condition Evaluation of Bridges*, Second Edition (2000) and its 2001 and 2003 Interim Revisions with the *Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges*, First Edition and its 2005 Interim Revisions. Revisions based on approved agenda items from annual Subcommittee meetings in 2007 and 2008 are also incorporated into the MBE.

The Manual for Bridge Evaluation, First Edition, with 2010 Interim Revisions supersedes the *Manual for Condition Evaluation of Bridges*, Second Edition and any revisions made in previous Interim Revisions. With the 2008 publication of the MBE, the Subcommittee conferred archive status on the *Manual for Condition Evaluation of Bridges*, the *Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges*, and all Interim Revisions of both prior bridge evaluation titles.

1. Load and Resistance Factor Design Specifications, AASHTO, 1994.

Section 4 — Federal and State Inspection Procedures

The Bridge Inspector's Reference Manual

- The *Bridge Inspector's Reference Manual* (*BIRM*) is a comprehensive manual on programs, procedures, and techniques for inspecting and evaluating a variety of in-service highway bridges. It is intended to replace the *BITM 90* which was first published in 1991 to assist in training highway personnel for the new discipline of bridge safety inspection. *BITM 90* replaced *BITM 70* which had been in use for twenty years and has been the basis for several training programs varying in length from a few days to two weeks. Comprehensive supplements to *BITM 70* have been developed to cover inspection of fracture critical bridge members, and culverts are not covered in the *BIRM*.
- The *BIRM* is a revision and upgrading of the previous manual. Improved Bridge Inspection Techniques are presented, and state-of-the-art inspection equipment is included. New or expanded coverage is provided on culverts, fracture critical members, cable-stayed bridges, prestressed segmental bridges, and underwater inspection. Previous supplemental manuals on moveable bridge inspection and nondestructive testing are excerpted and referenced. These supplemental manuals are still valid supplements to *BIRM*.

Texas Bridge Inspection Procedures

- Inspection procedures in Texas have evolved since the first inspection program was initiated in about 1975.
- Data recorded in Texas exceed that of the current SI&A information required by the FHWA. Texas captures all the required information plus approximately 50 percent more. A detailed description of the data recorded is presented in the Coding Guide.
- The purposes of bridge inspection are:
  - To ensure public safety and confidence in bridge structural capacity
  - To protect public investment and allow efficient allocation of resources
  - To effectively schedule maintenance and rehabilitation operations
  - To provide a basis for repair, replacement, or other improvements such as retrofit railings
  - To ensure that federal funding will remain available for bridge rehabilitation and replacement
- Bridges are inspected every two years, but the frequency may be increased depending on the condition of the bridge. More detail will be given in Chapter 4, Field Inspection Requirements.
- There are five basic types of inspection, each of which will be described in greater detail in Chapter 4, Field Inspection Requirements:
  - **Initial Inspection.** Performed on new bridges or when bridge is first recorded.

- **Routine Inspections.** Those regularly scheduled, usually every two years for most normal bridges.
- **Event Driven Inspections (AASHTO Damage Inspections).** Those performed as a result of collision, fire, flood, significant environmental changes, loss of support, etc. These inspections are also called Emergency Inspections and are performed on an as-needed basis.
- **In-Depth Inspections**. Performed usually as a follow-up inspections to better identify deficiencies found in any of the above three types of inspection. Detailed Underwater Inspections are considered a type of In-Depth Inspection. Fracture-critical Inspections are another type of In-Depth Inspection.
- **Special Inspections.** Performed to monitor a particular deficiency or changing condition. Unusual bridge designs or features such as external, grouted, post-tensioned tendons, may require a Special Inspection.

Chapter 3 — Qualifications and Responsibilities of Bridge Inspection Personnel

Contents:

Section 1 — Requirements

General Requirements

Personnel involved in the various bridge inspection activities must be qualified for their specialized jobs. In general, depending on the level of responsibility, they must be knowledgeable in the various aspects of bridge engineering including design, load rating, construction, rehabilitation, and maintenance.

Federal Requirements

The United States Code (23 U.S.C. 151) requires the Secretary of Transportation, in consultation with State transportation departments, to establish national bridge inspection standards for the proper safety inspection and evaluation of all highway bridges. These requirements are spelled out in the Code of Federal Regulations (Part 650, Subpart C) and govern the National Bridge Inspection Standards (NBIS) through purpose, applicability, definition of terms, qualification of personnel, inspection frequencies, inspection procedures, inventory procedures, and supporting references.

The NBIS have specific qualification requirements for individuals working in the bridge inspection program of a state. These are summarized as:

- The individual in charge of each organizational unit (the Bridge Inspection Branch of the Bridge Division, the project manager for each firm under contract with TxDOT to perform bridge inspections) must:
  - be a Registered Professional Engineer or have a minimum of ten years experience in bridge inspection experience; **and**
  - successfully completed an FHWA approved comprehensive bridge inspection training course.
- The individual in charge of a bridge inspection team (Team Leader) must:
  - have the same qualifications as above, **or**
  - have a minimum of five years experience in bridge inspection assignments 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[1] (NICET) and have completed an FHWA approved comprehensive bridge inspection training course; **or**

1. National Society of Professional Engineer's program for National Certification in Engineering Technologies, National Institute for Certification in Engineering Technologies (NICET), current.

- have all of the following:

1. 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; **and**
2. successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination;
3. two years of bridge inspection experience; **and**
4. successfully completed an FHWA approved comprehensive bridge inspection training course; **or**

- have all of the following:

1. an associate's degree in engineering or engineering technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology; and
2. four years of bridge inspection experience; **and**
3. successfully completed an FHWA approved comprehensive bridge inspection training course.

- The individual charged with the overall responsibility for load rating bridges must be a registered professional engineer.
- An underwater bridge inspection diver must complete an FHWA approved comprehensive bridge inspection training course or other FHWA approved underwater diver bridge inspection training course.

AASHTO Requirements

AASHTO also has essentially the same requirements as the FHWA. These are described in the current AASHTO *Manual for Bridge Evaluation*[1].

TxDOT Requirements

At a minimum, all bridge inspection activities performed by TxDOT and by TxDOT bridge inspection consultants must comply with Federal requirements. In addition to Federal requirements for bridge inspection personnel, some jobs may require more specific job-related knowledge and skills such as:

- The use of breathing apparatus for underwater inspection.
- The various applicable requirements for inspection safety including applicable Occupational, Safety, and Health Administration (OSHA) requirements, such as safety requirements for working in confined spaces and at heights.

1. *Manual for Bridge Evaluation*, AASHTO

- Advanced computer skills related to bridge analysis.
- Geotechnical and hydrological knowledge.
- Familiarity with TxDOT bridge construction specifications and with current and old TxDOT bridge designs.

TxDOT also has special requirements for consultants retained to perform bridge inspection tasks. All firms must be pre-qualified. Further information on consultant requirements is presented later in this chapter in Section 3 titled "Bridge Inspection by Consultants."

Section 2 — TxDOT Bridge Inspection Personnel

Specific Position Requirements

The following subsections briefly describe each TxDOT job position. Greater detail is given in the Human Resources Manual describing the various positions. TxDOT bridge inspection personnel must have the appropriate Bridge Inspection job classification, experience and training.

Division Manager of Bridge Inspection Operations

This person heads the Bridge Inspection Branch of the Bridge Division. Under the general direction of the Director of the Bridge Division, the position has statewide responsibility for the Texas bridge inspection operations.

All the bridge inspection activities for Texas are under the general oversight of this position and includes such major items such as:

- Oversee and maintain or assist in overseeing and maintaining the Bridge Inspection Program in the Bridge Division and assist districts with bridge inspection-related matters.
- Coordinate fracture critical, underwater or off-system bridge inspection programs.
- Develop standards in conjunction with TxDOT divisions and districts and the Federal Highway Administration and ensure compliance with National Bridge Inspection Standards.
- Perform, review and monitor detailed investigations, data collection, analyses and coordination of bridge related research and recommend cost effective project level design for new, rehabilitated and reconstructed bridges.
- Prepare, evaluate, perform final reviews, and negotiate contracts with consultants for routine, fracture critical and underwater inspections of the district bridges.
- Monitor consultants' progress and work quality; check invoices and associated documents; prepare supplemental agreements.
- Schedule, assign and oversee bridge inspection activities.
- Oversee and perform bridge structural evaluations/analyses of structures; inspect bridges that have appraisal and condition ratings or are recommended for closure.
- Rate and monitor load carrying capacities of bridges.
- Maintain a critical bridge list and coordinate with the Bridge Division, area engineers and other district staff on critical findings involving state maintained bridges to have them posted, repaired or closed to the traveling public.

- Recommend replacement, rehabilitation or repair of damaged bridges and coordinate with local officials on critical findings involving structures not under state jurisdiction, to have them posted, repaired or closed to the traveling public.
- Perform critical inspections on large or unusual structures when requested by the Bridge Division or in response to an emergency.
- Recommend prioritization of bridge replacement, bridge rehabilitation and repair of damaged bridges.
- Review contract development and related documents for execution.
- Oversee the processing and review of consultant selection documentation, contracts, and related documents.
- Interpret laws, rules, and regulations pertaining to professional services contracting to ensure compliance with Department and governmental regulations.
- Chair or serve as a member of a contract selection team.
- Negotiate fees and budgets; develop and negotiate scopes of work; negotiate contract work schedules; and negotiate other contract agreements.
- Monitor contract performance; evaluate contract deliverables; review billing documentation; monitor consultants' compliance with contract terms; and prepare and deliver a written evaluation of the consultant performance.
- Serve as a project manager overseeing consultants performing advanced and complex engineering work.

District Bridge Inspection Coordinators or Bridge Engineering Specialist in a Division

The TxDOT personnel assigned to these positions are directly responsible for bridge inspection operations within the division or district. Under general guidance from the Division Manager of Bridge Inspection or from the District Engineer, they perform a variety of tasks. If the individual filling the District Bridge Inspection Coordinator position is not an engineer, then they must meet the minimum requirements of a Bridge Engineering Specialist.

Some of the major bridge inspection responsibilities and duties of this position may include:

- Implement and monitor the bridge inspection program in a district.
- Maintain and review files which indicate the condition of the bridge inventory and document compliance with bridge inspection manuals.
- Inspect and appraise bridge structures according to the bridge inspection *Manual of Procedures*.
- Coordinate the bridge load-posting program in the district
- Performs structural analysis and calculations on structures to certify load-carrying capacity.

- Perform bridge appraisals and sufficiency rating calculations according to the bridge inspection *Manual of Procedures*.
- Conduct immediate inspection of damaged bridges, determine necessity of temporary or permanent repairs and notifify maintenance personnel; make recommendations to close bridges.
- Implement and prepare Bridge Maintenance Program for a district.
- Prepare bridge inspection follow-up worksheet for maintenance and give instructions for recommended actions.
- Monitor follow-up actions taken by maintenance.
- Work with county officials to post or repair bridges under the county's jurisdiction.
- Work with design and construction personnel on new construction projects to determine new structures to be added to the inventory.
- Determine extent of deterioration requiring rehabilitation or replacement as the basis for planning bridge replacement and rehabilitation programs.
- Prepare and analyze summaries of bridge inspection computer data.
- Monitor inspection contract work authorization performance; evaluate deliverables; review billing documentation; monitor the consultant compliance with the terms of the contract; and evaluate the consultant performance.
- Perform fracture-critical bridge member inspections.
- Maintain bridge inspection and diving equipment.
- Research plan sets for use in underwater, fracture-critical and on and off system bridge inspections.
- Perform underwater bridge inspection requiring diving.
- Ensure compliance with Occupational Safety and Health Administration (OSHA) standards and direct the Diving Safety Program.

Bridge Inspection Staff Technicians

These TxDOT engineering technicians perform many of the bridge inspection tasks within the division or a district. Under direct supervision from the Bridge Division Inspection Branch Manager or, the District Bridge Inspection Coordinator, or a Bridge Inspection Engineer, the positions are responsible for many specific tasks.

Some of the specific bridge inspection responsibilities and duties of these positions may include:

- Assist with fracture-critical bridge member inspection.
- Assist with bridge inspections.

- Record data and maintain and review bridge inspection files for compliance with bridge inspection manuals.
- Prepare and analyze summaries of bridge inspection computer data.
- Prepare drawings and sketches to be included in bridge inspection reports.
- Perform bridge appraisals and sufficiency rating calculations according to the bridge inspection *Manual of Procedures*.
- Research plan sets for use in underwater, fracture-critical and on- and off-system bridge inspections.
- Maintain bridge inspection and diving equipment.
- Assist with underwater bridge inspection.
- Perform underwater bridge inspection requiring diving.

Section 3 — Bridge Inspections by Consultants

General Requirements

All firms contracted by TxDOT to perform routine bridge inspections must be pre-certified in accordance with the requirements of the applicable portions of the Code of Federal Regulations given in Appendix A. In general, inspections performed under contract to TxDOT for inspection of both on- and off-system bridges will conform to the FHWA *Bridge Inspector's Reference Manual* [1], Service to Be Provided provisions in the TxDOT Bridge Inspection Contract, and this *manual*.

Routine Bridge Inspections

For routine bridge inspections, the firm must employ an individual to serve as Project Manager who meets the following qualifications:

- Is a Licensed Professional Engineer in the State of Texas; **and**
- Has successfully completed an FHWA approved comprehensive bridge inspection training course.

The requirement for completion of a comprehensive training course will be considered to mean completion of the two-week course presented by the National Highway Institute (NHI) called Safety Inspection of In-Service Bridges[2] .

TxDOT requires all Project Managers to successfully complete a mandatory refresher course every four years, NHI Course No. 130053.

The bridge inspection Team Leaders employed by the firm must also be qualified and have:

- the same qualifications as required for the Project Manager, **or**
- a minimum of five years experience in bridge inspection assignments and successfully completed an FHWA approved comprehensive bridge inspection training course, **or**
- certification as a Level III or Level IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies[3] (NICET) and have successfully completed an FHWA approved comprehensive bridge inspection training course, **or**
- all of the following:

1. Bridge Inspector's Training Manual 90, FHWA, 1991.
2. Safety Inspection of In-Service Bridges, National Highway Institute, current.
3. National Society of Professional Engineer's program for National Certification in Engineering Technologies, National Institute for Certification in Engineering Technologies (NICET), current.

1. 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; **and**
2. successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination; **and**
3. two years of bridge inspection experience; **and**
4. successfully completed an FHWA approved comprehensive bridge inspection training course, **or**

- all of the following:

1. an associate's degree in engineering or engineering technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;
2. four years of bridge inspection experience; **and**
3. successfully completed an FHWA approved comprehensive bridge inspection training course.

TxDOT requires all team leaders to successfully complete a mandatory refresher course every four years, NHI Course No. 130053.

Complex Bridge Inspections

For complex bridge inspections, such as those requiring fracture-critical inspections, the firm must employ an individual to serve as Project Manager who meets the following qualifications:

- Is a Registered Professional Engineer in the State of Texas; **and**
- Has seven years of bridge inspection or design experience, including one year of inspection or design of bridges considered as complex; **and**
- Has successfully completed an FHWA approved comprehensive bridge inspection training course.
- If complex bridge inspection assignment includes fracture critical inspections, then this individual must have successfully completed an FHWA approved fracture critical inspection course, NHI Course No. 130078.

TxDOT requires all Project Managers to successfully complete a mandatory refresher course every four years, NHI Course No. 130053.

The bridge inspection Team Leaders employed by the firm must also be qualified and have:

- Six years of bridge inspection or design experience, including one year of inspection or design of bridges considered as complex; **and**
  - The same qualifications as required for the Project Manager; **or**

- Have certification as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies[1] (NICET) and successfully complete an FHWA approved comprehensive bridge inspection training course; **or**
- Have all of the following:

1. 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; **and**
2. successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination;
3. two years of bridge inspection experience; **and**
4. successfully completed an FHWA approved comprehensive bridge inspection training course, **or**

- Have all of the following:

1. an associate's degree in engineering or engineering technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology; **and**
2. four years of bridge inspection experience; **and**
3. successfully completed an FHWA approved comprehensive bridge inspection training course.

◆ If complex bridge inspection assignment includes fracture critical inspections, then individual must have successfully completed an FHWA approved fracture critical inspection course, NHI Course No. 130078.

TxDOT requires all team leaders to successfully complete a mandatory refresher course every four years, NHI Course No. 130053.

Pre-certification Procedures for Consultants

Bridge inspection contracts are developed and monitored by both district and division personnel. Consultants must demonstrate the required minimum amount of experience in bridge inspection, rating, and evaluation. Consultants must have knowledge of TxDOT bridge inspection procedures, requirements, and goals of the statewide bridge safety inspection program.

Consultant personnel must have completed the required training in bridge inspection.

Familiarity with current and past AASHTO specifications is necessary. Extensive knowledge of TxDOT bridge construction specifications, including current and past TxDOT bridge designs is

1. National Society of Professional Engineer's program for National Certification in Engineering Technologies, National Institute for Certification in Engineering Technologies (NICET), current.

also necessary since many off-system bridges with no documented plans were constructed using TxDOT standard designs.

Section 4 — Use of the Consultant Pool

Consultant firms who are under contract with the Bridge Division to perform bridge inspections in Texas are available for use by the districts. New inspection contracts are executed every two years by the Bridge Inspection Branch of the Bridge Division. The necessary procedures that must be followed by the districts to utilize these consultants is described below.

Request for Consultant Inspection

The district must initially provide the following three items to the Bridge Inspection Branch of the Bridge Division with a lead time of at least three months:

- A request in writing
- The total numbers of bridges to be inspected broken out by county
- An identification of the bridges as being on- and/or off-system

Work Authorization Issuance

The Bridge Inspection Branch of the Bridge Division will send to the district a blank Work Authorization along with a fee schedule for the recommended consulting firm who has been contacted. The district then proceeds with the following:

- Complete the Work Authorization and fee schedule.
- Include description of where the bridge inspections will take place (multiple counties may be included in the same Work Authorization).
- Complete the fee schedule with the number of bridges to be inspected by type.
- Include the total dollar amount on the Work Authorization.
- Contact the consultant firm and agrees to a termination date for the completion of the inspections, which is entered on the Work Authorization.
- Send the Work Authorization to the inspection firm for signature.
- Fill out and send to the Bridge Division a copy of the State Agency Uniform Nepotism Disclosure Form - June 2005.

The Bridge Division will execute the Work Authorization and notify the district and the consulting firm once the Work Authorization has been executed. The consultant may begin bridge inspections upon execution of the Work Authorization.

Managing Consultant Bridge Inspections

To ensure that bridge inspections are performed in a competent and timely fashion, the district will perform oversight of the work by following these steps:

- Verify the bridge inspection firm's Project Manager and individual Team Leaders against the list provided by the Bridge Inspection Branch of the Bridge Division.
- Periodically visit the firm's inspection teams in the field to verify team composition and to observe actual inspections.
- When completed inspections are submitted by the consultant, the District Bridge Inspection Office should review at least 10 percent of the office work and perform field reviews of 7 percent of the field work.
- When invoices are submitted to the district by the consultant, they should be reviewed and submitted to the Finance Division as soon as possible (TxDOT has a maximum of 30 days to process an invoice from the date it is received to avoid payment of interest). Date-stamp each invoice, whether transmitted by mail or electronically, with the date on which the receiving TxDOT district received the invoice.
- The district should monitor the amount of completed consultant bridge inspections to ensure that additional structures that might be added as the work progresses will have sufficient funds in the Work Authorization.
- If additional funds or time is needed to complete the Work Authorization, a request for a Supplemental Agreement must be made to the Bridge Inspection Branch of the Bridge Division at least 2 weeks before the termination of the initial Work Authorization.

Evaluation of Bridge Inspection Consultant Firm and Project Manager

When the bridge inspections covered by the Work Authorization are finished, the district should complete an evaluation form provided by the Consultant Contract Office of the Design Division. Refer to the Consultant Certification Information System for the evaluation form at https://www.dot.state.tx.us/des/ccis/Sign_On.htm. Evaluations should be submitted within 30 days of the completion of the Work Authorization. Properly evaluating the inspection firms ensures the overall quality of the work provided by the consultant, and also aids in the consultant pool selection for the next two-year cycle. The evaluations should be based on the following criteria:

Project Manager Evaluation

- **Accuracy and Completeness of Deliverables:** Information and/or quantities are correct. Technical judgment was exercised. Quality assurance measures are implemented - apparent that deliverables are checked prior to submission. The Project Manager should be evaluated on the number of errors in the work and if Quality Assurance methods have been implemented to prevent errors in the files before submission.

- -15 points - Numerous files were submitted with significant errors and it is apparent that they were not checked before submission.
- -12 points - A few files were submitted with significant errors and it is apparent that they were not checked before submission.
- -9 points - Numerous files were submitted with errors that were not significant but made it questionable if the files were checked before submission.
- -6 points - A few files were submitted that had errors that were not significant but made it questionable if the files were checked before submission.
- 0 points - Few errors that were easily corrected.
- +3 points -Very few errors that were easily corrected, it is apparent that files are checked before submission.
- +6 points - No errors, it is apparent that a Quality Assurance process is in place to produce a quality product.

◆ **Deliverable Presentation and Format:** Products are neat, organized, clear, and in conformance with applicable standards and requirements. The Project Manager should be evaluated on how well the reports were filled out and how the files and folders were put together.

- -12 points - All files and/or reports are not per the contract or TxDOT standards. Folders are not put together in an acceptable manner. Forms used are in a different format than the TxDOT standard forms.
- -9 points - A few files were not put together per the contract. Some of the submitted forms were a different format than the TxDOT standard forms.
- -6 points - Folders and reports were acceptable, but need improvement.
- 0 points - Folders, files and reports were satisfactory.
- +6 points - Excellent presentation. Folders, files and reports exceed requirements.

◆ **Schedule Management:** Generally adheres to the schedule and meets major deadlines. Also, proactive in addressing issues potentially affecting schedule. (Missed deadlines attributed to slow or poorly timed TxDOT responses should not count against the provider.) The Project Manager should be evaluated on making sure bridges are inspected with 30 days of the assigned inspection frequency and there was coordination with the District on the inspection schedule so as not to "compress" the schedule on the next inspection cycle. All inspection reports should be completed and returned to the District within 45 days of inspection.

- -12 points - Missed deadlines and permitted bridge to be out of compliance in regards to their inspection dates; did not consult with the District and inspection dates are compressed for the next inspection cycle.
- -9 points - Bridge inspections were in compliance but the 45 day requirement to return completed reports to the District were always missed.
- -6 points - Bridge inspections were in compliance but the 45 day requirement to return completed reports to the District were periodically missed without notifying the District.

  - -3 points - Bridge inspections were in compliance but the 45 day requirement to return completed reports to the District were periodically missed (the District received notification of the late submittal).
  - 0 points - Deadlines met; effective schedule management.
  - +6 points - Compressed schedule met.

- **Responsiveness to Review Comments:** Comments (many or few) are appropriately addressed within one review iteration. The Project Manager should be evaluated on making sure that review comments are addressed quickly and correctly.
  - -9 points - Multiple iterations are always required.
  - -6 points - Multiple iterations are routinely required.
  - -3 points - Multiple iterations are occasionally required.
  - 0 points - Comments are appropriately addressed within one review iteration.
- **Level of TxDOT Oversight:** TxDOT's involvement is commensurate with project requirements. Additional time and attention is not required as a result of the provider's need for management or technical support. The Project Manager should be evaluated on how much additional time and attention was required by TxDOT to ensure that the provider would fulfill the requirements of the Contract.
  - -9 points - Significantly more than expected.
  - -6 points - Increased review time; TxDOT interaction needed on basic technical issues.
  - -3 points - More than expected.
  - 0 points - As expected; normal oversight.
  - +3 points - Less than expected; Project Manager's expertise and experience provided significant benefit; saved TxDOT time.
- **Project Manager Responsiveness/Availability:** Project Manager promptly returns calls and e-mails. Is available for questions and meetings as needed.
  - -6 points - Problem with response rate and/or availability.
  - -3 points - Project Manager slow to respond; inconsistent availability.
  - 0 points - Responsive and available.
- **Coordination and Communication:** There is a clear, effective communication structure. Issues are communicated promptly. Documentation and coordination is professional. Familiar with and effective in required/necessary external coordination (with the public, other agencies, etc.). The Project Manager should be evaluated on how promptly and accurately issues are related to TxDOT and other entities (cities or counties).
  - -6 points - Less than satisfactory.
  - -3 points - Acceptable, but lacks consistency; could be better.
  - 0 points - Good coordination and communication.

- +3 points - Communication and coordination capabilities add to quality of project/ process.

◆ **Reliability/Responsibility:** Takes responsibility - no excuses. Proactive in avoiding problems, bringing solutions to TxDOT, and obtaining necessary information, as appropriate. Stays on top of the situation.

- -6 points - Unacceptable; expected TxDOT to solve issues.
- -3 points - Acceptable, but needs improvement.
- 0 points - Satisfactory; reliable and responsible.
- +3 points - Above satisfactory; made TxDOT's job easier.

◆ **Subconsultant Management:** Subs were well-managed. Issues, if any, were not apparent and were managed so not to interfere with production. Project Manager takes responsibility for all products. Poor subconsultant performance not an issue.

- -6 points - Sub issues not managed well; coordination affected.
- -3 points - Less than satisfactory.
- 0 points - Satisfactory subconsultant management.

◆ **Scope Management - Supplemental Work:** Scope changes (additional work) identified in advance and well supported, reasonable time and cost estimates provided. Concerns identified in a timely manner that could affect scope or schedule. The Project Manager should be evaluated on how well he manages additional work added (This additional work must be approved by the Bridge Division and added to the contract through a Supplemental Agreement.

- -3 points - Less than satisfactory.
- 0 points - Satisfactory scope management.

◆ **Contract Administration:** Project Manager is familiar with and abides by the terms and conditions of the contract and/or work authorization. Coordinates with TxDOT as required, provides appropriate progress reports, and remains aware of end dates. The Project Manager should be evaluated on how well he meets the terms of the contract and work authorization.

- -3 points - Less than satisfactory.
- 0 points - Satisfactory; contract terms and conditions followed.

Firm Evaluation

◆ **Responsiveness:** Anticipates or responds timely to needs identified by TxDOT, such as adjusting resources in response to schedule demands, replacing project manager, task leaders, or other staff, if problems exist. The Firm should be evaluated on how well they can add additional resources or replace key inspection members if problems exist.

- -15 points - The firm is non-responsive and problems are not addressed.
- -12 points - The majority of issues are not addressed in a timely manner.

- -9 points - Numerous issues were not addressed in a timely manner.
- -6 points - Most issues were addressed in a timely manner but some issues were not addressed.
- 0 points - Satisfactory, firm was responsive.
- +3 points - Firm goes above and beyond normal practices in response to TxDOT needs.

◆ **Resource Management:** Personnel/expertise and/or equipment are appropriately allocated. Promptly/adequately addresses staffing issues, when necessary. Minimum reallocation of staff throughout project life except for instances beyond the provider's control (retirements, resignations, dismissals, unexpected/excessive delays imposed by TxDOT or others).

- -15 points - Personnel or equipment not appropriate; multiple changes in Project Manager or key staff.
- -12 points - The majority of resource issues are not addressed in a timely manner
- -9 points - Numerous resource issues were not addressed in a timely manner.
- -6 points - Response to personnel or equipment issues were less than satisfactory.
- 0 points - Satisfactory resource management.
- +3 points - Minimum reallocation of staff when significant uncontrollable delays occur.

◆ **Invoicing:** Neat, accurate, consistent, includes required back-up, prepared according to payment terms, and timely (according to contract terms).

- -9 points - Frequently late or consistently submitted with problems.
- -6 points - Less than satisfactory; periodically late; frequent problems.
- -3 points - Needs improvement.
- 0 points - Satisfactory; on-time; generally good form.
- +3 points - on-time; exceptional form; saves TxDOT time.

Once an evaluation has been completed, print out a copy and sign. Send the signed version to the project manager of the firm being evaluated for review and comment. Make sure that the project manager has signed the evaluation after the review and any comments added. Have the project manager return the evaluation to the originating bridge inspection office. Send a copy of the evaluation form, with both signatures, to the Bridge Inspection Office of the Bridge Division. Enter any comments from the project manager of the evaluated firm into the Consultant Certification Information System through the previously used link.

Chapter 4 — Field Inspection Requirements

Contents:

Section 1 — Types of Bridge Inspection

There are five basic types of bridge inspections:

- Initial inspections.
- Routine inspections.
- Event-driven inspections (AASHTO damage inspections).
- In-depth inspections.
  - Underwater inspections and fracture-critical inspections are two types of in-depth inspections.
- Special inspections.
  - Inspection of post-tensioned, grouted, external tendons is an example of a special inspection.

Section 2 — Initial Inspections

Overview

The *Code of Federal Regulations* contains the National Bridge Inspection Standards (NBIS). The NBIS require inventory information to be entered into the State's database within 90 days after the bridge is placed in service (begins carrying traffic).

Perform initial inspections on new bridges or when existing bridges are first entered into the database. This inspection provides a basis for all future inspections or modifications to a bridge.

Note initial deficiencies which might not have been present at the time of construction. Note changes in the condition of the site, such as:

- Erosion
- Scour
- Regrading of slopes

Notify the District Bridge Inspection Coordinator when the bridge is opened to traffic and available for use by permit vehicles. Include this information in the final New Bridge Completion Checklist.

The opening of a new bridge, particularly an off-system bridge, is a good time to ensure that a copy of the bridge plans are included with the Bridge Records described in Chapter 8 of this manual. Texas law[1] requires a governmental entity that owns a bridge on a public road must submit a copy of the final structural plans to TxDOT within 31 days after construction or rehabilitation is completed.

Prepare the initial Bridge Folder as a result of the Initial Inspection. A detailed description of the Bridge Folder contents is given in Chapter 8 of this manual, Bridge Records. Arrange the folder consistently in all districts and include the recommended series of photos.

1. Submission of Bridge Design Plans to Department, Texas Transportation Code, Section 201.804.

Section 3 — Routine Inspections

Overview

Routine inspections are those regularly scheduled, performed, and recorded in accordance with all the procedures described in Chapter 8 of this manual, Bridge Records and the instructions Coding Guide. Conduct these at least every twenty-four months for most bridges, and every forty-eight months for some concrete culverts.

Inspection Equipment

The equipment needed for routine bridge inspections usually includes the following:

- Cleaning tools including wire brushes, screwdrivers, brushes, scrapers.
- Inspection tools including pocket knife, ice pick, hand brace, bit, and increment borer for boring timber elements, and chipping hammer.
- Visual aid tools including binoculars, flashlight, magnifying glass, dye penetrant, and a mirror.
- Basic measuring equipment including thermometer, center punch, and simple surveying equipment.
- Recording materials such as appropriate forms, field books and cameras.
- Safety equipment including rigging, harnesses, scaffolds, ladders, Bosun;s chairs and a first-aid kit.
- Miscellaneous equipment should include C-clamps, penetrating oil, insect repellant, wasp and hornet killer, stakes, flagging, and markers.

A more complete description of the usual inspection equipment can be found in Chapter 5 of the *Bridge Inspector's Reference Manual*.[1]

Some inspections may significantly interfere with normal traffic movement and could endanger the bridge inspectors and traveling public. Coordinate these inspections with District personnel to ensure that appropriate traffic control measures are taken.

The underside of some bridges cannot be reached for inspection by conventional ladders. Perform these inspections using a vehicle with under-bridge platforms. TxDOT owns and operates several of these vehicles. Small boats are also available.

Coordinate in advance with the Bridge Inspection Branch of the Bridge Division to use any Division specialized access equipment.

1. *Bridge Inspector's Reference Manual*, FHWA, 2002 and 2006.

Section 4 — Event-Driven Inspections

Perform event-driven inspections as a result of collision, fire, flood, significant environmental changes, or loss of structural support. These inspections are also called emergency inspections and are performed on an as-needed basis. In the past AASHTO referred to these inspections as damage inspections.

Prepare a report for each Event-Driven Inspection. Include in the report, at a minimum, the following:

- photos documenting any damage
- load ratings verifying capacity after event
- channel profiles (when applicable)
- repair recommendations
- load restriction recommendations (if applicable).

Include all documentation from Event-Driven Inspections in the permanent bridge inspection record.

Section 5 — In-Depth Inspections

Reasons for In-Depth Inspections

In-Depth Inspections are usually performed as a follow-up inspection to an Initial, Routine, or Event-Driven Inspection to better identify any deficiencies found.

Underwater Inspections and Fracture-Critical Inspections are both types of In-Depth Inspection. These are described in more detail below.

Load testing may also sometimes be performed as part of an In-Depth Inspection. However, load testing for determining bridge load capacity is costly and its results open to interpretation.

Underwater Inspections

Underwater Inspections are a type of In-Depth Inspection. Perform these at least every sixty months or more frequently if conditions warrant. Perform an Underwater Inspection on structures where the submerged portions of the structure have a history of water depths of at least four feet year round or where the submerged elements are in less than four feet of water, but wading would be unsafe due to channel bottom conditions, high current or localized scour.

A majority of the bridge structures in the United States, some 86 percent in the National Bridge Inventory, are over some type of waterway. The lower elements and foundations of many of these bridges are permanently inundated, so there is no opportunity to view the effects of scour or damage to the structure. To determine the condition of these bridge foundation elements and ensure the safety of the traveling public, perform Underwater Inspections on a regular basis. As a result of several bridge collapses during the 1980s, the National Bridge Inspection Standards[1] (NBIS) were revised to require a master list of bridges requiring Underwater Inspections, and to establish an inspection frequency not to exceed five years.

The master list of Underwater Inspections is reviewed and updated during Routine Inspections. Once a bridge is added to the master list, it remains there until it is no longer in use. Some bridges must be inspected at intervals more frequent than the required sixty months due to the susceptibility to scour or other factors such as the age of the bridge, configuration of the substructure, environment, adjacent features, or existing damage. The frequency, type, and level of inspection are left up to the owner of the structure.

Underwater Inspection Methods

There are currently three methods used to conduct Underwater Inspections. These are:

1. The National Bridge Inspection Standards, Code of Federal Regulations, Title 23, Part 650, October, 1988

- Wading -- The most basic of the three methods, wading requires only a probing rod and wading boots to be effective. This is performed during Routine Inspections.
- Scuba diving -- A method that allows a more detailed examination of substructure conditions at the mudline. The diver has freedom of movement and may carry a variety of small tools with which to probe or measure.
- Hardhat diving -- Involves the use of sophisticated diving equipment and a surface supplied air system. This inspection method is well suited when adverse conditions will be encountered, such as high water velocity, pollution, and unusual depth or duration requirements.

The choice of which method to employ depends largely on accessibility and the required inspection detail.

Levels of Underwater Inspection

Standard levels of inspection originated in the U.S. Navy. Three levels have been established as the result of the process through time.

- Level I -- A simple visual or tactile (by feel) inspection, without the aid of tools or measuring devices. It is usually employed to gain an overview of the structure and will precede or verify the need for a more detailed Level II or III inspection.
- Level II -- A detailed inspection which involves physically cleaning or removing growth from portions of the structure. In this way, hidden damage may be detected and assessed for severity. This level is usually performed on at least a portion of a structure, supplementing a Level I.
- Level III -- A highly detailed inspection of a structure which is warranted if extensive repair or replacement is being considered. This level requires extensive cleaning, detailed measurements, and testing techniques that may be destructive or non-destructive in nature.

Underwater Structural Elements

The elements of a bridge structure that may be located below the water line are abutments, bents, piers, and protection systems. Bents are distinguished from piers in that they carry the loads directly to the foundation rather than using a footing.

Abutments normally do not require an Underwater Inspection, but in rare instances may be continuously submerged. Although usually founded on piles or drilled shafts, abutments occasionally rest on spread footings in rock. Scour is almost always the primary consideration when an underwater abutment inspection is being conducted. Local scour is often detectable during diving inspections, although sediment will eventually refill a scour hole between the events that cause the scour. More general scour, or channel degradation, will usually be undetectable to the diver and must be determined from known channel cross sections or historical data.

Underwater Inspection Devices

Divers may use several types of sounding or sensing devices in underwater investigations. The most common device is the black-and-white fathometer. It uses sound waves reflected from the channel bottom and records the depths continuously. It provides an inexpensive, effective means of recording channel depths, but does not detect a refilled scour hole. Another device is the color fathometer. It uses different colors to record different densities and in this way often detects scour refill. Other devices include ground penetrating radar, which works well for shallow water but has limited usefulness in murky water, and fixed instrumentation, which is reliable but requires periodic monitoring and resetting to be effective.

Underwater Structural Materials

Piers and bents, if located in a navigable waterway area, are often subject to material defects, collision damage and scour. Concrete is the most common type of material encountered in Underwater Inspections, followed by timber, steel, and masonry. Common defects in concrete substructures include cracking, spalling, laitance, and honeycombing. Minor or even moderate damage to concrete can be tolerated if it does not endanger the reinforcing. Corrosion of the reinforcing can lead to serious difficulties.

Timber has frequently been used for piles, especially in fenders or protection systems. The most common type of damage to timber members is from biological organisms, such as fungus, insects, and marine borers. In order to control infestations, timber is usually treated to poison the wood to block a food source for organisms. In time the treatment may leach out of the wood or the treatment layer may be penetrated. Pay particular attention to the area of the waterline and the vicinity of connectors where this type of damage may occur.

Steel substructures are very susceptible to corrosion near the waterline or between the high and low water levels. In this area, oxygen and frequent wet/dry cycles promote deterioration at an accelerated rate. Measure steel to determine the possibility of section loss.

Masonry substructures are rare and if present, are almost always on very old bridges. These elements are subject to damage similar to concrete, in addition to the loss of joint mortar and individual pieces.

Fracture-Critical Inspections

Fracture-Critical Inspections are a type of Special Inspection. These inspections are usually limited to non-redundant load path tensile stress areas. Perform Fracture Critical Inspections every twenty-four months. Perform them more frequently if conditions warrant. A Fracture Critical Inspection is a hands-on (within arms length of the component) inspection of a fracture critical member or member components. It may include visual and other nondestructive evaluation. Methods of Non-

Destructive Evaluation (NDE) of steel members may include dye penetrant, magnetic particle, or ultrasonic techniques.

History of Fracture Critical Considerations

Early development of modern steel design focused on stress and strain. Little was known or recognized about the potential adverse effects of multiple stress cycles. Early materials such as wrought iron were not capable of great unit strength. Early designs lacked the sophistication that would allow a designer to closely address details. Even after the introduction of electric arc welding in the 1880s, most steel bridges were simple-span, composed of built-up and riveted members.

Design of continuous beam highway bridges began after welding technology was improved. Some of the first welded steel beam bridges were in Texas. The use of continuity resulted in more flexible structures that were more subject to deflections and rotations. The use of welding, particularly in Texas, resulted in simpler bridges and more consistent construction quality.

As steel production and availability improved, along with higher strength steels, design engineers were quick to accept the obvious benefits. However, no material is perfectly homogenous, and the fact that steel could have hidden flaws was essentially ignored by designers. After World War II, there was a massive expansion of highway bridge construction. The popularity of personal motor vehicles increased as a result of more highways and thus more roadways and bridges were needed. The construction material of choice was initially steel throughout much of the country. However, Texas designed many smaller structures with concrete, which is still serving well in many locations. Steel bridges, particularly trusses, were used for longer crossings, usually for streams and rivers.

Fatigue Failures

A number of steel structures failed in the 1950s and 1960s due to various causes, but the failure of the Silver Bridge at Point Pleasant in West Virginia in 1967 got national attention. This truss collapsed suddenly due to the brittle fracture of an eyebar link, resulting in the loss of 46 lives and closure of a major route. As a result of this terrible tragedy, the *National Bridge Inspection Standards*[1] (NBIS) were developed as part of the Federal-Aid Highway Act[2] of 1968. In addition, significant additional research efforts were initiated in fracture mechanics. As a result, the effects of multiple stresses at less than yield of the materials were understood more thoroughly.

Redundant and non-redundant members were first recognized in the twelfth edition of the *AASHTO Bridge Specifications*[3] in 1977. The first guide specifications for fracture critical bridge members was issued by AASHTO[4] in 1978.

1. The National Bridge Inspection Standards, Code of Federal Regulations, Title 23, Part 650, October, 1988.
2. Federal-Aid Highway Act of 1968.
3. Standard Specifications for Highway Bridges, AASHTO, 1977.

Fracture-Critical Members

After design engineers began to recognize the problems associated with multiple stresses at less than allowable values, further information was developed to assist in the design process and in evaluation of existing structures. After notable failures, it was recognized that many existing bridges may be nearing failure due to fatigue. Fracture-Critical (FC) members were recognized and defined as a steel member or component whose failure in tension would result in the total or partial collapse of a bridge. These are commonly referred to as non-redundant members. Methods were developed to help determine which structures must be further evaluated by designers for susceptibility to fatigue problems. Designers began to include Fracture Control Plans in bridge design details.

The most common types of FC members are tension flanges and parts of webs of flexural members such as beams and girders. Tension members of trusses, particularly eyebars, which commonly make up the lower chords of old trusses, can also be FC. Other tension members of trusses, such as diagonals, are also FC. Concrete members are not often used in tension. The design of flexural concrete members with multiple reinforcing bars precludes the possibility of abrupt failure due to their internal redundancy.

The following circumstances determine FC members:

- Define all two-girder bridges as FC. Fracture of lower flanges in positive moment areas (mid spans) and upper flanges in negative moment areas (over supports) can be expected to lead to collapse of the structure. However, cracks over interior supports may lead to subsequent higher positive stresses in the spans with no catastrophic collapse. Therefore, these FC components receive more frequent periodic In-Depth Inspections.
- Define the majority of steel caps FC. The exceptions are those where support columns provide load path redundancy.
- Define a floorbeam as FC if one or more of the following conditions exist: Flexible or hinged connection to support girders, or floorbeam spacing greater than 14 feet, or no stringers connected to the floorbeams supporting the deck, and stringers not continuous over floorbeams.
- Define lower chords of trusses as FC. This determination is based on the fact that most truss bridges employ only two trusses and most are simple-span.
- Do not define secondary members such as diaphragms and stiffeners as FC. They are rarely used in a manner where failure would lead to a structure collapse. However, use caution in evaluating certain truss members that may appear to be secondary when, in fact, their attachment to main FC members can provide a starting place for the main member failure. The only exceptions to this are diaphragms used in horizontally curved fracture critical units. These elements are almost always classified as primary members due to the forces they are carrying and are also considered to be FC.

4. Guide Specifications for Fracture Critical Non-redundant Steel Bridge Members, AASHTO, 1986.

- The tied arch is a variation of the through arch with one significant difference. In a through arch, the horizontal thrust of the arch reactions is transferred to large rock, masonry, or concrete foundations. A tied arch transfers the horizontal reactions through a horizontal tie which connects the ends of the arch together, like the string on an archer's bow. As can be imagined, the tie is a tension member. If the string of a bow is cut, the bow will spring open. Similarly, if the arch tie fails, the arch will lose its compression and will collapse. The tie girder is FC.

Redundancy

In order for a bridge to be classified as fracture critical, it must have an element that if failed would cause total or partial collapse of the bridge. With this in mind, it is crucial to recognize and identify the type redundancy present in a bridge. Redundancy allows the load that was previously carried by the failed member to be redistributed to other members, thus avoiding failure or collapse.

There are three basic types of redundancy present in bridges:

- Load path redundancy
- Structural redundancy
- Internal Redundancy

Load Path Redundancy

Bridges with three or more main load-carrying members or load paths are considered load path redundant. If one member were to fail, load has a better chance of being safely redistributed to the other members, and bridge failure may not occur. An example of load path redundancy is a multi-girder bridge. Definitive determination of load path redundancy requires structural analysis with members eliminated in turn to determine resulting stresses in the remaining members. In extreme cases where girder spacing exceeds fifteen feet a three girder bridge will also be classified as fracture critical.

Structural Redundancy

Bridges which provide continuity of load path from span to span are referred to as structurally redundant. Bridges where girders are continuous across internal span two-girder bridge designs are structurally redundant. In the event of a member failure, loading from that span can be redistributed to the adjacent spans, and bridge failure may not occur. The degree of structural redundancy can be determined through computer programs which model element failure. Some truss bridges have structural redundancy, but this can only be determined through analysis.

Internal Redundancy

Internal redundancy exists when a bridge member contains three or more elements that are mechanically fastened together so that multiple independent load paths are formed. Failure of one member element would not cause total failure of the member. Internal redundancy of a member can be decreased or eliminated by repairs that involve welding. The welds provide paths for cracks to travel from one element to another.

Presently TxDOT only considers load path redundancy for the classification of fracture critical members.

Inspection Procedures for Fracture Critical Members

Inspection procedures begin with proper advance planning. Important planning aspects, usually based on an office review of the structural plans, include:

- Identify possible FC members.
- Note the particular members in the structure that may require special field attention, such as built-up tension members composed of few individual pieces.
- Pre-plan necessary access to the members, including special equipment needs such as a snooper truck, ladders, bucket truck, air monitoring device, or climbing gear.
- Many structures designed for urban situations with necessary complex alignment geometries result in FC members. Proper inspection of these bridges may require closing a traffic lane and require a night time inspection due to high ADT, during normal business hours. Coordinate safe traffic control in advance with the local district and Area Engineer offices and their Safety Review Team.
- Use a railroad flagger coordinated with the proper railroad company if the structure crosses and is within 25 ft. proximity of a railroad track. Every individual entering a railroad right-of-way must is required to complete, and have certification of completion of the on-line Safety Awareness Course. This course can be found at www.contractororientation.com.
- Identify and make available any necessary special tools and equipment that may be required in addition to the normal inspection gear. A high-pressure washer is often useful in cleaning areas where a large accumulation of debris might obscure view of FC areas. Non-destructive test equipment such as ultra-sonic or ultra-sound devices may be advantageous in some areas, particularly inspection of box-type bent caps and pin-and-hanger connections.

The actual field inspection of all FC members consists of several steps. The most important step is a visual inspection. The inspector notes any:

- Visual cracks and their direction and location
- Evidence of rust, which may form at a working crack
- Weld terminations in a tension area
- Interrupted back-up bars used for built-up-member fabrication
- Arc strikes, scars from assembly cables or chains, or other physical damage

- Cross-section changes which may cause a sudden increase in the stress pattern

Fatigue and Fatigue Fracture

Members subjected to continued reversal of stress, or repeated loading such that a range of change in stress occurs, are subject to a behavior called fatigue. Members that have a relatively constant, steady stress are not subject to fatigue. The term has been in use for almost a century and is currently defined by the American Society of Testing Materials (ASTM 1823-96e1) as "the process of progressive localized permanent structural change occurring in a material subjected to conditions that produce fluctuating stresses and strains at some point or points and that may culminate in cracks or complete fracture after a sufficient number of fluctuations." Fatigue can result in:

- Loss of strength
- Loss of ductility
- Reduced service life

Fatigue fractures are the most difficult to predict since conditions producing them are often not clearly recognizable. Fatigue occurs at stress levels well within the elastic range, that is, less than the yield point of the steel, and is greatly influenced by minor imperfections in the structural material and by fabrication techniques.

Fatigue fracture occurs in three distinct stages:

- Local changes in atomic structure, accompanied by sub-microscopic cracking
- Crack growth
- Sudden fracture

Fatigue-Prone Details

Fatigue fracture almost always begins at a visible discontinuity, which acts as a stress-raiser. Typical examples are:

- Design details such as holes, notches, or section changes
- Flaws in the material such as inclusions or fabrication cracks
- Poor welding procedures such as arc strikes, gouges and start-stops
- Weld terminations

Certain structural details have been long recognized as stress-raisers and are classified as to their potential for damage. These details appear in the current *AASHTO Bridge Specifications*[1], and

1. Standard Specifications for Highway Bridges, AASHTO, 1996

other technical publications. Ensure that these common details should be familiar to the fracture critical bridge inspector.

Proper consideration of member detail and sizing during design will help control stress level and, thus, control crack growth. The stress range, or algebraic difference in the maximum and minimum stress, also is important. The most effective way to control cracking and eventual fracture is sensible detailing. Details such as out-of-plane bending in girder webs and certain weld configurations can cause crack propagation and fracture.

Design for fatigue also includes observing a Fracture Control Plan. The Fracture Control Plan identifies the person responsible for assigning fracture-critical designations. It establishes minimum qualification standards for welding personnel and fabrication plants. It also sets forth material toughness and testing procedures. The specific members and affected sections are also identified in the plan. During fabrication, these members are subject to special requirements.

A fatigue failure is classified as a brittle fracture and is always an abrupt fracture. A brittle fracture is distinguished from a ductile fracture by absence of plastic deformation and by the direction of failure plane, which occurs normal to the direction of applied stress. Other failure surfaces due to high stress are usually at an angle to the direction of the stress and are often accompanied by a narrowing or necking of the material. Brittle fracture failures have no narrowing or necking present to indicate potential failure.

The three main contributing factors to brittle fracture are:

- Stress level
- Crack size
- Material toughness, sometimes called fracture toughness

Small, even microscopic cracks can form as a result of various manufacturing and fabrication processes. Rate of propagation, or growth, of cracks also depends on the stress level and the material toughness. Material toughness is the ability of a material to resist when stressed or the ability to absorb energy and plastically deform without fracturing. This resistance is primarily determined by chemical composition and to some extent by the manufacturing processes.

Usually, higher strength steels are more susceptible to brittle fracture and have lower toughness. Toughness can be improved by techniques such as heat treatment or by quenching and tempering or modifying the steel composition with varying amounts of alloys.

Weld Details

Be familiar with the characteristics of good and poor structural details and identify those details in the field. Welding creates the details most susceptible to fatigue and fracture. Therefore, it is imperative to recognize features prone to FC failure.

Major FC problem areas are at weld discontinuities or changes in geometry such as:

- Toes of fillet welds
- Weld termination points
- Welds to girder tension flanges from other connections such as stiffeners or diaphragms
- Ends of welded cover plates

Welded cover plates on rolled beams were a very common detail until fatigue failures began to be recognized by bridge engineers. Whether the weld is terminated or continued around the end of the cover plate, the condition is at best Category E fatigue detail, which has a greater susceptibility to crack.

Weld attachments to a girder web or flange can reduce fatigue strength as the length of the attachment increases. Welds two inches or less fall in Category C and those greater than four inches in length reduce to Category E. Such details are commonly used to attach diaphragms for lateral stability and wind bracing to main structural members, either at the flange or web. Details such as run-off tabs and back-up bars may also provide possible stress riser discontinuities if not smoothed by grinding after removal.

Be familiar with acceptable and unacceptable fillet weld profiles in order to recognize potential problem areas in the field.

Fatigue in Secondary Members

Secondary members may also have fatigue problems. For instance, main girder stress reversal may induce vibrations in lateral bracing or diaphragms. In many cases the number of stress reversals in the secondary member is a magnification of those stresses in the main member. The attachment of plates to a girder web may cause out-of-plane bending in the web, a situation not usually considered by the designer.

In general, secondary members themselves are not subject to a FC inspection. However, some secondary members, even though designed only as secondary members, such as lateral wind bracing in the lower plane of a girder system, will act as primary members. These cases generally occur in curved or heavily skewed structures. A curved bridge will have twisting or torsional effects due to the live loads that are partially resisted by the diagonal lateral wind bracing. These braces, particularly those near supports, should be inspected for possible fatigue cracks.

Proper Welding and Repair Techniques

Proper welding of structural steel members is a tedious process under the very best of conditions, which are usually found in the fabrication shop. Closely examine any field welding, whether it is a welded girder splice, retrofit detail, or repair, for visible problems. Many shop splices are accomplished by automatic welding machines under controlled conditions and can be smoothly ground to eliminate surface discontinuities. Field splicing operations are subject to exposure to the elements and difficulties in stabilizing the pieces to be joined. In addition, the welding is usually done by hand and, therefore, subject to human error. Fortunately, welded field splices for bridges constructed with state supervision in Texas have always been subject to careful inspection and must be done by certified welders. The welded field splices for these bridges are usually of the same quality as shop splices and are often further inspected by radiographic (X-ray) techniques.

Be aware of problems that may arise from the use of improper field repair processes. Often a well-intentioned repair can actually make a member even more susceptible to a fatigue fracture.

FC Inspection Techniques

FC inspection techniques may include non-destructive testing to determine the condition of a structural member. There are several types available, including radiographic, ultrasonic, dye penetrant, and magnetic particle inspection. All are acceptable methods, but each has limitations and may not be suitable for a particular situation. One single technique may not be sufficient to assess damage and a combination of more than one may be advisable. Perform these types of inspection only if you have undergone the proper training.

The selection of the type of non-destructive testing method for a particular location is a function of the detail. For instance, potential cracks at the ends of welded cover plates are often inspected by the use of radiographic methods. Cracks in pins are best inspected by ultrasonic techniques. Subsurface defects such as inclusions may be found by magnetic field irregularities, and cracks adjacent to fillet welds at tee-joints are usually inspected by dye penetrant. These methods are all described in more detail in the *Bridge Inspector's Reference Manual* [1].

1. *Bridge Inspector's Reference Manual*, FHWA, 2002 and 2006.

Section 6 — Special Inspections

Overview

Special Inspections are performed to monitor new types of structures, structure details, or materials. A Special Inspection may also be used to help develop an information database.

An example of a Special Inspection is the inspection of the grouted ducts in externally post-tensioned members of pre-cast segmental type bridges.

Chapter 5 — Ratings and Load Posting

Contents:

Section 1 — Condition Ratings

Definition of Condition Ratings

Condition ratings based on field inspections are snapshots in time and cannot be used to predict future conditions or behavior of the structure. However, condition ratings based on inspections along with written comments by a field inspector act as the major source of information on the status of a bridge. Condition ratings also help planning for necessary repairs or modifications. In addition, the condition ratings are used as flags when performing over-weight permit evaluations.

Condition ratings are one-digit numbers given by the field inspector to the various components of a bridge. They are objective and not opinions.

Condition ratings reflect deterioration or damage and do measure design deficiency. For instance, an old bridge designed to a low load capacity but with little or no deterioration may have excellent condition ratings while a newer bridge designed to modern loads but with deterioration will have lower condition ratings.

Channel, waterway, riprap, and other channel protection components under and directly upstream and downstream of the bridge are often related in assignment of a condition rating for the channel.

Recording Condition Ratings

Condition ratings are entered on the Bridge Inspection Record. Six component items are covered on the form, and each lists four to 11 elements. The Item Numbers relate to the entry of the data in the electronic Bridge Inventory Files, the detailed instructions for which are contained in the Coding Instructions of the Coding Guide:

- Deck (Item 58)
- Superstructure (Item 59)
- Substructure (Item 60)
- Channel (Item 61)
- Culverts (Item 62)
- Approaches (Item 65)
- Miscellaneous (used for information, but not entered in the Bridge Inventory File. Still important as part of the Bridge Folder).

The rating must equal or exceed the minimum values for each element of a component (shown to the left of the element description on the form). Each element is rated based on independent consideration. For instance, poor or deficient secondary members (bracing, diaphragms, etc.) in a superstructure may cause the Superstructure (Item 59) component to have a poor rating even though the main members show no significant deterioration. The summary Component Rating must be the least of the element ratings comprising that component.

However, Deck (Item 58) component is independent of its associated element ratings such as joints, railings, wearing surface, etc.

Do not base condition ratings on the known presence of chlorides in the deck, superstructure, or substructure concrete or low compressive strengths from core samples. Determine the condition rating solely on the observed, materials-related, physical condition of the component at the time of the inspection.

The Bridge Inspection Form has space for fully supportive written comments for each of the above features. These comments are required for any condition rating of 7 or less. The form includes a brief summary of the description of each level of rating. More detail on the condition rating for each item number is given in the instructions of the Coding Guide.

Assigning Condition Ratings

Evaluate each element separately based on general considerations for assignment of the ten levels of condition ratings. However, other deficiencies may affect the condition if they are directly related. For instance, instability of an approach embankment may reduce the abutment condition rating but not reduce the Superstructure condition rating.

Consider only permanently installed repairs when assigning condition ratings. Permanent implies that the repair has returned the damaged or deteriorated element to a condition as good as or better than the remainder of the bridge. For instance, a steel beam damaged by an over-height load that reduced the load capacity of the beam is considered permanently repaired when a section is replaced or a bent section is straightened by proper techniques and no residual cracks can be found. The strength of the repaired member is the primary concern. Modifications and repairs that simply improve the appearance of a damaged member are not considered to improve the condition rating.

Do not consider as temporary any repair which remains in place without further project activity for a significant period of time. Consider the repair permanent and evaluate the structure accordingly. Four years from the repair date is a reasonable amount of time for a District to move a project forward. If the District requires more time, then submit a written justification for continuing to classify a repair as temporary.

Do not consider for condition rating any components with temporary repairs, even though functioning. For instance, a support or brace to a partially undermined column could be susceptible to damage from another flood; therefore, make the condition rating on the basis that the support is not present. Do not consider temporary repairs in determining condition ratings because they directly affect the calculations of the sufficiency ratings described in Chapter 7.

Condition ratings are still a matter of judgment, which should be made based on experience, knowledge, and consistency with other structures with the same deterioration.

Section 2 — Appraisal Ratings

Definition of Appraisal Ratings

In making appraisal ratings, consider the field condition, waterway adequacy, geometric and safety configurations, structural evaluation, and safe load capacity of the bridge. Appraisal ratings should be consistent among appraisers given the same field information, project plans, materials, and geometric and waterway data.

Evaluate seven features for their effect on the safety and serviceability of the bridge and its approaches. The intent is to compare the bridge to a new structure built to current standards. Different roadway standards - such as width, grade, and alignment - exist for the various roadway systems in Texas.

Appraisal ratings are usually done in the office where access to all necessary information and specifications is available. However, an experienced bridge appraiser may make some appraisals in the field while performing the duties of a bridge inspector.

Appraisal Ratings

The detailed instructions for entering data are contained in the Coding Guide. The seven features are:

- Traffic Safety Features (Item 36)
- Structural Evaluation (Item 67)
- Deck Geometry (Item 68)
- Underclearances (Item 69)
- Bridge Posting (Item 70)
- Waterway Adequacy (Item 71)
- Approach Roadway Alignment (Item 72).

Four of the seven appraisal ratings are automatically generated from other inspection and inventory data, and include Structural Evaluation (Item 67), Deck Geometry (Item 68), Underclearances (Item 69), and Bridge Posting (Item 70). The remaining three items, Traffic Safety Features (Item 36), Waterway Adequacy (Item 71), and Approach Roadway Alignment (Item 72) are based upon observations and historical data collected during routine inspection events. The following paragraphs summarize instructions for coding the above seven features.

Traffic Safety Features (Item 36). This feature applies only to bridges carrying vehicular traffic. . It is a measure of the adequacy of traffic safety features in meeting current acceptable standards, which reflect modern design criteria. Four digits are assigned that approximately measure the adequacy the traffic safety feature. The first digit is for the bridge railings, the second digit is for the guardrail to bridge railing transitions, the third digit is for approach guardrails, and the fourth digit is for guardrail terminals. Each of these four parts to Item 36 is assigned a value of 1 if it meets currently acceptable standards, a value of 0 if it does not, or a value of N if not applicable. These values do not give a true measure of the comparative strength or crash test level for the traffic safety feature.

Collision damage or deterioration is not considered when assessing traffic safety acceptability. Assume that damage to traffic safety features will be repaired in the near future. Note rail, transition, guardrail, or guardrail termination damage or deterioration on the Bridge Inspection Record.

Bridge class culverts do not require coding of traffic safety features if the headwall of the culvert is 30 ft or more from a traveled lane. With zero to three ft of fill over a culvert and acceptable guard fence installed over the culvert and along the approaches, bridge railings and transitions are not required. Culverts with less than three ft of fill may also have guard fence instead of bridge railing if steel posts are properly attached to the culvert.

Acceptable traffic safety standards have been developed using the current AASHTO Standard Specifications for Highway Bridges[1] and the AASHTO *Guide for Selecting, Locating, and Designing Traffic Barriers*.[2]

Current acceptable bridge railing details are shown in the Bridge Railing Manual.

Structural Evaluation (Item 67). This feature considers major structural deficiencies and is based on the condition ratings of the Superstructure (Item 59), the Substructure (Item 60), and the Inventory Rating (Item 66) as related to the Average Daily Traffic (Item 29). Items 66 and 29 are correlated in a table included with the detailed instructions for Item 67 in the instructions for the Coding Guide.

The Structural Evaluation Appraisal Rating should generally be no higher than the lowest of the Superstructure or Substructure condition ratings or the Inventory Rating - ADT correlation.

Deck Geometry (Item 68). This feature applies only to bridges that carry vehicle traffic. Roadway widths are measured perpendicular to traffic direction and between faces of railings, curbs, and median barriers. Mountable curbs are ignored if 4 in. or less high.

The Deck Geometry appraisal rating is determined from a four-part table included with the detailed instructions for Item 68 in the Coding Guide. This table relates the ADT (Item 29), Bridge Roadway Width (Item 51), and Number of Lanes (Item 28).

1. Standard Specifications for Highway Bridges, AASHTO, 1994.
2. Guide for Selecting, Locating, and Designing Traffic Barriers, AASHTO, 1977.

This appraisal rating is further controlled by another table in the instructions for Item 68 in the Coding Guide that relates the Minimum Vertical Clearance (Item 53) and the Functional Classification (Item 26) of the bridge.

The Deck Geometry appraisal rating is the lowest number based on width, lanes, or vertical clearance and functional classification of the highway on which the bridge is located.

Underclearances (Item 69). This feature is a measure of both vertical and lateral clearances for any roadway or railroad passing under the bridge being rated. The vertical clearance is measured down from the lowest part of the bridge to the lower traveled roadway surface (excluding paved shoulders) or top of railroad rails.

The Underclearances appraisal rating is determined from two tables included with the detailed instructions for Item 69 in the Coding Guide. These tables relate the Vertical Underclearance (Item 54) and the Functional Classification (Item 26) of the lower roadway or railroad, and the Lateral Underclearances Right and Left (Items 55 and 56) of the lower roadway or railroad.

The Underclearances appraisal rating is the lowest number based on the vertical and lateral clearances and the functional classification of the lower roadway or railroad.

Bridge Posting (Item 70). This feature compares the load capacity of the bridge to the state legal load. At this time, the term state legal load is a load equivalent to the conventional HS-20 load pattern shown in Figure 5-1. Therefore, any inventory rating less than HS-20 requires further evaluation of the bridge. Bridges are normally not load restricted unless the capacity is less than an HS-20 Operating Rating. See the section of this chapter titled Legal Loads and Load Posting for more detail on the need for load restriction.

Specific criteria for coding this appraisal rating are included with the detailed instructions for Item 70 in the file titled Coding Guide, which has five posting levels. The Bridge Posting appraisal rating is 5 if the Operating Rating (Item 64) is more than HS-20. The Bridge Posting appraisal rating has a value of 0 to 4 depending on the percentage the Operating Rating is below the state legal load, which for this item is HS-20 loading.

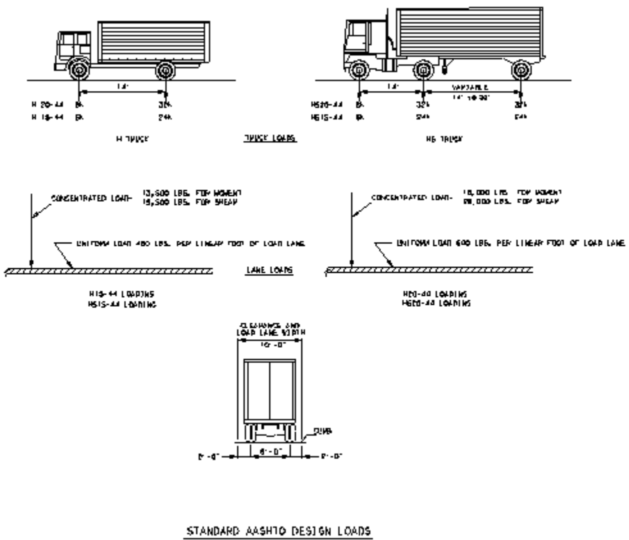


Figure 5-1. Standard AASHTO Design Loads

Waterway Adequacy (Item 71). This appraisal feature applies to all bridges carrying vehicle traffic over any type of waterway. It represents the capacity of the waterway opening to carry peak water flows and is based on the criteria included with the detailed instructions for Item 71 in the Coding Guide, which has eight values. The eight values range from 2, meaning the bridge is frequently overtopped by flood waters, to 9, meaning that chance of overtopping is remote.

The estimated potential for traffic delays from flood overtopping is also considered when assigning a value to Waterway Adequacy. The design flood is the maximum water flow that can pass under bridge for a given recurrence frequency, usually expressed in years.

When hydraulic information is unavailable, the design flood is assumed to be equal to the frequency of overtopping the bridge. Local officials and residents can often provide information on the frequency of overtopping.

Approach Roadway Alignment (Item 72). This feature applies to adequacy of the approach roadway to safely carry vehicle traffic considering both horizontal and vertical alignments.

Specific criteria are included with the detailed instructions for Item 72 in the instructions in the file titled Coding Guide. Approach curvature, lane and shoulder widths, surface roughness, and sight distances all enter into the evaluation of this appraisal rating. For bridges on crest or sag vertical curves, consider also headlight and stopping sight distances.

When approach alignment is questionable, drive the alignment on the approaches to the bridge in order to estimate an advisory safe speed with due consideration given to minimum sight distances. Advisory speed on approach curves is the speed above which more than usual concentration and effort on the part of a normal driver would be required to remain safely in the proper lane. Advisory speed limit should be the posted advisory speed if one exists.

Section 3 — Load Ratings

Definition of Load Ratings

The Load Rating is a measure of bridge live load capacity and has two commonly used categories:

- Inventory Rating, as defined by the current AASHTO *Manual for Bridge Evaluation*,[1] is that load, including loads in multiple lanes that can safely utilize the bridge for an indefinite period of time.
- Operating Rating, defined by the same manual, is the maximum permissible live load that can be placed on the bridge. This load rating also includes the same load in multiple lanes. Allowing unlimited usage at the Operating Rating level will reduce the life of the bridge.

Determination of Load Ratings

Currently, all Inventory and Operating Ratings are expressed in terms of an equivalent HS-truck as shown in the *Manual for Bridge Evaluation.*[2] Prior to about 1995, many ratings were for an equivalent H-truck, shown in *Manual for Bridge Evaluation.*[3] The H-truck directly corresponds to single-unit trucks, which used to be common on rural highways. Today, even rural Farm- or Ranch-to-Market highways and many off-system highways are exposed to much larger semi-trucks; therefore, the HS-truck is more realistic.

Traditionally Inventory or Operating Ratings were determined using either Load Factor (LF) or Allowable Stress (AS) methods. Since 2000, LF is to be used for all on-system bridges, except for timber bridges. It is difficult to assign an ultimate strength to timber. Therefore, both on- and off-system timber bridges are rated using only AS methods. AASHTO has included Load and Resistance Factor Rating (LRFR) as an acceptable method for load rating bridges. Calculate load ratings using LRFR methods if the bridge was designed using the Load and Resistance Factor Design (LRFD) methodology.

Either AS or LF may be used for all off-system bridges.

Inventory Rating and Design Load Considerations

The Inventory Rating (Item 66) can be initially estimated to be at least equal to the design loading if no damage or deterioration exists and the original design was made using an HS or HL-93 (LRFR) load pattern. Assumed load ratings based on original design loads require plan sheets with design the design load identified to be added to the Bridge Record. Many old plans have a design loading

1. Manual for Bridge Evaluation, AASHTO, 2011.
2. Manual for Condition Evaluation of Bridges, AASHTO, 1994.
3. Manual for Condition Evaluation of Bridges, AASHTO, 1994.

shown as H-20 S-16, which some raters have misinterpreted as meaning H-20. AASHTO replaced the H-20 S-16 designation in 1965 with the HS-20 designation. Re-rating these bridges using LF procedures will usually increase the Inventory Rating above HS-20. Rating bridges designed between 1946 and about 1958 by current LF procedures may result in significantly different values than the original design loading. Although the plans may say designed to H-20 S-16 and THD Supplement No. 1, the bridge may rate significantly less than HS-20 loading. This difference is due to the more liberal effects of THD Design Supplement No. 1 described below.

THD Design Supplement No. 1

In 1946, the Bridge Division of TxDOT (then called THD) issued what is commonly called THD Supplement No. 1.[1] Texas was influential in the development of the AASHTO Bridge Design Specifications. However, not all the Texas opinions were immediately accepted by the AASHTO Bridge Committee, which includes all states. As a result, TxDOT used the supplement for a number of years to amend portions of the 1944 and 1949 *AASHTO Standard Specifications for Highway Bridges*[23] for use in Texas.

The first version of Supplement No. 1 was dated June 1946.[4] The second version of Supplement No. 1 was dated September 1953[5] and included only those items of the 1946 version that had not been incorporated into the 1949 *AASHTO Standard Specifications for Highway Bridges*.[6] The primary subjects of the supplement that affected bridge design can be summarized as follows:

- **Crown Width Bridges.** The 1944 AASHTO Bridge Specifications[7] required curbs on all bridges. Texas initiated the concept of crown-width bridges with the following: "On non-restrictive bridges the curbs may be omitted provided the guard fence or an equivalent member is carried continuously through the structure." The 1949 AASHTO Bridge Specifications[8] allowed the condition of no curbs with certain additional width limitations. Texas continued the crown-width, no-curb concept with the retention of the provision in the second version of Supplement No. 1 dated September 1953.[9]
- **Design Overload.** The 1944 AASHTO Bridge Specifications[10] required an overload to be considered for all bridges designed for less than an H-20 (40,000 lbs) or H-20 S-16 (72,000

1. THD Supplement No. 1, TxDOT, September 1953.
2. Standard Specifications for Highway Bridges, AASHTO, 1944.
3. Standard Specifications for Highway Bridges, AASHTO, 1949.
4. THD Supplement No. 1, TxDOT, June 1946.
5. THD Supplement No. 1, TxDOT, September 1953.
6. Standard Specifications for Highway Bridges, AASHTO, 1949.
7. Standard Specifications for Highway Bridges, AASHTO, 1944.
8. Standard Specifications for Highway Bridges, AASHTO, 1949.
9. THD Supplement No. 1, TxDOT, September 1953.

lbs) loading, now called HS-20 loading. The overload was to be the design truck (usually H-15) increased by 100 percent, but without concurrent loading of adjacent lanes, thus allowing single-lane load distribution. The allowable stress was to also be increased to 150 percent of the basic allowable. Texas modified this provision specifically to apply the same overload to truss counter members for all design loadings. Truss counters are those members that, for some positions of live load, will change from tension to compression. If a truss was designed H-15, H-20, or H-20 S-16, the overload was applied in determining the size of counter member.

- **Lane Load Negative Moments.** The 1944 AASHTO Bridge Specifications[1] required for H-10, H-15, or H-20 lane loads an additional concentrated load in one other span in a continuous unit positioned to produce maximum positive and negative moments. Texas limited the distance between the concentrated loads for the lane load to a maximum of 30 ft. This is probably based on the fact that the AASHTO 1944 bridge specifications[2] did not require an additional concentrated load for H-20 S-16 lane loadings. The H-20 S-16 truck loadings have a second axle spaced from 14 to 30 ft from the first heavy axle. This is probably the rationale for the limit of 30 feet in THD Supplement No. 1.[3] The 1949 AASHTO bridge specifications[4] made the lane loading negative moment requirement the same for HS-trucks. However, the 1953 THD Supplement No. 1[5] continued modifying the provision for continuous spans subjected to lane load by limiting the spacing between the additional concentrated load to 30 ft. This limit had the effect of reducing the lane load negative moment maximums for some continuous spans. The 30-ft limit may also have been in recognition that the second large axle for an HS-load pattern is spaced at a maximum of 30 feet from the first large axle, or it might have been because the lane load approximately represents a train of trucks with a headway distance of 30 feet between trucks. Placing the second concentrated load at least 30 ft from the first instead of a maximum of 30 ft would have been more logical. Current specifications do not limit the distance between the two loads for negative moment lane loadings.
- **Impact Load Provision.** The 1944 AASHTO Bridge Specifications[6] required that the shortest length of adjacent spans in a continuous unit be used for the negative moment impact value. In 1949, AASHTO changed this to the current provision of using the average length of the adjacent spans. Both versions of THD Supplement No. 1[78] changed the impact provision for continuous units or other structures where discontinuous lane loadings are applied to be the

10. Standard Specifications for Highway Bridges, AASHTO, 1944.
1. Standard Specifications for Highway Bridges, AASHTO, 1944.
2. Standard Specifications for Highway Bridges, AASHTO, 1944.
3. THD Supplement No. 1, TxDOT, June 1946.
4. Standard Specifications for Highway Bridges, AASHTO, 1949.
5. THD Supplement No. 1, TxDOT, September 1953.
6. Standard Specifications for Highway Bridges, AASHTO, 1944.
7. THD Supplement No. 1, TxDOT, June 1946.
8. THD Supplement No. 1, TxDOT, September 1953.

loaded length as indicated by the influence line for the section of member considered. This change had the effect of slightly increasing the impact value.

- **Special Axle Loads.** The 1946 THD Supplement No. 1[1] added a provision that no axle load in excess of 24,000 lbs should be considered in the design of floor slabs. It further required that either a single 24,000-lb axle or two 16,000-lb axles spaced four ft apart must be used for the design of H-20 and H-20 S-16 bridge floors (slabs, grids, timber) instead of the 32,000 lb axle. The provision was dropped in the 1953 THD Supplement No. 1[2] because the 1949 AASHTO Bridge Specifications[3] included the provision specifically for concrete bridge slabs. The AASHTO Bridge Specifications further limited the 24,000-lb axle to slab spans under 18 ft and the two 16,000 lb axles for slab spans over 18 ft. This provision had the effect of reducing the design load for many slab spans designed during that time. It has been found that some beams have been designed in Texas using the single 24,000-lb axle. It is believed to bean error for beams to have been designed this way. For this reason, carefully evaluate any plans prepared during the period between approximately 1949 and 1961 with a design load of H20 or H20 S-16 that also had the THD Supplement No. 1[4] notation.

Customary Rating Procedures

When a bridge was originally designed, the designer often had to select the next size of reinforcing bar, size of steel beam, or thickness of cover plate to meet the design stress criteria. Sizes that were larger than the theoretically perfect size of member result in Inventory Ratings significantly higher than the design loading. However, the design loading and date of original construction are important parts of the bridge data since they often provide a basis for determining initial routing of overload permits.

If the original design was made using an H-load, such as H-15 or H-20, then the equivalent HS Inventory Rating will usually be significantly less numerically. For example, an H-15 design might rate at HS-12. However, this difference means that the total inventory HS-load capacity is 43,200 lb (two 19,200 pounds axles and one 4,800 lb axle totaling 21.6 tons) as compared to the H-15 design of 30,000 pounds (15 tons).

Determine the original design load from a review of the bridge plans if available. If the structure essentially matches an old TxDOT standard bridge, then the design load for that standard can be used for the Design Load (Item 31). Enter appropriate notation about this in the Bridge Record, and update the electronic Bridge Inventory File. However, use caution accepting the design load in plans that used the THD Design Supplement No. 1[56] due to circumstances described above.

1. THD Supplement No. 1, TxDOT, June 1946.
2. THD Supplement No. 1, TxDOT, September 1953.
3. Standard Specifications for Highway Bridges, AASHTO, 1949.
4. THD Supplement No. 1, TxDOT, September 1953.
5. THD Supplement No. 1, TxDOT, June 1946.

AS rating procedures are usually set at 55 percent of the material yield stress for steel structures and 50 percent of the material yield stress for Grade 40 reinforcing steel in concrete structures. When AASHTO first introduced the use of Grade 60 reinforcing steel in the 1970 Interim Bridge Design Specifications,[1] the allowable of 24 ksi for Grade 60 was assigned based approximately on the ratio of the Grade 60 ultimate strength to that of Grade 40. Thus, the AS procedures were still compatible in factor of safety for concrete members.

LF rating procedures usually assign a dead load factor of 1.3 and live load factors of 2.17 (when computing Inventory Ratings) and 1.3 (when computing Operating Ratings). The resulting stresses or bending moments are compared to the yield of steel members or the ultimate capacity of concrete members also considering appropriate phi strength reduction factors.

Note that the value of 2.17 is the dead load value of 1.3 times 1.67. The load factor of 1.3 accounts for a 30 percent increase in all loadings, either dead or live, so as to provide a uniform safety factor. The factor of 1.67 accounts for the variability of live load configurations other than a standard HS-load pattern and further provides for potential overloads or loads in excess of the State Legal Loads.

Specific analysis of structures for over-weight loads, particularly superheavy permits over 254,300 pounds, is usually done with a load multiplier consistent with the restricted speed of the vehicle. Commonly this factor is about 1.1, with total stresses compared to an allowable of 75 percent of the yield for steel bridges or 75 percent of the ultimate capacity for concrete bridges including prestressed beam bridges. This procedure is explained more fully in Chapter 6, Routing and Permits.

Do not consider temporary repairs for Inventory or Operating Ratings. However, take temporary repairs into account when assigning the operational status code of Item 41 to the structure. Temporary repairs are to be considered for the operational status code only until a more permanent repair is made. Do not use temporary repairs for more than four years. The Inventory Rating directly affects the Sufficiency Rating, so therefore do not assign any weight to temporary repairs in the Load Rating calculations.

Use all field information and conventional analysis techniques when the design loading is unknown or deterioration exists. Even when the design loading is known, the only acceptable method for accurate load rating is to do calculations based on the plans and known field measurements.

Rating Concrete Bridges with No Plans

A concrete bridge with unknown reinforcing details (no plans) can be rated for the State Legal Load (HS-20) at the Operating Level, which is currently defined for load rating purposes as an HS-20 design load, provided that the following two considerations are met:

- It has been carrying unrestricted traffic for many years.

6. THD Supplement No. 1, TxDOT, September 1953.

1. Interim Specifications for Highway Bridges, AASHTO, 1970.

- There are no signs of significant distress.

Ratings are assumed in the permanent Bridge Record, described in Chapter 8. This procedure is summarized in detail by Figure 5.2.

Three additional considerations for rating concrete bridges with unknown reinforcing are:

- Ensure bridge exhibits proper span-to-depth ratios of the main members, which indicates that the original design was by competent engineers. In general, this consideration means that for simple span structures the span-to-depth ratio of main members should not exceed approximately 20. Span-to-depth ratios exceeding this ratio may indicate that the designer did not properly consider reasonable design truck loadings.
- Construction details such as slab thickness and reinforcement cover over any exposed reinforcing to specifications current at the time of the estimated construction date.
- Appearance of the bridge shows that construction was done by a competent builder.

A comparative original design rating can be used to estimate the amount of reinforcing in the main members. Normally, if the design was done prior to about 1950 and the above five considerations are met exist, then the amount of reinforcing can be estimated based on a percentage of the gross concrete area of the main beams (if tee-beam construction), or depth of slab (if slab construction). Two of the examples below describe this method, and a third example describes a method that can be used for prestressed beam bridges with no plans or other documentation.

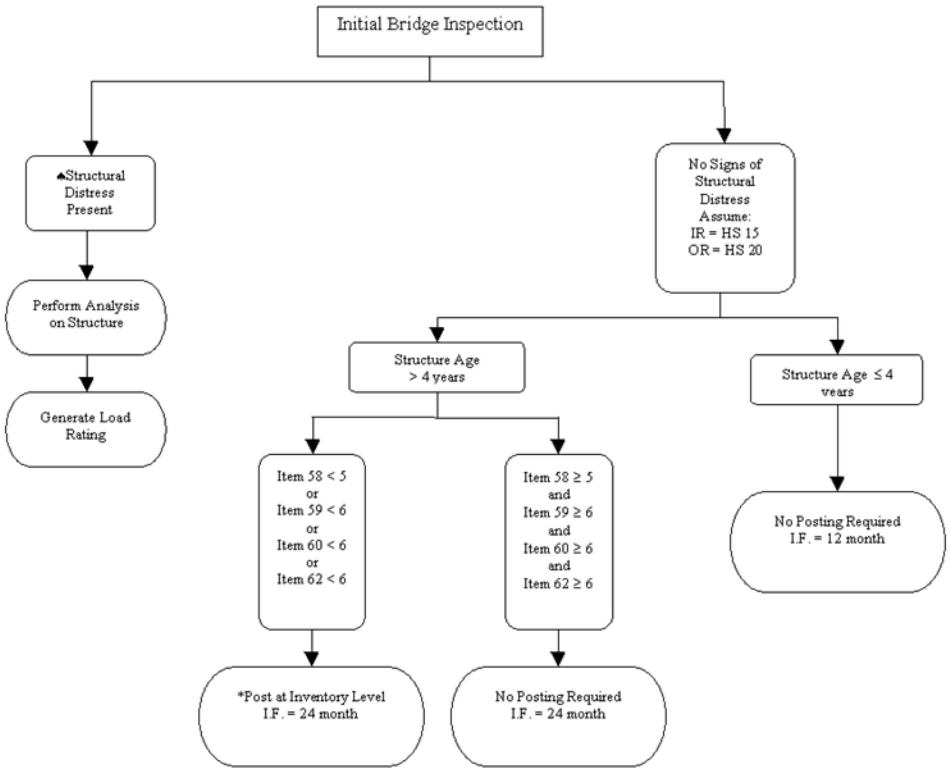


Figure 5-2. Load Ratings for Concrete Bridges without Plans

NOTE 1: *Permit Trucks with gross or axle weights that exceed the state legal load limits will not be allowed to use these bridges.

NOTE 2: I.F. - Inspection Frequency.

NOTE 3: Refer to AASHTO Manual for Bridge Evaluation, Chapter 6, Section B.

Examples of Rating Concrete Bridges with No Plans

Example 1. A flat-slab bridge designed between about 1930 and 1960 can be assumed to have approximately 0.7 percent tension steel based on the total slab depth. Calculations with this amount of steel using AS procedures with stresses, materials, covers, and live load distribution appropriate to the AASHTO Bridge Specifications for the estimated date of construction should give at or very near an H-10, H-15, or perhaps an H-20 theoretical rating. Any other value would make the assumptions suspect. After this analysis is made, an analysis using LF procedures, HS loading, and current load distributions should give an acceptable rating. Flat-slab bridges constructed off-system can also often be rated by this procedure providing the above five considerations are also met. This method is not suitable for evaluation of FS slabs, which may be recognized as those with narrow roadways and tall integral curbs.

Example 2. A multi-beam concrete bridge built between about 1940 and 1965 can be estimated to have approximately 0.3 percent tension steel based on beam spacing and an estimated depth to the center of the steel group of 0.9 D where D is the total depth of the tee-beam. As in Example 1, an old AS rating can first be calculated for comparison. If reasonable, then a modern LF rating can be made with HS loading and the estimated amount of reinforcing steel. The amount of steel can be adjusted slightly so the AS design exactly matches an H-rating of H-10, H-15, or H-20.

Example 3. Some bridges built since about 1955 are composed of prestressed beams and no plans exist. This condition is often found for off-system bridges. The ratings should be done using conservative assumptions and good engineering judgment. One procedure would be to assume that the beams were designed to an H-15 loading in conformance with the estimated date of specifications. Using this assumption, an AS calculation can be made to estimate the even number of 7/16-in. 250 K strands. An LF rating using the HS-loading can then be performed based on this number and size of strand. In Texas, prestressed beams were probably never designed to less than H-15. Most beams have been designed to H-20 or HS-20. Texas prestressed beam fabricators keep good records of their products, and identification of the design loading may sometimes be tracked down.

All three of these examples should give H-ratings using AS procedures that are close to a realistic design load. For instance, a calculated value of H-14.4 could reasonably be assumed to verify that the original design was H-15. A calculated AS value of H-13 would be suspect and further investigation will be required.

Ratings for Unusual Bridges

Unusual bridges, such as those composed of old railroad flat cars, can be rated, but ensure that the critical rating component is considered. For instance, flat cars were originally designed for a maximum point load combined with a uniform load over the whole car. When used for traffic loadings, even though the main two-girder members may give a good equivalent HS load rating, the transverse stiffening members and floor beams often control the live load capacity.

Another unusual type of bridge in Texas is the continuous cast-in-place (CIP) flat slab. Most of these bridges were designed in the 1940s and 1950s with an H-15 or H-20 load pattern. Unfortunately, the design negative moments were from the single truck load in one span. As a result, these bridges may be under-designed for HS-loadings and, as a consequence, may require a load restriction. Design procedures using an HS-20 design load; use a lane load with two concentrated loads in adjacent spans for the controlling negative moment case for longer continuous bridges. For shorter, continuous bridges, an HS-20 design uses two heavy axles of the HS-20 load pattern at variable spacing in adjacent spans. However, the current AASHTO Bridge Specifications do not differentiate between single-and multiple-lane distribution factors for slab bridges. As a result, this type of bridge has greater strength for multiple trucks positioned in the middle of the bridge span. Some structural evaluators make live load distribution adjustments based on the number of lanes loaded for flat slab bridges. Exercise care and properly correlate it to two- or three-dimensional methods of analysis to use this procedure.

H- and HS-Load Ratings

Previously, all ratings were done with the equivalent H-truck, shown in Figure 5-1, or the HS-truck shown in Figure 5-1. Currently, all ratings are only with the HS-truck. A moment equivalency conversion from H- to HS-ratings is not recommended since this process would assume that the structure was exactly designed for the given H-loading. In addition, continuous spans cannot be converted by this process. Most structures have a degree of capacity past the design H-load, particularly since load distribution assumptions of the AASHTO Bridge Specifications[1] have been made more liberal since the time many structures were commonly designed using H-loads. However, as previously explained, some bridges were intentionally designed with AS methods to a 5 percent overstress for some components.

It is not acceptable to ratio the design live load moments for an H-truck to the same moment for an equivalent HS-truck. For instance, if a 48-ft simple-span bridge has a design load of H-15, the design load for moment equivalency would be HS-10.8. However, due to the above reasons, the actual rating based on LF methods might easily be HS-9 or HS-13. Generate an LF rating in this case.

1. Standard Specifications for Highway Bridges, AASHTO, 1994.

Section 4 — Legal Loads and Load Posting

Definition of State Legal Loads

State Legal Loads may safely use any of our highways and bridges. Some routes and many bridges must be load-posted to protect them from possible damage. At this time, a load capacity of HS-20 is considered to best represent the State Legal Load for evaluation of the need for load posting.

Truck loads in Texas are considered legal if the gross load, axle load, axle configuration, length, and width are within the current size and weight laws or rules. The applicable laws are contained in the current volume of the *Texas Transportation Code*.[1] See Section 623.0111 of the *Texas Transportation Code* for permit fees for selected numbers of counties, and see Section 201.8035 for requirements related to the notification of off-system municipalities and counties of deficient bridges.

The laws also provide for additional rules and regulations regarding truck weights and configurations as may be formulated by the Texas Transportation Commission.

In general, the laws require that the maximum gross load on any truck cannot exceed 80,000 lbs, the maximum load on any pair of tandem axles cannot exceed 34,000 lbs, and the maximum load on any single axle cannot exceed 20,000 lbs. Total length must not exceed 65 feet and total width must not exceed 96 inches. However, in 1989 the Texas Legislature enabled truck owners to pay an annual fee to allow their gross legal loads to be increased by 5 percent with any individual maximum axle load increased by 10 percent.[2] The bill was considered controversial because it allowed travel on any bridge, on- or off-system, even if it is load restricted. This portion of the Transportation Code was amended during the 77th Legislative Session to restrict vehicles possessing a permit of this type from crossing load restricted bridges unless the bridge is the only vehicular access.

There are other so-called legal loads, sometimes referred to as Bonded Trucks, such as ready-mix trucks, utility-pole trucks, garbage trucks, mobile cranes, oil well servicing equipment, etc., that have special rules passed by the legislature allowing special categories of loads and lengths exceeding the normal limits for trucks.

Most State Legal Loads do not have a greater effect on bridges than the current HS-20 design total gross load of 72,000 lbs even though they may have a total legal weight of 84,000 lbs.[3] This apparent contradiction is due to the different axle load configurations and numbers of axles.

1. Texas Transportation Code, Title 7, Chapter 621.
2. Texas Transportation Code, Section 623.011.
3. Texas Transportation Code, Section 623.011.

Load Posting

Load posting is often required for structures that, due to their original design or condition, do not have the structural capacity to safely carry the State Legal Loads. Posting is usually necessary for bridges designed at a time when the design truck for the particular stretch of roadway was only H-10 or H-15, meaning gross truck loads of 20,000 or 30,000 lbs. Structures may be posted at Operating Rating levels provided that the condition ratings exceed those defined in Figure 5-3 and Figure 5-4 and other requirements are met. Otherwise, if the Condition Ratings are less than those defined, the Posting must be at Inventory Rating level of the corresponding element (i.e. if the Condition Rating of the superstructure on a particular bridge is a 5, and the Condition Rating of the substructure is a 4, then the Posting is at the Inventory Rating level of the substructure, not the superstructure).

A load posting of a given truck size actually means that two trucks of the posted capacity to safely pass on the bridge. This concept is often misinterpreted by those doing load ratings and making load posting recommendations. It is recognized that a bridge posted for an HS-5 (18,000 lbs gross load) can safely carry a single truck of significantly more than 18,000 lbs. No method ensures that only a single truck is on the bridge. Therefore, assume that two trucks of the same size could be passing on the bridge simultaneously.

However, some bridges, particularly off-system, are load posted assuming only one rating truck even though they may be wider than 18 feet. This condition usually occurs due to the volume of truck traffic, structure width or approach roadway width, striping, runners, etc., making them functionally one-lane bridges for trucks.

It is important to recognize that even though a bridge may have been designed to an H-15 loading, it may not need to be load posted due to considerations discussed previously, such as reinforcement or member size in excess of the theoretical amount, more liberal load distribution now used in analysis, and LF analysis methods which usually increase Inventory Ratings significantly more than the original design loading.

Senate Bill 220, 77th Legislature, 2001, amended Transportation Code, Section 621.301, to provide that a county may establish load limits for a county road or bridge only with the concurrence of the department. If a county determines that the load limit of a county bridge should be different than the load limit supported by a department inspection, the county must submit the proposed load limit to the district engineer. A request for a load limit must be accompanied by supporting documentation that is sealed by an engineer and that includes at a minimum: calculations supporting the proposed limit and a structural evaluation report documenting the condition of the bridge. The district engineer will give a concurrence to a county's proposal in writing. If the department does not indicate concurrence or non-concurrence in writing within 30 calendar days of receipt by the department of a request that included all required documentation, the proposed load limit must be deemed concurred with by the department. The department may review the load limit and withdraw this concurrence at any time by providing written notification to the county. A county may appeal the decision of the district engineer by submitting a written request along with the required documentation to the executive director. The executive director will review the request and determine if department concurrence will be granted. The executive director's decision is final.

Supply the recommended load posting of all off-system bridges to the affected municipalities and counties. TxDOT provides the necessary posting signs and placement hardware. If the local jurisdiction elects not to post the bridge, all federal funds could be jeopardized or delayed for all transportation-related projects, on- or off-system, in that county.

Send a list of off-system bridges that are recommended for load posting by certified mail to the owner of the bridges. A signed copy of the cover letter is returned to TxDOT from the local jurisdiction official. Subsequently, after the appropriate load zone signs have been prepared by TxDOT, a letter is sent notifying the local jurisdiction as to where the signs and hardware may be picked up along with installation instructions. After the signs are installed, the local jurisdiction returns a statement of compliance to TxDOT. Use photographs to document installation of load restriction signs, and then submit them to the inspection file for historical reference.

Typical load posting signs are shown in Figure 5-5.[1] Texas must comply with posting time limits, which are set by the *Code of Federal Regulations*. The time limit for initial or revised posting after bridge inspection is 90 days after the change in status for on-system bridges. This time limit is extended to 180 days for off-system bridges.[2]

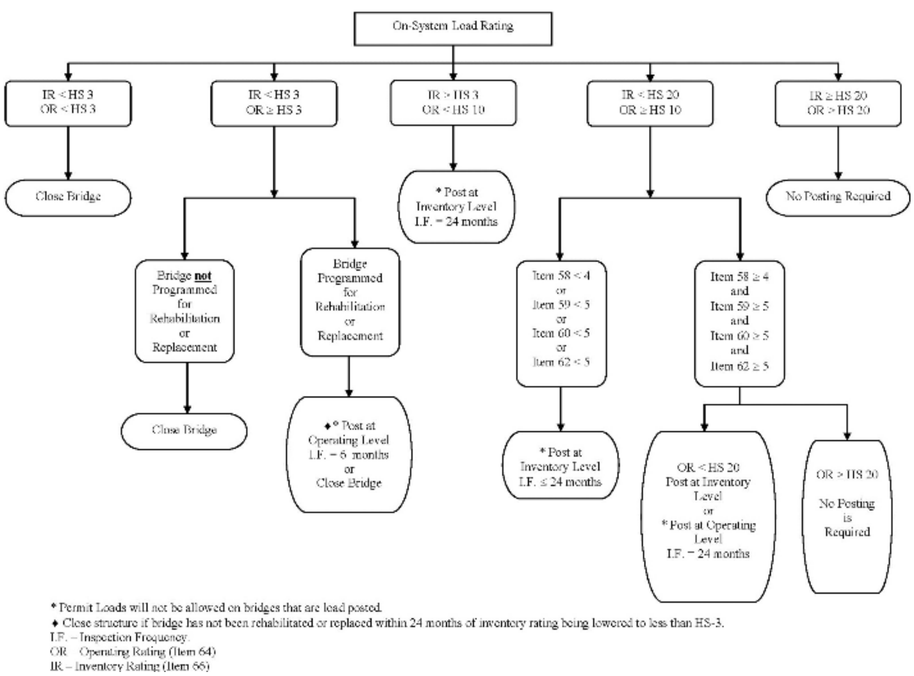


Figure 5-3. On-System Load Posting Guidelines

1. Texas Manual on Uniform Traffic Control Devices, 1980
2. "Closing and Posting Recommendations for Off-System Structures," Memo from Robert L. Wilson, P.E., TxDOT, October 1997

NOTE 1: * Permit Loads will not be allowed on bridges that are load posted.

NOTE 2: " If the bridge has not been rehabilitated or replaced in 24 months then the structure shall be closed.

NOTE 3: I.F. - Inspection Frequency.

NOTE 4: OR - Operating Rating (Item 64)

NOTE 5: IR - Inventory Rating (Item 66)

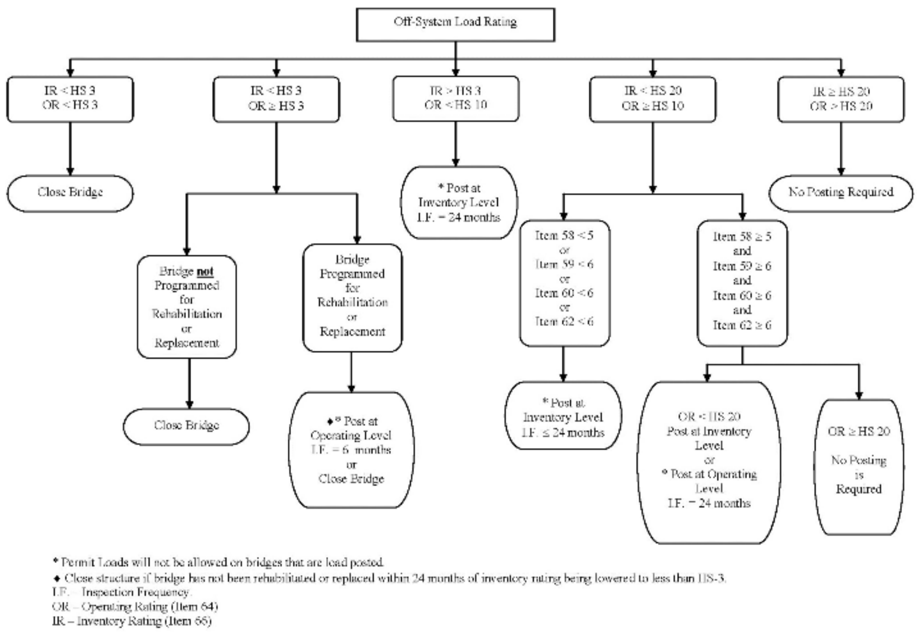


Figure 5-4. Off-System Load Posting Guidelines

NOTE 1: * Permit Loads will not be allowed on bridges that are load posted.

NOTE 2: If the bridge has not been rehabilitated or replaced in 24 months then the structure shall be closed.

NOTE 3: I.F. - Inspection Frequency.

NOTE 4: OR - Operating Rating (Item 64)

NOTE 5: IR - Inventory Rating (Item 66)

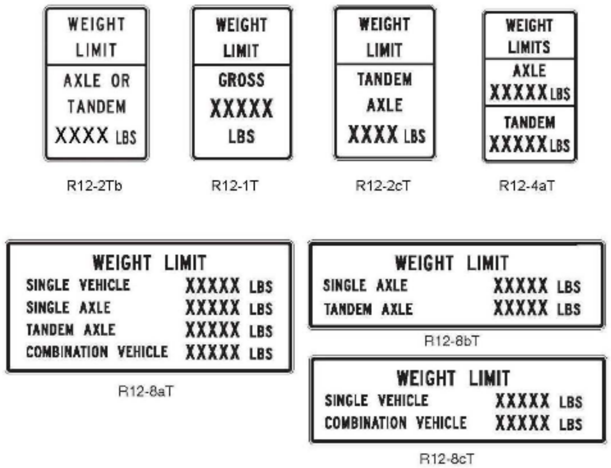


Figure 5-5. Typical Load Posting Signs

Procedures for Changing On-System Bridge Load Posting

The following table outlines the procedure for changing the load posting of an on-system bridge.

Table 5-1: Changing Load Posting of an On-System Bridge

Step	Responsible Party	Action
1	Consultant/District/BRG	Inspector determines a change in posting status based on condition ratings and load rating of the structure. A change in posting status may result from one of the following: ◆ a new load restriction ◆ a revision to an existing load restriction ◆ a removal of a load restriction
2	Consultant/District/BRG	◆ Submit Form 1083R, bridge inspection record, plans and supporting calculations to TxDOT Bridge Division within 30 days of inspection date.
3	Bridge Division Load Rating Engineer	◆ The date that the Bridge Division Load Rating Engineer receives 1083R starts the 90 day time period for posting On-System bridges. ◆ Record this date in the Bridge Load Posting database and on Form 1083R. ◆ Review the recommendation and perform more detailed analysis, if necessary.

Table 5-1: Changing Load Posting of an On-System Bridge

Step	Responsible Party	Action
4a	Bridge Division Load Rating Engineer	Disapproval of recommendation: ◆ Notify the District that the recommendation was not approved. ◆ Update the Bridge Load Posting database with this information and complete Form 1083R. ◆ Scan the form and upload it to the structure's file in PonTex with the file name format: DD-CCC-CCCC-SS-SSS_LPR_YYYY-MM-DD (Load Posting Request with date of disapproval). ◆ If the Load Rating Engineer performed a separate analysis, scan the load rating and uploads it to the structure's file in PonTex with the file name format: DD-CCC-CCCC-SS-SSS_LR_YYYY-MM-DD (Load Rating with date signed and sealed).
4b	Bridge Division Load Rating Engineer	Approval of recommendation or modifies recommendation: ◆ Calculate the appropriate posting level. ◆ Forward Form 1083R with the Load Rating Engineer's load posting recommendation to the Bridge Division Director for approval. ◆ Record the approval date in the Bridge Load Posting database and on Form 1083R.
5a	Bridge Division Director	Approval of recommendation: ◆ Record the approval date on Form 1083R and sign form. ◆ Return form 1083R to Bridge Division Load Rating Engineer.
5b	Bridge Division Director	Approval of recommendation: ◆ Record the disapproval date on Form 1083R and sign form. ◆ Return Form 1083R to Bridge Division Load Rating Engineer.
6a	Bridge Division Load Rating Engineer	Upon Bridge Division Director Approval: ◆ If the Load Rating Engineer performed a separate analysis, scan the load rating and upload it to the structure's file in PonTex with the file name format: DD-CCC-CCCC-SS-SSS_LR_YYYY-MM-DD (Load Rating with date signed and sealed). ◆ Forward Form 1083R to Bridge Division QA/QC Engineer. ◆ Scan the load posting calculations and upload them to the structure's file in PonTex with the file name format: DD-CCC-CCCC-SS-SSS_LPSign_YYYY-MM-DD (Load Posting Sign with date of Administrative approval). ◆ Record the date of Bridge Division Director approval in the Bridge Load Posting database.

Table 5-1: Changing Load Posting of an On-System Bridge

Step	Responsible Party	Action
6b	Bridge Division Load Rating Engineer	Upon Bridge Division Director Disapproval: ◆ If the Load Rating Engineer performed a separate analysis, scan the load rating and upload it to the structure's file in PonTex with the file name format: DD-CCC-CCCC-SS-SSS_LR_YYYY-MM-DD (Load Rating with date signed and sealed). ◆ Forward Form 1083R to Bridge Division QA/QC Engineer. ◆ Scan the load posting calculations and upload them to the structure's file in PonTex with the file name format: DD-CCC-CCCC-SS-SSS_LPSign_YYYY-MM-DD (Load Posting Sign with date of Administrative disapproval). ◆ Record the date of Bridge Division Director disapproval in the Bridge Load Posting database.
7	Bridge Division QA/QC Engineer	Upon receipt of the approved load posting recommendation from the Load Rating Engineer: ◆ Provide approval notification to the District. ◆ Record this date in the Bridge Load Posting database and on Form 1083R. ◆ Send follow-up emails to the District at 45 days, 60 days, and 75 days after the date that the Load Rating Engineer was notified of a recommended status change.
8	District	Upon receipt of recommendation approval notification, take one of the following actions: ◆ New Load Posting or Load Posting Revision- Immediately order load posting signs and erect the signs upon their receipt. ◆ Load Posting Removal - Immediately remove load posting signs.
9	District	After signs have been placed or removed: ◆ Notify the QA/QC Engineer that the signs have been erected/removed at the bridge, and include the completion date. ◆ Document the placement or removal of signs with photos.
10	Bridge Division QA/QC Engineer	Upon receiving district notification: ◆ Enter the erected/removed date on Form 1083R and record the date in the Bridge Load Posting database. ◆ Notify the Texas Department of Motor Vehicles (DMV) and the Texas Department of Safety (DPS) of the status change for the structure. The notification includes: District name, county name, the facility carried, the feature crossed, latitude and longitude, the status prior to the change, and the changed status of the bridge. ◆ Record the DMV and DPS notification dates in the Bridge Load Posting database. ◆ Scan the completed 1083R form and upload it to the structure's file in PonTex with the file name format: DD-CCC-CCCC-SS-SSS_LPR_YYYY-MM-DD (Load Posting Request with date of Administrative approval).

Under the following conditions, the District submits to the Bridge Division's Inspection Branch a completed Form 1083R showing reasons for a restriction removal:

- Repair or rehabilitation of a bridge that increases load capacity and eliminates a load restriction.
- Construction of a new bridge that replaces one with a load restriction.

Procedures for Emergency On-System Bridge Load Posting

The following table outlines the procedure for changing the load posting of an on-system bridge in an emergency.

Table 5-2: Changing Load Posting of an On-System Bridge in an Emergency

Step	Responsible Party	Action
1	District	Notify the Bridge Division's Inspection Branch by telephone that an emergency load restriction is required. Identify deficiencies that justify the placement of an emergency load limit.
2	Bridge Division	Work with the District to determine the load limit, if required, and verbally authorize an emergency load restriction for a period not to exceed 60 days if necessary.
3	Bridge Division	Prepare a letter to the District for signature by the Director of the Bridge Division authorizing the temporary load limits and specifying the duration of the temporary limit.
4	Bridge Division	Verbally notify the District of official approval of the emergency load limit.
5	Bridge Division	Notify the Texas Department of Motor Vehicles and the Texas Department of Public Safety of any bridge load restriction.
6	District	On receipt of verbal approval by the Bridge Division, immediately erect signs indicating the emergency load limit.

If the emergency load limit is required for a period longer than 60 days, the District should submit a request to the Bridge Division for the emergency load restriction to remain in place for another 60 days. If the bridge is not replaced or repaired before the emergency load restriction extension expires, the District should submit a request to the Bridge Division for a permanent load restriction following the procedures for changing on-system bridge load postings.

Closure of Weak Bridges

Close bridges with less than an HS-3 Operating Rating capacity pursuant to the Texas Load Posting Guidelines presented in Figure 5-3 and Figure 5-4. Follow these policies for on-system bridges and they are strongly recommended for the municipalities and counties with jurisdiction over off-system bridges. Bridges with Inventory Ratings less than HS-3 but with Operating Ratings greater than HS-3 may remain open for a limited amount of time. If it is desired to leave a bridge in this category open, then inspect it every six months and ensure the bridge is programmed for rehabilitation or replacement within two years. Close the bridge if after 24 months it has not been rehabilitated or replaced.

Procedures for Closing an Off-System Bridge

If inspection reveals deterioration that affects an off-system bridge's ability to safely carry vehicular traffic, the department may use the following procedure to recommend that it be closed for safety reasons:

Recommending Off-System Bridge Closures

Step	Responsible Party	Action
1	Consultant/District/BRG	Inspector immediately notifies the District and the Inspection Branch of the Bridge Division if a bridge should be closed based on the results of an inspection.
2	District	The district will verify as soon as possible the condition of a bridge recommended for closure by a consultant.
3	District	The District will immediately notify the local entity of a valid closure recommendation, and offer to meet representatives of the local entity at the bridge location. The District will inform the local entity that its participation in the TxDOT Participation Waived and Equivalent Match Program depends on full compliance with departmental closure and posting recommendations and that failure to follow closure recommendations could result in the loss of federal funds. The District will promptly update the Bridge Inspection database to reflect the closure recommendation. (See Item 41 in the Coding Guide.)" NOTE: TxDOT will not conduct another formal inspection of the bridge until it is repaired or replaced.
4	Local Entity	Close the bridge and notify the District when the bridge is closed to traffic.
5	District	Verify closure of the bridge upon receipt of notification and include a photo or certified documentation verifying the closure in the bridge inspection file. Promptly update the Bridge Inspection database to reflect the closure status of the bridge. (See Item 41 in the Coding Guide.")
6	District	If the bridge will remain closed for an extended period of time, the district will verify and document with a photo that the bridge is still closed to traffic as part of the regular inspection cycle.

Procedures for Changing Off-System Bridge Load Posting

Use the following procedure to place, modify or remove load restrictions for off-system bridges where an inspection and subsequent load rating show that the bridge's ability to safely carry state legal loads is compromised:

Recommending Off-System Load Posting Changes

Step	Responsible Party	Action
1	Consultant/District/BRG	Inspector determines a change in posting status based on condition ratings and load rating of the structure. A change in posting status may result from one of the following: ◆ a new load restriction ◆ a revision to an existing load restriction ◆ a removal of a load restriction ◆ replacement of missing or damaged signs
2	District	Upon receipt of a recommendation for a change in load restriction, take the following actions: ◆ Notify the local entity that owns the bridge of the recommended change in load restriction. ◆ If the recommendation involves a new load posting, a load posting revision, or replacement of missing or damaged signs, immediately order the necessary signs. ◆ If the recommendation involves a removal of a load restriction, notify the local entity that the existing signage can be removed. ◆ The entire process for changing an off-system load restriction is not to exceed 180 days from the time the recommendation for change is made. Monitor the timeline to ensure that this requirement is met.
3	District	Take the following steps if signs are ordered for a load posting implementation: ◆ Monitor sign making request for delivery. If signs have not been received within 30 days contact GSD sign shop to follow-up. If sign orders continue to be delayed then the issue should be elevated to district administration or the Bridge Division. ◆ Once signs have been delivered, immediately notify the local entity that signs and hardware are ready for pick up. This process should be documented in writing or e-mail. ◆ Monitor sign pick up by local entity. If signs have not been picked up within 30 days then a reminder should be sent and documented. If signs have not been picked up within 15 days after reminder then the issue should be elevated to district administration or the Bridge Division. ◆ When the local entity picks up the signs and hardware have the local entity representative sign upon receipt. ◆ Monitor sign installation by the local entity. If signs have not been installed within 30 days of receipt then a reminder should be sent and documented. If signs have not been picked up within 15 days after reminder then the issue should be elevated to district administration or the Bridge Division.

Recommending Off-System Load Posting Changes

Step	Responsible Party	Action
4	District	After signs have been placed or removed: ◆ Document the placement or removal of signs with photos.

Chapter 6 — Routing and Permits

Contents:

Section 1 — Role of District Permit Officers, District Bridge Inspection Coordinators, and the Texas Department of Motor Vehicles

One of the responsibilities of the District Permit Officer is to assist the Texas Department of Motor Vehicles (TxDMV) in the evaluation of over-height and over-width permit routes. Should there be any question regarding the accuracy of the current electronic Bridge Inventory Files, the actual plans should be reviewed and/or a field visit made prior to issuing a permit. The TxDMV issues the permit only after review by the District Permit Officer, who also coordinates closely with the District Bridge Inspection Coordinator.

A supplementary role of the District Bridge Inspection Coordinator is to notify the District Permit Officer of any changes to bridge load postings, particularly for bridges not previously posted. The TxDMV maintains a master set of maps showing the various width, height, and load restrictions on all highways. Each District Permit Officer coordinates with the TxDMV in maintaining the maps. Copies of the maps showing all restrictions for load, width, and heights on the various routes are distributed to each district.

All permits are issued by the TxDMV with the cooperation of the District Permit Officer. For overweight permits, the District Permit Officer also works closely with the District Bridge Inspection Coordinator. Any superheavy permits must also be coordinated the Bridge Division (BRG) for structural evaluation of the bridges on a proposed route. This process is fully explained below.

The TxDMV, in conjunction with the mover, selects a route based on known information in the Bridge Inventory Files, day-to-day construction status, road closures, and other known route restrictions.

Section 2 — Permits

OverHeight and OverWidth Permits

Many permits are for over-height or over-width loads. The routing of these loads usually depends on data contained in the electronic Bridge Inventory File. These types of loads do not normally require a structural evaluation of the affected bridges unless the weight and axle load distribution is such that an over-weight permit may also be required.

The electronic Bridge Record gives the values for available clearances as Items 51 (Roadway Width), 52 (Deck Width), 53 (Vertical Clearance over Roadway), 54.2 (Vertical Clearance Under Bridge), 55 (Lateral Underclearance on Right), and 56 (Lateral Underclearance on Left). These items taken together usually give sufficient information to define the limits for the passage of over-height and over-width vehicles.

The permit investigator, District Permit Officer, or District Bridge Inspection Coordinator can quickly access the electronic Bridge Record to determine if the proposed route is capable of handling the proposed overwidth or overheight load. Truss bridges are particularly of concern for both these types of loads since many are in the 18- to 22-foot width range, and vertical clearance to the portals is often less than normal current design clearances.

The electronic Bridge Inventory File gives vertical clearances to the least inch of clearance over the roadway, including shoulders rounded down to the nearest inch. The posted clearance signs are normally 3 inches less than this value. The clearance symbols maintained on the TxDMV permit maps are rounded down to the next 6 inches below the posted clearance. For instance, if the actual recorded clearance is 14-ft 2-in., the clearance sign is 13-ft 11-in., and the permit maps show the maximum available clearance as 13-ft 6-in. Occasional over-height loads can therefore be permitted for heights slightly over the limits given in the TxDMV permit maps provided there is close coordination between the district and the owner and pre-move specific measurements taken.

Normally, over-width permits are granted simply on the basis of available Roadway Width (the clear distance between curbs or railings). If the over-width load is configured such that the load will adequately clear bridge railings, then moves may be granted for loads significantly wider than the Deck Width. This requires the careful cooperation of all concerned parties including escort vehicles and traffic control. Damage and or removal of signs and delineators may occur for some over-width permits. TxDOT personnel should ensure that all such temporary changes are corrected immediately after the permit load has passed.

More information on over-height and over-width permit requirements and procedures is given in the Motor Carrier Division's *Permit Officer Reference Guide*[1] and the *Motor Carrier Division Handbook*[2].

1. Permit Officer Reference Guide, TxDOT, Motor Carrier Division, May, 2010.

Over-weight Permit Loads

Misconceptions often arise about the relationship between Operating Ratings and Overweight Permit Loads. The primary difference is that overweight Permit Load analysis usually assumes only one load on the bridge, which, therefore, allows the use of single-lane load distribution. The Operating Rating is based on the standard AASHTO load distribution given in the current *Standard Specifications for Highway Bridges*[1] for multi-lane distribution for bridges over 18 feet in width. This distribution implies two or more of the Operating Rating trucks being on the bridge side-by-side at the same time.

The other major difference is that Operating Ratings and Overweight Permit Loads use different load multipliers, resulting in Overweight Permit Load analysis being significantly more liberal than Operating Rating analysis. Review the current Operating and Inventory Ratings, the age and type of structure, the span lengths, and the Condition Ratings for any structure proposed on a permit route. For any Condition Rating of 4 or less, request more detailed information on the structure, including the written inspection comments. Reduced strength in a portion of a bridge can often be avoided by controlling the load path of the Overweight Permit Load across the bridge.

Superheavy Loads

Over-weight Permit Loads are classified as Routine or Superheavy. Routine Overweight Permit Loads may be allowed in the regular traffic stream. An escort is required if the load is also over-length or over-width. Use the standard AASHTO load distributions since there may be a legal truck alongside the Routine Overweight Permit Load truck crossing a bridge at the same time.

The term Superheavy Permit Load designates total loads over 254,300 lbs gross. This load was determined cooperatively by the Motor Carrier Division and the Bridge Division in 1981 to represent the lower range of a typical superheavy load. It consists of a 14,300 lb steering axle followed by four groups of three axles, each totaling 60,000 lbs. Any configuration with multiple axles with a gross load of over 254,300 lbs is considered a Superheavy load and requires structural evaluation of individual bridges. Loads with individual axles or axle group weights that exceed the maximum permit weights are also considered to be Superheavy. Any load exceeding 200,000 lbs with a total overall length of less than 95 feet is also considered Superheavy.

More information on superheavy permit requirements and procedures is given in *Permit Officer Reference Guide*[2] and the *Motor Carrier Division Handbook*[3].

2. Motor Carrier Division Handbook, TxDOT, Motor Carrier Division, August 2010.

1. Standard Specifications for Highway Bridges, AASHTO, 17th Ed., 2002.
2. Permit Officer Reference Guide, TxDOT, Motor Carrier Division, May, 2010.
3. Motor Carrier Division Handbook, TxDOT, Motor Carrier Division, August 2010.

The Superheavy Permit often requires that the load cross all bridges straddling a lane line in the case of four or more lanes on a two-way bridge, or straddling the center line for a two-lane bridge. This procedure ensures that other legal trucks will not be alongside the Superheavy load and also gives better load distribution. The AASHTO load distributions used for Superheavy loads are, therefore, usually single-lane. This allows higher Superheavy Permit gross loads to safely cross the bridge.

A printout of the proposed list of bridges to be crossed is reviewed by the TxDMV and the Bridge Division. Often, based on experience of the evaluator and other guidelines, it is necessary to structurally evaluate only a portion of the bridges on an extensive proposed Superheavy route. For any bridges on the route with a Deck, Superstructure or Substructure condition Rating of 4 or less, review the actual written Bridge Inspection Record. This bridge-by-bridge evaluation is one of the primary reasons that the data in the electronic Bridge Records must be accurate and up-to-date.

Superheavy Permit Loads are usually speed-controlled on bridges, sometimes as slow as a walk speed to minimize impact forces.

Many Superheavy Permit Loads also have greater than the usual 6-foot axle gage. The gages for Superheavy Permits can commonly be as much as 20 feet with 16 tires on each axle line. Methods of load distribution for these special carriers cannot directly use the customary AASHTO distributions, which are based on 6-foot axle gages with four tires on an axle line.

Other Differences Between Overweight Permits and Operating Rating

There are other major differences between Operating Ratings and Overweight Permit Loads.

The Operating Rating is usually based on Load Factor (LF) criteria, which use multipliers of 1.3 applied to both the dead and live loads. The live load has an additional allowance of up to 30 percent for impact. Note that Inventory Rating uses a significantly higher live load multiplier of 2.17. The result for either Operating Rating or Inventory Rating is compared to the yield or ultimate strength capacity of the members. A “phi” strength reduction factor (usually from 1.0 to 0.85) is also applied for concrete members.

Overweight Permit Load analysis usually assumes a factor of 1.0 applied to both the dead and live loads. Ten to 30 percent is added to the live load for impact, depending on the speed control and type of load suspension system. Stresses are compared to an allowable maximum of 75 percent of the yield capacity of steel members or 75 percent of the ultimate capacity for concrete members. The reciprocal of 75 percent is 1.33; thus it can be seen that Overweight Permit Load analysis with Allowable Stress (AS) methods has essentially the same factor of safety as an analysis using LF criteria. This result will be demonstrated below by a specific example comparison.

Overloads on Posted or Substandard Bridges

Occasionally a request is made for a Routine Overweight Permit or a Superheavy Overweight Permit to cross a load-posted bridge. TxDMV does not allow overweight permits for posted bridges.[1] However, Section 623.0113 of the *Texas Transportation Code* allows TxDOT to issue weight tolerance permits for over-weight vehicles to cross load-posted bridges only when there is no other route.

Certain other bridges that are not load posted may not be capable of carrying Routine Overweight Permit Loads or Superheavy Permit Loads. Bridges that are in this category include but are not limited to continuous flat slabs with original H-15 designs. These bridges have short spans and were designed with the single H-load pattern truck placed along the span for maximum design conditions. Many of these bridges when rated with the now-required HS-load pattern, and even using LF analysis, will rate at significantly less capacity than other types of bridges designed with H-load patterns. These bridges, though not currently load posted, must be carefully evaluated when overload permits are considered. This is the primary reason that the original design loads given in the Coding Guide should be entered correctly. Often these bridges have been widened, and the widening design load has been incorrectly entered as the original design load.

Pre- and Post-Move Inspection

Another occasional responsibility of the District Bridge Inspection Coordinator is to inspect bridges before and after the passage of a particular overweight permit load. A representative of the owner-mover should be present at these types of inspections. Cast-in-place short span slab bridges, particularly those which have been widened from an original H-10 design to an H-15 or H-20 design, are susceptible to cracking by overloads.

Unusual bridges, such as arch spans, segmentally constructed post-tensioned spans, or long-span plate girder bridges, may also need special attention before, during, and after the move of an overweight permit load. It has been found that simple attention to the sounds made by a bridge when the load passes will call attention to possible broken diaphragm connections or lateral wind bracing connections that actually act as torsional bracing for curved and/or heavily skewed structures.

1. Motor Carrier Division Handbook, TxDOT, Motor Carrier Division, August 2010.

Section 3 — Example Comparison of Inventory, Operating, and Permit Loads

Typical Continuous I-Beam Bridge

To further demonstrate the differences between the various types of analyses, a typical standard bridge common in Texas is chosen for comparative analysis. This bridge is a three-span continuous I-Beam bridge originally designed in the 1950s and 1960s for use on many of the Farm- and Ranch-to-Market highways. Bridges on these routes were commonly designed to H-15 loads (30,000 lbs) since that load was believed to represent the maximum farm truck. Since that time, many of these routes have been incorporated in more heavily traveled routes. Farm-to-Market (FM) roadways crossing Interstate (IH) or other major highways often have this type of H-15 design. Tractor-trailer trucks with a legal load of 80,000 lbs are now commonly using these bridges. The legal load of these trucks can be 84,000 lbs with use of the Weight Tolerance (2060) Permit[1].

Details for the bridge may be found in Standard Ic26h-230 (70-90-70) dated 1965. However, similar bridges before 1965 were also designed to the same H-15 loading. This design loading was in use until about 1975 or 1980. The bridge has a 26-ft roadway between faces of railings and is composed of four 30-inch deep wide-flange rolled beams with relatively short cover plates at the interior supports. The beams are spaced at 7-ft 4-in., and the slab is 6.5-in. thick. An elevation and cross-section of the bridge are shown in Figure 6-1. The design is non-composite, meaning that the slab is assumed to slip longitudinally along the top flanges when loaded. The beams are 36W135 continuous with 10-in. X 0.625-in. X 14-ft cover plates top and bottom at supports.

1. Texas Transportation Code, Section 623.011.

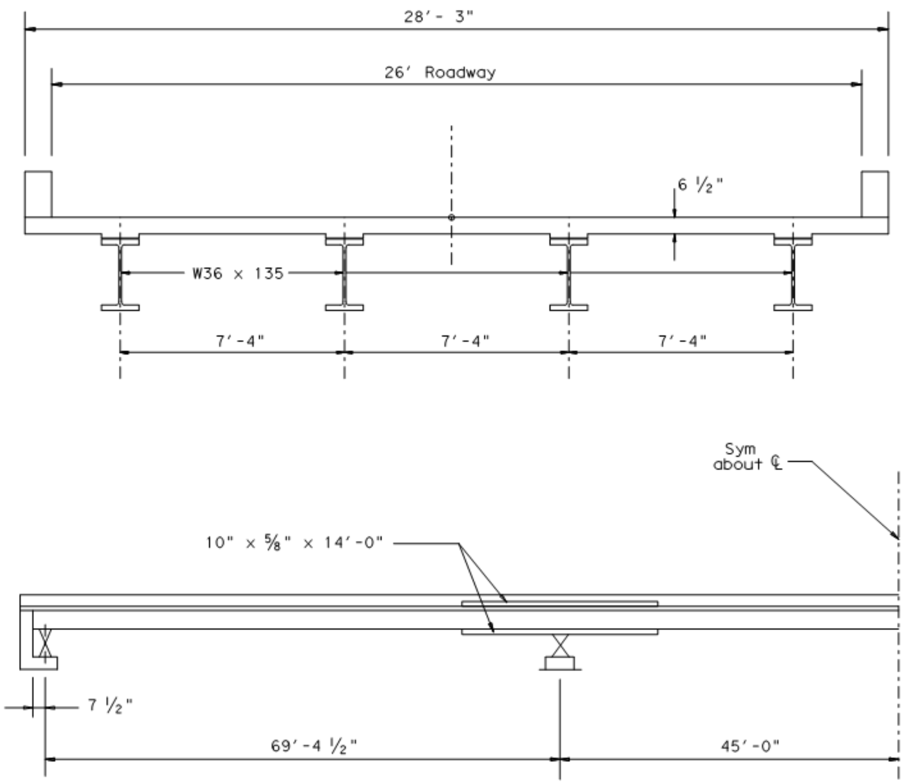


Figure 6-1. Typical Continuous I-Beam Bridge Elevation and Cross Section

Rating Analysis Steps

The steps used in a typical rating analysis for the structure are described below.

Calculate Dead Load. Using the total steel weight given in the plans, subtract calculated weight of beams including cover plates, and check that remainder is about 5 percent of beam weight. This result represents the diaphragms, connections, and other miscellaneous steel. If this number is not about 5 percent, determine the discrepancy. Sometimes the total weight in the plans is in error, but this check usually gives the rater a verification for the estimated dead load. Use the total steel weight, which includes the diaphragms, as a uniform load per linear foot (LF), distributed equally to one of the interior beams. Use the total slab quantity given in the plans calculated as a uniform load per LF also distributed equally to an interior beam. Verify by comparison to the dead load of slab for a typical interior beam using the slab thickness. Add in dead load for any overlay and railings.

Compute Dead Load Moments. Dead load moments need only be calculated at critical locations such as the maximum positive moments for each span and the negative moments at the interior supports. The analysis should use the actual span lengths center-to-center of bearing and not the nominal span lengths. It is preferable to use a computer program, but hand analysis from continuous beam coefficients is also acceptable. The normal sizes of cover plates over supports will "draw" up to about 6 to 12 percent more negative moment and will reduce positive moments when compared to a constant cross section analysis, which is assumed when using continuous beam coefficients or other similar tables or charts. Almost all continuous beam designs in Texas until the advent of computer analysis in the early 1960s used influence coefficients for a constant cross section.

Determine Controlling Live Loading Conditions. Some computer programs do this determination automatically, but there is a risk in using these programs unless the user is familiar with their limitations and assumptions. One popular program is BMCOL51[1], which is a continuous beam analysis program. It allows any pattern of live load to be moved in increments along the beam, which can have cover plates and any areas of composite section if necessary. Thus, it is particularly suited to the analysis of Superheavy loads. It can also identify the locations where the concentrated load(s) for lane loads must also be placed. Most continuous beams will have the following live load maximum moments:

- Max positive moment in end and center spans will usually be from an HS-20 live load with 14-ft center-to-center of trailer axles. However, for very long plate girders, the lane loading criteria may sometimes control positive moment.
- Max negative moment will also usually be from the HS pattern, perhaps with more than 14 feet between the trailer axles if total length of first plus second spans is less than about 70 feet. If the sum of the first two spans is more than about 75 or 80 ft, then the negative moment will be from lane loading of the two adjacent spans with the concentrated loads applied at the critical positions in the two spans.

  The "Texas Bridge Load Rating Program" of 1988[2] can also be used for analysis. However, the program is limited to simple spans of uniform cross section or the estimate of the equivalent simple span for each span of a continuous beam.

Tabulate the Maximums. Identify the locations for which stresses and ratings are to be calculated. Often the maximum positive moment sum of dead plus live effects will not be at the point of maximum dead load or live load moment. This condition is another reason to use a computer analysis such as BMCOL51[3]. This program allows the combination of dead and live loads to be investigated at all points along the continuous member with proper consideration of the effects of cover plates and composite regions, if any. The maximum moments in the end spans may not be the same even though they have the same span length, due to the unsymmetrical live load pattern. For the results discussed in the remainder of this section, Program BMCOL51 was used with 69-90-69 ft spans.

1. "A Computer Program to Analyze Beam-Columns under Movable Loads," Hudson Matlock and Taylor, T.P., Research Report 56-4, Center for Highway Research, University of Texas at Austin, 1968.
2. "Texas Bridge Load Rating Program," TxDOT, 1988.
3. "A Computer Program to Analyze Beam-Columns under Movable Loads," Hudson Matlock and Taylor, T.P., Research Report 56-4, Center for Highway Research, The University of Texas at Austin, 1968.

Calculate the Moments and Load Ratings. Apply the appropriate load factors for the various ratings to both the dead and live load moments at each member location being investigated. Subtract the dead load effect from the member capacity at yield (if load factor analysis) or from the member capacity at allowable stress (if allowable stress analysis). The remainder is the live load capacity. Ratio the remainder to the calculated live load value at the location, and multiply by the live load ton designation. The result is the member rating at that location. It is best to understand this basic process rather than use a set formula for calculating the load rating.

Results for I-Beam Bridge

An H-pattern was used for comparison (normally not necessary) with no railing and no overlay as an additional check on the original design using allowable stresses. This design pre-dated the 1965 design shown on the standard plans and obviously was done using an allowable stress of 18 ksi. In 1965 many standard details were changed to specify "H.Y.C." structural steel[1], which is equivalent to ASTM A-36.[2] However, the design load was kept the same, and no change was made in the size of the cover plates. An HS loading, using the allowable stress or load factor methods, and Inventory Rating or Operating Rating methods was also made for comparison. The various analyses are summarized in the following table.

Table 6.1 Comparison of Analyses for Example Bridge

Loading	Analysis Method	First or Third Span	Support	Middle Span
H (1)N	AS – IR	H 20.08	H 14.24 *	H 18.94
H (2)N	AS – IR	H 23.46	H 17.59 *	H 22.28
HS (3)N	AS – IR	HS 15.78	HS 17.60	HS 14.84 *
HS (4)Y	AS – IR	HS 12.65	HS 10.40 *	HS 11.48
HS (5)Y	LF – IR	HS 15.84	HS 17.80	HS 14.97 *
HS (6)Y	LF – OR	HS 26.40	HS 29.67	HS 24.96 *
N = Light railing and no overlay AS = Allowable stress OR = Operating rating		Y = T501R railing and 2-in overlay LF = Load factor IR = Inventory rating * = Controlling rating		

Discussion of the Analysis Comparisons

The various analyses summarized in Table 6.1 are discussed in the sequence of the loading number. Current bridge rating analysis usually requires only loadings HS (5) and HS (6). However, if the

1. Texas Standard Specifications, TxDOT, 1962.
2. "Specification for Carbon Structural Steel A36/A36M -97," Vol 01.04, ASTM, 1997.

resulting rating is significantly different than the design load, then solutions similar to loadings H (1) or H (2) may be necessary to determine the reasons for the difference.

- H (1). Used to verify analysis with an assumed allowable stress of 18 ksi which is appropriate for A7 steel. Also assumed to have no overlay and light railings. Note that the controlling rating of H14.24 is close to H-15. There would be an overstress of 2.5 percent if exactly H-15 loading was used. Designing up to a 5-percent overstress was very common for these structures.
- H (2). This comparison analysis was made with an allowable stress of 20 ksi, which is appropriate for A36 steel. The remainder of the following comparisons are also with A36 steel.
- HS (3). This comparison is with an HS truck. Note that the controlling HS14.84 rating implies a total individual rating truck load of 26.7 tons, which compares with the H17.6 rating truck of 17.6 tons.
- HS (4). This analysis demonstrates the effect of using the actual current in-place modern railing, a T501R retrofit railing in this case, and a 2-in. overlay. This amount of overlay is very common for structures of this age. Note that the controlling rating shifts from the end span to the support due to the added influence of the greater uniform dead load. The reduction in the rating is 30 percent simply due to the added dead load.
- HS (5). This analysis demonstrates the current IR for the bridge using LF analysis methods. The HS14.97 rating implies a single inventory rating truck load totaling 26.9 tons or two trucks side-by-side totaling 53.9 tons.
- HS (6). This analysis demonstrates the current OR for the bridge using LF analysis methods. The HS24.96 rating implies a single operating rating truck load totaling 44.9 tons or two trucks side-by-side totaling 89.9 tons. Note that the OR of solution HS (6) is equal to 5/3 x the IR of solution HS (5), which directly reflects the difference in the live load rating factors.

Chapter 7 — Bridge Programming

Contents:

Section 1 — Basis for Bridge Rehabilitation or Replacement

Overview

Some bridges on public highways in Texas are considered structurally deficient or functionally obsolete. The terms functionally obsolete (FO) and structurally deficient (SD) are general terms used by the FHWA to classify bridges for eligibility to receive federal funding from the Highway Bridge Program.

Structurally Deficient

The term "structurally deficient" is used by the Federal Highway Administration to designate bridges eligible for federal funding. A structurally deficient bridge is one with routine maintenance concerns that do not pose a safety risk or one that is frequently flooded. To remain open to traffic, structurally deficient bridges are often posted with reduced weight limits that restrict the gross weight of vehicles using the bridges. A structurally deficient bridge should not be confused with an unsafe bridge. Through regular inspection, TxDOT identifies unsafe conditions and closes unsafe bridges. A structurally deficient bridge, when open to traffic, typically requires significant maintenance and repair to remain in service and eventual rehabilitation or replacement to address deficiencies. To remain in service, structurally deficient bridges are often posted with weight limits to restrict the gross weight of vehicles to less than the maximum weight allowed by Texas law (80,000 pounds).

Functionally Obsolete

The term "functionally obsolete" is another FHWA term for classifying bridge eligibility for federal funding. A bridge is classified by the FHWA as functionally obsolete if it fails to meet its design criteria either by its deck geometry, its load-carrying capacity, its vertical or horizontal clearances, or the approach roadway alignment to the bridge.

Summary

Methods have been developed to allocate funds and prioritize the rehabilitation or replacement of structurally deficient or functionally obsolete bridges. These methods are described below. Further information on the subject can be found in the *Bridge Project Development Manual*.

Section 2 — Federal Bridge Program

Funding Classifications

The Federal Highway Administration designates two classifications of deficient bridges that are eligible for funding under the Federal Highway Bridge Program (HBP). A bridge must be classified as Structurally Deficient or Functionally Obsolete in order to be eligible for funding by the Federal Bridge Program.

The funding for this program is limited and is divided between bridges located on the state highway system (on-system) and those bridges located on city streets or county roads (off-system). As of September 1, 2010, there is about $230 million available for the HBP each year. About $170 million is for on-system bridges and about $60 million is for off-system bridges.

Selection Process

All publically owned, vehicular bridges in Texas are inspected every two years and a sufficiency rating for each bridge is generated using information from the inspection and other factors in the Bridge Record. Approximately 34,000 bridges are on the state system and about 18,000 bridges are off the state system. Safety is TxDOT's main focus in prioritizing bridges for replacement or rehabilitation in the HBP. Accordingly, structurally deficient (SD) bridges are given the highest priority for the program. SD bridges are programmed in order of lowest sufficiency rating first. The sufficiency rating is a numerical evaluation of a bridge's structural adequacy and safety, serviceability and functional obsolescence, and essentiality for traffic service.

The Bridge Division is responsible for selection of bridges for the HBP and develops a list of all bridges eligible for HBP funding. The Bridge Division then works with the Districts to establish a list of bridges that the Districts submit for consideration of funding through the HBP. The Bridge Division sorts the bridges that are submitted from the Districts and orders them by SD and lowest sufficiency rating for the year the district has requested funding.

Five year bridge programming plans are developed. The bridges selected for the first year of the program are authorized for construction letting. The other four years are for planning purposes and letting dates are subject to change based on changing conditions.

Each year the Bridge Division evaluates all eligible HBP bridges for the next five years. Bridges programmed for the second year of the five-year program are automatically programmed for the first year of the next five-year program subject to available funding.

Bridges are selected in this order until funding is exhausted for the first year of the program. Bridges that are not programmed in the first year are added to the second year and are prioritized until funding is exhausted. This process is repeated for each year of the HBP. If all of the SD bridges being considered for a particular year are funded, then Functionally Obsolete bridges are considered for that year giving highest priority by lowest sufficiency rating.

After this five-year list has been established, the Districts are given the opportunity to request special consideration of projects that were not selected in the first year. The Bridge Division and Administration review these requests and determine if they will be programmed. However, if a special consideration project is approved, another project(s) on the approved list must be moved to the following year because the program is fiscally constrained. This in turn requires projects in the second year to be moved to the third year and so on until the program is adjusted for all five years. The bar is very high for special consideration projects to be approved since a project that made the list based on a worse condition than the special consideration project has to be moved to the next year.

Our goal is to use all of the available funding each year so that as many deficient bridges are replaced as soon as possible. However, funding not used in the current fiscal year is rolled over to the next year. To best utilize all of the available funding each year, bridge projects that are selected in the second year of the program are to be developed and ready to go to letting in the first year of the program. This allows second year projects to be moved easily into the current fiscal year upon the delay of another project.

Each month the Bridge Division monitors the status of projects that go to letting and the available funds remaining in the current fiscal year. Around March of each year the Bridge Division evaluates projects that have been delayed and moves projects from the next year to the current fiscal year to use the balance of funds in the HBP.

Structural Deficiency

A bridge is considered Structurally Deficient if there is a Condition Rating of 4 or less for:

- Item 58 (Roadway) or
- Item 59 (Superstructure) or
- Item 60 (Substructure)
- Item 62 (Culvert)

or if it has an Appraisal Rating of 2 or less for:

- Item 67 (Structural Condition) or
- Item 71 (Waterway Adequacy)
- Item 71 is considered only if the last digit of Item 42 (Type of Service Under the Bridge) is 0, 5, 6, 7, 8, or 9

Functional Obsolescence

Three methods establish if a bridge is considered Functionally Obsolete:

- An Appraisal Rating of 3 or less for Item 68 (Roadway Geometry), and Item 51 (Bridge Roadway Width) is less than the following:

If Item 29 (ADT) equal or less than...	Item 51 (Roadway Width) Curb to Curb (feet) <...
250	20
750	22
2,700	24
5,000	30
9,000	44
35,000	56
ADT greater than 35,000 requires review by the FHWA	

- An Appraisal Rating of 3 or less for either of:
  - Item 69 (Underclearances) or
  - Item 72 (Approach Roadway Alignment)

  Item 69 is considered only if the last digit of Item 42 (Type of Service under the Bridge) is 0, 1, 2, 4, 6, 7, or 8
- An Appraisal Rating of 3 or less for either of:
  - Item 67 (Structural Condition) or
  - Item 71 (Waterway Adequacy)

Section 3 — Sufficiency Ratings

Calculation of Sufficiency Ratings

Sufficiency ratings are used by the Federal Highway Administration to select candidate bridges for the Highway Bridge Program. Sufficiency ratings are determined during the biennial bridge inspection and are intended to indicate a measure of the ability of a bridge to remain in service. Calculations for Sufficiency Ratings utilize a formula that includes various factors determined during the bridge field inspection and evaluation. The items considered below are those described in the instructions for the Coding Guide. Ratings are on a scale of 1 to 100, with 100 considered as an entirely sufficient bridge, usually new; an entirely deficient bridge would receive a rating of 0. Only bridges that carry vehicular traffic receive a Sufficiency Rating.

A TxDOT interactive program is available to calculate Sufficiency Ratings and determine Structural Deficiency and Functional Obsolescence. The program is called BRISUF and it calculates the Sufficiency Rating based on data entered through an interactive prompt process. The Bridge Inspection Branch of the Bridge Division (BRG) should be contacted for assistance.

Whether using the prompted program BRISUF or hand calculations, the Sufficiency Rating (SR) is calculated by the equation: $S = S_1 + S_2 + S_3 + S_4$

1. S_1 is the **Structural Adequacy and Safety** (55 maximum, 0 minimum) calculated by the equation: $S_1 = 55 - (A + I)$
   a. A is the **Reduction for Deterioration** (not to exceed 55 or be less than 0) based on the lowest value of Item 59 (Superstructure Rating) or lowest value of Item 60 (Substructure Rating):

   if ≤ 2, then A = 55

   if = 3, then A = 40

   if = 4, then A = 25

   if = 5, then A = 10

   if ≥ 6, then A = 0

   if = N, then A = 0

   b. I is the **Reduction for Load Capacity** (not to exceed 55 or be less than 0) calculated by the equation and table: $I = 0.2778(36 - AIT)^{1.5}$

AIT is the Adjusted Inventory Tonnage, calculated by the following table of multipliers based on Item 66 (Inventory Rating):

1st digit of Item 66 is...	AIT = 2nd and 3rd digits of Item 66 multiplied by…
1	1.56
2	1.00
3	1.56
4	1.00
5	1.21
6	1.21
9	1.00

2. S_2 = the **Serviceability and Functional Obsolescence** (30 maximum, 0 minimum) calculated by the equation: $S_2 = 30 - [J + (G + H) + I]$
   a. J is a **Rating Reduction** (not to exceed 15) calculated by the following equation and tables: $J = A + B + C + D + E + F$

If Item 58 (Deck Condition) is...	If Item 67 (Structural Evaluation) is...	If Item 68 (Deck Geometry) is...	If Item 69 (Underclearances) is...	If Item 71 (Waterway Adequacy) is...	If Item 72 (Approach Roadway Alignment) is...
≤ 3, then A = 5	≤ 3, then B = 4	≤ 3, then C = 4	≤ 3, then D = 4	≤ 3, then E = 4	≤ 3, then F = 4
= 4, then A = 3	= 4, then B = 2	= 4, then C = 2	= 4, then D = 2	= 4, then E = 2	= 4, then F = 2
= 5, then A = 1	= 5, then B = 1	= 5, then C = 1	= 5, then D = 1	= 5, then E = 1	= 5, then F = 1
≥ 6, then A = 0	≥ 6, then B = 0	≥ 6, then C = 0	≥ 6, then D = 0	≥ 6, then E = 0	≥ 6, then F = 0
= N, then A = 0	= N, then B = 0	= N, then C = 0	= N, then D = 0	= N, then E = 0	= N, then F = 0

   b. (G + H) is a **Width of Roadway Insufficiency** (not to exceed 15) calculated by the following relationships where the values for X and Y are first found by the following equations:

   Y = Item 51 (Roadway Width) ÷ First two digits of Item 28 (Lanes On)

   If Item 5.6 = 1, 2 or 8, then;

   X = Item 29 (Inventory Route ADT) ÷ First two digits of Item 28 (Lanes On)

Then use the following conditions of (1), (2), or (3) to obtain the values for G and H:

(1) For all bridges except culverts:	**(2) For one-lane bridges (including one-lane culverts:**	**(3) For bridges with two or more lanes (including culverts):**
◆ If Item 43.4 (Culvert Type) is blank or 0 and; ◆ If Item 51 (Roadway Width) + 2 ft < Item 32 (Approach Roadway Width), then G = 5. ◆ If Item 51 (Roadway Width) + 2 ft ≥ Item 32 (Approach Roadway Width), then G = 0.	◆ If the first two digits of Item 28 (Lanes On) = 01 and; ◆ If Y < 14, then H = 15 ◆ If 14 ≤ Y but < 18, then H = 3.75 (18 - Y). ◆ If Y ≥ 18, then H = 0.	◆ If the first two digits of Item 28 (Lanes On) = 02 and Y ≥ 16, then H = 0. ◆ If the first two digits of Item 28 (Lanes On) = 03 and Y ≥ 15, then H = 0. ◆ If the first two digits of Item 28 (Lanes On) = 04 and Y ≥ 14, then H = 0. ◆ If the first two digits of Item 28 (Lanes On) = 05 and Y ≥ 12, then H = 0. If any one of the preceding conditions is met, do not continue trying to determine H because no lane width reductions are necessary. Otherwise, determine H based on the following values for X and Y: ◆ If X ≤ 50 and Y < 9, then H = 7.5 ◆ If X ≤ 50 and Y ≥ 9, then H = 0. ◆ If 50 < X ≤ 125 and Y < 10, then H = 15. ◆ If 50 < X ≤ 125 and 10 ≤ Y < 13, then H = 5 (13 - Y) ◆ If 50 < X ≤ 125 and Y ≥ 13, then H = 0 ◆ If 125 < X ≤ 375 and Y < 11, then H = 15 ◆ If 125 < X ≤ 375 and 11 ≤ Y < 14, then H = 5 (14 - Y) ◆ If 125 < X ≤ 375 and Y ≥ 14, then H = 0 ◆ If 375 < X ≤ 1350 and Y < 12, then H = 15 ◆ If 375 < X ≤ 1350 and 12 ≤ Y < 16, then H = 3.75 (16 - Y) ◆ If 375 < X ≤ 1350 and Y ≥ 16, then H = 0 ◆ If X > 1350 and Y < 15, then H = 15 ◆ If X > 1350 and 15 ≤ Y < 16, then H = 15 (16 - Y) ◆ If X > 1350 and Y ≥ 16, then H = 0

c. I is a **Vertical Clearance Insufficiency** (not to exceed 2) set by the following:

If Item 100 (STRAHNET) > 0 and;

Item 53 (Min Vert Clearance Over Bridge Deck) $\geq$ 1600 then I = 0

Item 53 (Min Vert Clearance Over Bridge Deck) < 1600 then I = 2

If Item 100 (STRAHNET) = 0 and;

Item 53 (Min Vert Clearance Over Bridge Deck) $\geq$ 1400 then I = 0

Item 53 (Min Vert Clearance Over Bridge Deck) < 1400 then I = 2

3. S_3 is the **Essentiality for Public Use** (not to exceed 15 or be less than 0) calculated by the equation: $S_3 = 15 - (P + M)$

a. P is the portion for **Public Use**.

First calculate K, which is a value based on the previously calculated S_1 and S_2:

$K = (S_1 + S_2) \div 85$

P = (Item 29* (ADT) x Item 19* (Detour Length) x 15) ÷ (200,000 x K)

*If Item 5.1 = 1 use Item 29 (ADT) and Item 19 (Detour Length)

*If Item 5.1 = 2 use Item 29A (Intersecting Route ADT) and Item 19A (Intersecting Route Detour Length)

b. M is the portion for **Military Use**.

If Item 100 (STRAHNET) > 0, then M = 2

If Item 100 (STRAHNET) = 0, then M = 0

4. S_4 is a **Special Reduction** used only when S1 + S2 + S3 ≥ 50. Calculate S_4 using the equation: $S_4 = R + S + T$

a. R is a **Detour Length Reduction** (not to exceed 5) calculated by the equation:

R = [Item 19* (Detour Length)]^4 x (5.205 x 10^{-8})

*If Item 5.1 = 1 use Item 19 (Detour Length)

*If Item 5.1 = 2 use Item 19A (Intersecting Route Detour Length)

b. S is a **Structure Type Reduction** set by the following:

If the first digit of Item 43.1 (Main Span Type) is 7 or 8 or if the 2nd digit of Item 43.1 (Main Span Type) is 2, 3, 4, 5, 6, or 7, then S = 5.

Otherwise, S = 0

c. T is a Traffic Safety Feature reduction set by the following:

If 2 digits of Item 36 (Traffic Safety Features) = 0, then T = 1

If 3 digits of Item 36 (Traffic Safety Features) = 0, then T = 2

If 4 digits of Item 36 (Traffic Safety Features) = 0, then T = 3

Section 4 — Bridge Management System

Overview

PonTex is a bridge inspection data management system which was developed in-house by TxDOT. It features a web-enabled, role-based relational database structure, and was designed to replace the BRINSAP legacy mainframe system which has been in service for decades. Major improvements over BRINSAP include the ability to directly populate the database with elemental inspection data, up-front data validations before an inspection can be submitted for approval, electronic storage of all inspection documentation, and complete audit records for all data entries. Another advantage of PonTex is that it makes all bridge inspection and inventory data readily available to all end users of the data through the applications itself, or through a link to the relational database used to store the data.

TxDOT first began implementing PonTex in the Odessa District in February of 2009. Additional Districts were brought online with PonTex according to routine inspection cycles across the state. All Districts are now utilizing this system to record inspection and inventory information. PonTex will assist in the performance of complex bridge management tasks by providing all inventory and inspection data in a single relational database, to be used as the front-end for modeling and performance prediction scenarios within software systems such as PONTIS, the bridge management system which is being developed under the guidance of AASHTO.

Chapter 8 — Bridge Records

Contents:

Section 1 — Definition of Terms

Bridge Record Terms

A partial list of definitions related to bridge inspection is given in the *AASHTO Manual for Bridge Evaluation*.[1] The same AASHTO definitions and specific additional terms are also used in various other chapters of this manual. The following discussion of Bridge Records includes some of the additional specific terms.

Bridge—A structure, including supports, erected over a depression or an obstruction, such as water, a highway, or a railway; having a roadway or track for carrying traffic or other moving loads; and having an opening measured along the center of the roadway of more than 20 feet between faces of abutments, spring lines of arches, or extreme ends of the openings for multiple box culverts or multiple pipes that are 60 inches or more in diameter and that have a clear distance between openings of less than half of the smallest pipe diameter.

Bridge Folder—Until recently the file for each bridge maintained by the District Bridge Inspection Office was a hard copy record of all inventory and inspection documentation for a bridge. With data now being submitted directly to PonTex, all data is recorded and held in electronic format and the bridge folder is now an archive of historical bridge information.

National Bridge Inventory Number —The unique 15-digit number assigned to any structure meeting the definition of a bridge. The number includes the 2-digit District Number, 3-digit County Number, a 1 digit fixed zero, the 4-digit Control Number, the 2-digit Section Number, and the 3-digit Permanent Structure Number. The Transportation Planning and Programming Division (TPP) assigns the county road and city street index numbers, which begin with a letter instead of number. This off-system index number uses the same 6 digits assigned to Control and Section for on-system highways. The Permanent Structure Number for off-system bridges is assigned by the district.

Bridge Inventory File—The electronic data in TxDOT's bridge inventory, inspection, and appraisal ratings for each bridge on a public roadway in Texas. The data formerly were entered from a completed coding form. Data now is entered through PonTex either using the TxDOT network or the internet. The instructions for the Coding Guide describe the step-by-step data entry requirements.

Bridge Record—The over-all collection of data including the Bridge Folder with completed forms, printout of coded electronic data, sketches, cross sections, photos, etc. It also includes the Bridge Inventory File stored on electronic media. The Bridge Record also includes the bridge plans, if available, copies of which may be in the Bridge Folder or in TxDOT's accessible file systems. Some of the bridge plans may also be available on electronic media in the form of computer-aided drafting (CAD) drawings. Historically this information was stored in hard copy format, but now the Bridge

1. *AASHTO Manual for Bridge Evaluation*, Second Edition, 2011.

Record is being stored in the PonTex bridge inventory and management system.

Control-Section-Job (CSJ) Numbers—These are numbers assigned to all on-system public highways in Texas. The Control Number is assigned to a stretch of highway that often breaks at a county line or a major highway intersection, river or stream, but can also break at any convenient location. The Section Number is a number within a specific Control and is usually assigned sequentially from the beginning of the Control. An average length for most Sections is about 4 to 5 miles but can be less than a mile or 15 to 20 miles. The Job Number is the sequential number for any type of construction project (bridge, paving, etc) that may have ever occurred on that Section of highway. Job numbers within a Section can be well over 100. All off-system highways are assigned similar sequential numbers by the district within each county. Refer to Items 8.4 and 8.5 of the "Instructions for Coding Guide" for more information.

Culverts—Multiple-barrel box culverts or multiple-pipe culverts are sometimes classed as bridges and a complete Bridge Record is made. The 1994 AASHTO Manual[1] defines a bridge as any structure carrying traffic (highway or railroad) having an opening measured along the centerline of the roadway of more than 20 feet between the limits of the extreme openings of abutments, arches, or multiple boxes. This definition has created the anomaly in some cases where, for instance, three 6-ft multiple box culverts installed at more than about a 15-degree skew to the roadway must have a Bridge Record. If the same three box culverts are installed perpendicular to the roadway, they have no Bridge Record. The AASHTO definition continues for multiple-pipe culverts by stating that they may be classed as bridges provided the distance between individual pipes (the fill) is less than half the adjacent pipe diameter. In addition to this provision, TxDOT also requires pipe culverts to be at least 60" in diameter to be considered as a multiple-pipe bridge class installation.

Elemental Data—Identifies the various parts of the bridge (Elements), the material type and measures or estimates the condition of that element through specific predefined condition states. Additional information is available in "Elements" Field Inspection and Coding Manual.
Collecting data in this manner helps to better quantify the condition of a bridge or a system of bridges. By characterizing part of a bridge by the type of member and its material the following types of analysis can more easily be performed: 1) prediction of deterioration, 2) prediction of costs for repair, rehabilitation or replacement, 3) identification of alternative programs based on level of service or other criteria, 4) optimization of expenditure based on user and agency costs, 5) budget forecasts, and 6) development of programs for improvements.

Engineer—The qualified, Texas-licensed, Professional Engineer having responsibility for ensuring the accuracy of the information contained in the Bridge Record. A pre-qualified consulting firm engaged by TxDOT to perform routine bridge inspections is also considered in the following discussions to be covered by the term Engineer. Inspections done by TxDOT staff must also have a qualified, Texas-licensed, Professional Engineer responsible for the Bridge Records. The same basic procedures are used by TxDOT personnel as are required for consulting firms.

Forms—Specific forms such as the Bridge Inspection Record, or the Bridge Inventory Record, or the Follow-up Action Worksheet forms may be developed as needed for specific types of data or classes of structures.

1. Manual for Condition Evaluation of Bridges, AASHTO, 1994

NBI Sheet—A printed copy with abbreviated names of the numerical data in the electronic Bridge Inspection File. NBI stands for National Bridge Inventory, which must include all the information required by the FHWA. Texas captures additional information exceeding that required by the NBI. However, in Texas the sheet is still commonly called the "NBI Sheet." The FHWA data requirements are described in a report titled Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges [1]."

Permanent Structure Number (PSN)—A unique three-digit number assigned to any structure meeting the definition of a bridge. It is part of the 15-digit National Bridge Inventory Number. PSNs are assigned by Control-Section Segments in ascending order as the bridges are built and are not necessarily in sequence along the Control-Section Segment. An on-system bridge replaced by a new bridge at the same location will have a new number assigned. A widened or reconstructed bridge will retain the same number. Districts assign similar unique numbers to off-system bridges. An off-system bridge replaced by a new bridge will retain the same PSN. A bridge with a longitudinal open joint in the middle will have two PSNs, even if the superstructures share a common substructure element[2].

Bridge Division.

Route Over or Under—A bridge at intersecting highways is defined as an underpass or overpass based on the inventory hierarchy of the two routes. This description is used where required on all forms, plans, etc. The hierarchy of Texas highways is: Interstate, US, SH, State Loops or Spurs, FM/RM, County Roads (CR), and Business Routes (BR). The lower route number takes precedence if the highways are of equal hierarchy. Examples are:

- IH 30 over IH 35 - IH 30 Overpass at IH 35
- IH 35 over IH 30 - IH 30 Underpass at IH 35
- FM 1234 over US 290 - US 290 Underpass at FM 1234
- CR 18 under US 183 - US 183 Overpass at County Road 18
- IH 20 Business under RM 456 - RM 456 Overpass at IH 20 Business

Signing and Sealing—The Engineer must affix a seal containing the Engineer's license number, sign, and date many of the documents prepared for a bridge inspection. The Signing and Sealing requirements are in conformance with the Texas Engineering Practice Act and TxDOT policy.[3,4] Date the seal on the day it was affixed to the document.

Work Authorization—Authorization issued by TxDOT to a consultant (Engineer) to perform inspections of bridge structures in various counties and districts in Texas. The Work Authorization is normally issued for a specific period of time with a commencement and ending date specified. Consultants under contract to TxDOT must pre-qualify by demonstrating that they are competent to inspect Texas bridges.

1. Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, FHWA, 1995.
2. "Permanent Structure Numbers," Administrative Circular 20-74, TxDOT, February 1974.
3. Occupations Code, Section 1001.401. Texas Administrative Code, Title 22, Section 131.166.
4. Procedures for Sealing Engineering Documents, Stand-alone Manual Notice 97-2, TxDOT, March 1997

Section 2 — Inspection Requirements

General Requirements

Inspect each bridge in the inventory in accordance with the current version of the State's Bridge Inspection Manual available at http://onlinemanuals.txdot.gov/txdotmanuals/ins/index.htm, and record the findings electronically in the PonTex application. Uphold a reasonable standard of care for routine safety inspections, which is understood to imply an attentive visual and auditory inspection aided by routine inspection tools as afforded by routine means of access.

Tools and Safety Equipment

Routine inspection tools are listed in the *FHWA Bridge Inspector's Reference Manual*, 2002, in Section 3.4.2 entitled "Standard Tools." [1] Use hard hats, safety vests, traffic cones, vehicle safety lights, and "BRIDGE INSPECTION AHEAD" or "SURVEY CREW AHEAD" signs for all bridges being inspected. Conduct the inspections with minimal disruption to traffic flow. Notify the District at least ten (10) working days in advance of any work in which any person or equipment will be within twenty-five (25) feet of any railroad track. The District will coordinate with the appropriate Railroad Representative to determine if a flagman needs to be present and whether the Engineer needs to implement any special protective safety measures. Complete, and have certification of completion of the on-line Safety Awareness Course.

Coordination with TxDOT District

Inspect the bridges within the assigned inspection area only and verify the bridge locations. Notify the District Bridge Inspection Office a minimum of 48 hours in advance with the locations and dates when inspections will be performed. Verify the bridge location on the map(s) furnished by the State. If an error or omission is discovered, correct it by marking up a hardcopy of the map provided by the State and return it by the end of the work authorization. Verify that the coordinates in the database are accurate, meaning located on the bridge. If the coordinates are missing, or not accurate, then collect new coordinates. Collect the coordinates by a hand-held GPS unit and provide the results in a decimal format. Sub-meter, differentially corrected data is not required. An Inspection Team Leader that has been approved by the Bridge Division must be present at each bridge site during the bridge inspection.

New bridges located by the Engineer require approval from the District Bridge Inspection Office before an identification number is assigned, the bridge is inspected, or the bridge is added to the inventory. Create a new file folder labeled in the format established by the district, complete all forms, and input all data required by the NBI to insure a complete and accurate record. Inventory or inspect a bridge that is under construction only with the approval of the District Bridge Coordina-

1. FHWA Bridge Inspector's Reference Manual, 2002.

tor. Do not delete any bridge record from the inventory without prior approval of the District Bridge Inspection Office.

When the inspections are finished, return completed reports to the State within 45 days from the date of inspection. Enter condition ratings and other coding changes, along with reports and sheets as detailed below using PonTex. However, bring to the attention of the District Bridge Inspection Office immediately, both verbally and in writing, the bridges needing special consideration (which includes ANY bridge in which the engineer lowers the condition rating to a 4 or lower, or recommends closure). Notify the Bridge Division Inspection Branch in writing only. If the inspection indicates significant deterioration of any structural element, include documentation such as notes, measurements, sketches and photographs. If there is a recommendation to change the status of an on-system bridge structure (load restriction, revision of an existing load restriction or the removal of a load restriction), submit the recommendation to the Bridge Division as soon as the calculations are complete, but not more than 30 days after the date of the inspection. Include in the recommendation to change the load posting the recommended posting level, the most recent Bridge Inspection Record, load rating calculations, pictures and the as-built plans (if available) used in the calculation of the load posting recommendation. Send the recommendation, along with the supporting documentation, to TxDOT's "Dropbox Service" at https://ftp.dot.state.tx.us/dropbox/. When using the "Dropbox", use BRG_Load_Posting@txdot.gov as the notification email address. Notify the District Bridge Inspection Office by email that a load posting recommendation has been sent to the Bridge Division.

Email and Correspondence

Maintain an Internet email address and notify the Inspection Branch of the Bridge Division of any address changes. The Bridge Division will use email for notification of all bulletins, policy changes, and updates sent out to the members of the Statewide Consultant Pool for Bridge Inspections. The State routinely will send emails to the Engineer in an effort to keep the Bridge Inspection operations uniform throughout the state.

Quality Control Program

Have a Quality Control program in place to ensure the work of the Engineer and that of the subproviders is of high quality. Submit a plan detailing the program to the Inspection Branch of the Bridge Division for review and approval prior to beginning of any contracted work. This program may be reviewed and audited by the Bridge Division on a random basis.

Section 3 — Coding Guidelines

Summary of Instructions

Adhere to the step-by-step instructions for entering the data in the electronic Bridge Inventory File as presented in the detailed instructions for the Code Guide. Follow coding and documentation requirements outlined in this chapter regardless of whether inspections are carried out in-house or by consultants. This requirement ensures statewide consistency in documenting and reporting inspection findings. The Coding Guide also includes interpretations, examples, and other data input guidance. The electronic Bridge Inventory Files contain a record for each Bridge Class Structure on public roadways in Texas. The definition of a Bridge Class Structure is described in Item 112 in the "Instructions for Coding Guide." The data are also used to update the National Bridge Inventory File for the FHWA. Once a year the complete Bridge Inventory files for off- and on-system bridges are converted to the actual NBI format and submitted to the FHWA.

Multiple-Pipe Culverts

To achieve future consistency in recording information, the following clarifications are to be used for creating or maintaining Bridge Records for multiple-pipe culverts:

- Do not remove any existing multiple-pipe culverts from the Bridge Inventory File. The installation may already be in the prioritization process for repair or replacement, and the process should not be disrupted.
- Do not create Bridge Records for any new multiple-pipe culverts that are individually less than 60-inches in diameter even if the total installation, including fill between pipes, is more than 20 feet along the roadway. Inspections of smaller diameters would be difficult to make and the results would probably be of dubious quality. It is also very inconsistent engineering logic to require inspection of, for instance, an installation of five 48-inch pipe culverts and no inspection of an installation of four or fewer pipes of the same diameter.
- Make and maintain Bridge Records for multiple-pipe culverts that are individually 60-inches or greater in diameter, providing the total installation meets the 20-ft length criterion and the distance between individual pipes does not exceed one-half the diameter of the smallest pipe.

Data Quality

Data quality for all information kept for each bridge, and in particular the electronic Bridge Inventory Files, cannot be overemphasized. Keep the data in the files as up-to-date as possible. Texas must comply with data update time limits which are set by the Code of Federal Regulations. The Federal Code requires data updates reflecting changes to an existing on-system structure to be made within 90 days of the evaluation or inspection that denotes the change in status. Report new, rebuilt, or rehabilitated structures within 90 days of job completion. The data update time limit is 180 days for off-system structures.

Section 4 — Inspection Documentation

Inspection File Contents - On System Bridges

The following documentation is to be completed for each on-system bridge.

- **Bridge Inspection Record** – Delineates the basic components of the bridge to be inspected. Enter a rating for each element of each component following guidelines from the National Highway Institute (NHI) Safety Inspection of In-Service Bridges two-week training course and in accordance with the current TxDOT Bridge Inspection Manual Coding Guide. For any rating of seven (7) or below, include comments explaining the rating in the report. This form also includes the appraisal of the traffic safety features, waterway adequacy and approach alignment. Include the typed name and signature of the Inspection Team Leader on each form. The Engineer must sign, seal, and date the form. Include on the form the Engineer's firm number. Scan a signed and sealed copy and import it into PonTex.
- **Bridge Inspection Follow-Up Action Worksheet** – Summarizes the areas of deterioration of the bridge and recommends how the bridge should be repaired. Reflect the TxDOT maintenance section number clearly on this form. The Engineer must sign, seal, and date the form. Include on the form the Engineer's firm number. Scan a signed and sealed copy and import it into PonTex.

NOTE: One extra copy of this form is required for each on-system bridge, grouped by Maintenance Section to include all bridges within that Maintenance Section. Submit these copies to the District Bridge Inspection Office at the end of the work authorization, and they will be transmitted to TxDOT maintenance personnel by the District Bridge Inspection Office.

- **Bridge Inspection Follow-Up Action Worksheet Summary** – Summarizes the information from the Bridge Inspection Follow-Up Action Worksheets of all the bridges assigned in the work authorization. Submit the electronic worksheet, in Microsoft Excel format, to the District Bridge Inspection Office at the end of the work authorization. (Do not sign and seal.)
- **Elemental Data Inspection Record** – Collect elemental data for use in the State's Bridge Management Information System (BMIS) for all on-system structures. Collect information per span, with the exception of culverts which are to be collected by the structure. The Engineer will determine the Elemental Data and quantities in each condition state for each on-system bridge. Do this in accordance with the State's "Elements" Field Inspection and Coding Manual. Special training is required if such training has not already been completed. Enter the information from these records into PonTex. Print the "Element Inspection Detail Listing" report from PonTex and include it in the Bridge Inspection Record. Field forms and other summary list will not be required. (Do not sign and seal.)
- **Bridge Inventory Record** – Provide a description of the bridge with a detailed sketch on the reverse side. If there have been no changes to the structure and the existing description and

sketch properly represent the condition in the field, a new form is not necessary; maintain the existing form in the file with no modification by the Engineer. Sketches are not required if plans are in the file. Scan and import the form into PonTex. If there is no form in the file, a new form is to be completed by the Engineer. If plans are unavailable, complete both sides of the form. If plans are available, complete only the front side. Show the maintenance section number on the form. The Engineer must sign, seal, and date the form. Scan a signed and sealed copy and import it into PonTex. If major (structural) changes have been made to the structure, complete a new "Bridge Inventory Record" form that is signed and sealed by the Engineer. Scan and import the document into PonTex.

- **Bridge Inventory Record Revisions** – Use this form only for minor (non-structural) changes to the Bridge Inventory Record. (Do not sign and seal.) Scan and import the document into PonTex.
- **Channel Cross-Section Measurements Record** – Complete this form for each span bridge over a waterway (whether the waterway is wet or dry). This form is not required for culverts. The Engineer will take measurements on the upstream side of the bridge starting at the abutment. Take the measurements from a fixed bridge reference down to the channel bed. Take these measurements at each bent, at each significant change in the channel bed, and at the midpoint of the channel. Record the horizontal distance between each vertical measurement, as well as the cumulative horizontal distance from the beginning of the bridge abutment. Record several reference dimensions, including top of water level (see the form). The Engineer must add comments on the back of the form. Scan and import the document into PonTex. (Do not sign and seal.)
- **Upstream Channel Cross-Section Sketch** – Required for span-type bridges only. (Culverts do not require an upstream channel sketch or any update to any such sketch that may be already in the file. Calculations of sediment material quantities are not required.) If there is an existing channel cross section plotted to scale in the inspection record, bring it forward into the current report and plot the new data on it in a different color ink. The Engineer is to initial and date the new plot. If the channel profile has not changed from the previous inspection, the Engineer is to initial and date a note stating that no significant change has occurred. For all bridges that have plans available, plot the channel section on a copy of the bridge layout sheet(s) from the plans. Insert two (2) copies of the layout into the file: one copy will act as a "work copy," for plotting and maintain the other copy as a clean, master copy. If plans are not available, draw a sketch using appropriate scale. It is acceptable for the horizontal and vertical scales to differ. Scan the sketch and import it into PonTex. (Do not sign and seal.)
- **Underclearance Record** – Record horizontal clearance information for on-system underpasses only. Draw a brief sketch indicating dimensions and reference points for collected horizontal clearance data. Provide all dimensions from a fixed reference point. Ultrasonic measuring is not acceptable. Scan the record and import it into PonTex. (Do not sign and seal.)

Inspection File Contents - Off System Bridges

The following documentation is to be completed for each off-system bridge.

- **Bridge Inspection Record** – Delineates the basic components of the bridge to be inspected. Enter a rating for each element of each component following guidelines from the National Highway Institute (NHI) Safety Inspection of In-Service Bridges two-week training course and in accordance with the current TxDOT Bridge Inspection Manual Coding Guide. For any rating of seven (7) or below, include comments explaining the rating in the report. This form also includes the appraisal of the traffic safety features, waterway adequacy and approach alignment. Include the typed name and signature of the Inspection Team Leader on each form. The Engineer must sign, seal, and date the form. Include on the form the Engineer's firm number. Scan and import the document into PonTex.
- **Elemental Data Inspection Record** – Collect elemental data for use in the State's Bridge Management Information System (BMIS) for all off-system structures for specific bridge owners as detailed in the work authorization. Collect information per span, with the exception of culverts which are to be collected by the structure. The Engineer will determine the Elemental Data and quantities in each condition state for each off-system bridge. Do this in accordance with the State's manual entitled, Elements: Field Inspection and Coding. Special training is required if such training has not already been completed. Enter the information from these records into PonTex. Print the "Element Inspection Detail Listing" report from PonTex and include it in the Bridge Inspection Record. Field forms and other summary lists will not be required. (Do not sign and seal.)
- **Bridge Inventory Record** – Provides a description of the bridge with a detailed sketch on the reverse side. If there have been no changes to the structure and the existing description and sketch properly represent the condition in the field, a new form is not necessary; maintain the existing form in the file with no modification by the Engineer. Sketches are not required if plans are in the file. Scan and import the form into PonTex. If there is no form in the file, a new form is to be completed by the Engineer. If plans are unavailable, complete both sides of the form. If plans are available, complete only the front side. The Engineer must sign, seal, and date the form. Scan a signed and sealed copy and import it into PonTex. If major (structural) changes have been made to the structure, complete a new Bridge Inventory Record form that is signed and sealed by the Engineer. Scan and import the document into PonTex.

NOTE: For off-system bridges, these forms and sketches serve as as-built plans in many cases because original plans are not available. When plans are available and copies are included in the file, a detailed sketch is not required; however, the Engineer must complete the front side of the Bridge Inventory Record.

- **Bridge Inventory Record Revisions** – Use this form only for minor (non-structural) changes to the Bridge Inventory Record. (Do not sign and seal.) Scan and import the document into PonTex.

- **Channel Cross-Section Measurements Record** – Complete for each span bridge over a waterway (whether the waterway is wet or dry). This form is not required for culverts. The Engineer will take measurements on the upstream side of the bridge starting at the abutment. Take the measurements from a fixed bridge reference down to the channel bed. Take these measurements at each bent, at each significant change in the channel bed, and at the mid-point of the channel. Record the horizontal distance between each vertical measurement, as well as the cumulative horizontal distance from the beginning of the bridge abutment. Record several reference dimensions, including top of water level (see the form). The Engineer must add comments on the back of the form. Scan a copy and import it into PonTex. (Do not sign and seal.)
- **Upstream Channel Cross-Section Sketch** – Required for span-type bridges only. (Culverts do not require an upstream channel sketch or any update to any such sketch that may be already in the file. Calculations of sediment material quantities are not required.) If there is an existing channel cross section plotted to scale in the bridge inspection record, bring it forward into the current report and plot the new data on it in a different color ink. The Engineer is to initial and date the new plot. If the channel profile has not changed from the previous inspection, the Engineer is to initial and date a note stating that no significant change has occurred. For all bridges that have plans available, plot the channel section on a copy of the bridge layout sheet(s) from the plans. Insert two (2) copies of the layout into the file: one copy will act as a "work copy," for plotting and maintain the other copy as a clean, master copy. If plans are not available, draw a sketch using appropriate scale. It is acceptable for the horizontal and vertical scales to differ. Scan the sketch and import it into PonTex. (Do not sign and seal.)
- **Underclearance Record** – Complete this form for all grade separations, including pedestrian, utility, and railroad underpasses. Draw a brief sketch indicating dimensions and reference points for collected vertical and horizontal clearance data. Reference in Item 54.2 the exact minimum vertical clearance under the structure. The vertical clearance sign must read at least 3 in. lower than the minimum measured vertical clearance of the roadway. Ultrasonic measuring is not acceptable. Scan the sketch and import it into PonTex. (Do not sign and seal.)
- **Bridge Summary Sheet** – Complete this form for all off-system bridges. Summarize each component rating, areas of deterioration of the bridge, and recommend how to repair the bridge. Indicate previous, observed and recommended load posting, record current status of all signs, and denote materials needed to properly post the bridge. The Engineer must document the condition, location, and number of all signs in place on the date of inspection for all load posted bridges. Also record the load limit shown on existing load posting signs. Document these signs with legible photographs. The Engineer must sign, seal, and date the form. Scan a copy and import it into PonTex.
- **Summary of Needed Load Posting Materials** – Use this summary to order signs/hardware needed for load posting on off-system bridges. Prepare a summary for each county, precinct and/or city, as agreed upon with the District Bridge Inspection Office, to insure each local jurisdiction has the materials necessary to properly post all of their bridges. Submit the summary to the District Bridge Inspection Office, never directly to a local jurisdiction. Complete

the summary using the form supplied by the State. Scan a copy and import it into PonTex. (Do not sign and seal.)

Section 5 — Calculations

General Calculation Requirements

Provide bridge load rating calculations in accordance with currently accepted TxDOT bridge inspection procedures as described in this manual and in other associated documents such as the *Bridge Inspector's Reference Manual*, [1] the *Manual for Bridge Evaluation,*[2] and the *Standard Specifications for Highway Bridges*.[3] Note that the methods of calculation are different for on- and off-system bridges.

Date, sign and seal documents in accordance with the requirements given in this chapter and with the Texas Engineering Practice Act.[4]

Calculations for On-System Bridges

Perform bridge load rating analyses (calculations) and submit them in the findings. If no deficiencies are noted, limit the analysis to the superstructure of the bridge. However, provide load rating analysis for any element that has any condition rating of 4 or less. All on-system bridge records must have documentation in the files to support any recommended changes in load ratings. If the Engineer agrees with the previous calculations, it is acceptable to provide a statement concurring with those calculations. Sign, seal and date any concurrence statement.

A qualified licensed Professional Engineer must sign, seal and date all calculations and/or documentation referring to load rating capacity. Perform all load rating calculations for on-system bridges not designed using Load and Resistance Factor Design (LRFD) using the "Load Factor" method as illustrated in AASHTO's *Manual for Bridge Evaluation* [5] with no exceptions. Load rate on-system bridges designed by LRFD using the Load and Resistance Factor Rating (LRFR) method as illustrated in *AASHTO's Manual for Bridge Evaluation*. When on-system ratings are calculated, present them to the State in HS loading. Some analyses may involve bridges that have section loss or damage to structural members. In these cases, verify and document the conditions of members and incorporate those findings into the analysis. The Inventory Rating (Item 66) can be assumed to be at least equal to the design loading if no damage or deterioration exists and the original design load was HS-20 or HL-93.If assumed load ratings of HS-20 or HL-93 based on the original design loads are to be used, then add plans sheets, preferably including the superstructure,

1. Bridge Inspector's Training Manual 90, FHWA, 1991.
2. Manual for Condition Evaluation of Bridges, AASHTO, 1994.
3. Standard Specifications for Highway Bridges, AASHTO, 1994.
4. Occupations Code, Section 1001.401. Texas Administrative Code, Title 22, Section 131.166.
5. Manual for Bridge Evaluation, AASHTO, 2008, with current revisions.

with the design load called out to the Bridge Record by scanning the applicable plan sheets and importing them into PonTex.

Import all calculations, along with pertinent plan sheets, into PonTex. If you concur with existing calculations, scan and import the original calculations and concurrence statement into PonTex.

Special attention is called to the coding of Items 41, 41.1, and 41.2 (operational status and posting limits). Verify these items and revise them, if needed, for all bridges to ensure that all posting, posting recommendations, closures and closure recommendations are properly reflected in the Bridge Record. Notify the District Bridge Inspection Office immediately of any bridges recommended for closure, and include details and calculations.

Calculations for Off-System Bridges

Provide bridge load rating calculations in accordance with the State's bridge inspection policy. Either Working-Stress or Load Factor analysis is acceptable. The Texas Bridge Load Rating Program (TBLR) which calculates load ratings using a Working-Stress analysis is acceptable. For all timber, steel, and truss bridge files, document calculations for load ratings of all structural elements that apply, including the deck, stringers or beams, truss members, bent caps, and piling or columns. The TBLR program will give an Inventory (INV) and Operating (OPR) rating both for H and HS truck loading. Continue to use Plate III in the Bridge Inspection Manual, applying the H-loading to the table, to select the proper load posting sign type and weight limits. Load rating documentation, including assumptions, is required in the files for all bridge class structures (including culverts). Bring into conformance to current TxDOT policy concerning assumed ratings, etc. any assumed load ratings for concrete structures. For all off-system bridge files, for all bridge types, include documentation in the files to support changes in load ratings. When off-system ratings are calculated, present them to the State in HS loading only.

Sign, seal and date all calculations and/or documentation referring to load rating capacity. (It is acceptable to only initial and date the calculations and seal only the Bridge Summary Sheet, which summarizes the results of the calculations, rather than sign, and seal each page of the calculations themselves.) It is also acceptable, if you are in agreement with the previous calculations, to provide a statement concurring with the existing calculations. Import all calculations, along with pertinent plan sheets, into PonTex. If you concur with existing calculations, scan and import the original calculations and concurrence statement into PonTex. Sign, seal and date any concurrence statement.

Special attention is called to the coding of Items 41, 41.1, and 41.2 (operational status and posting limits). Verify these items and revise them, if needed, for all bridges to ensure that all posting, posting recommendations, closures and closure recommendations are properly reflected in the Bridge Record. Notify the District Bridge Inspection Office immediately of any bridges recommended for closure, and include details and calculations. The State will set a time to meet with the Engineer to review the findings, and the State will notify the bridge owner.

SIMPLIFIED LOAD POSTING PROCEDURE

This procedure is appropriate for computing posting loads equivalent to the inventory rating. Approximations are involved which make this procedure unacceptable at load levels higher than the Inventory Rating.

The posting load in pounds is the product of the RATING MULTIPLIER and the INVENTORY RATING in tons for the standard "H" truck. In selecting the RATING MULTIPLIER from the table use the longest simple span length or 80% of the longest continuous span length, whichever gives the longest span length for the bridge. If the resulting span length is 160' or greater, then the bridge should receive an analysis more exact than this procedure.

The recommended posting increments are listed below. Round off to the nearest increment listed.

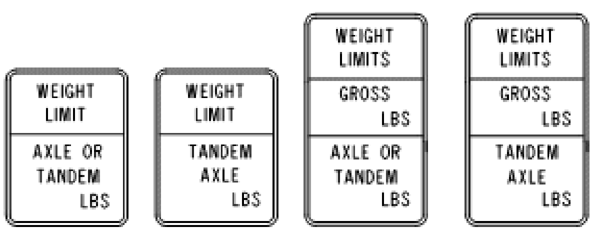
Post axle and gross load for span lengths 40' and greater. Post axle load only for span lengths 39' and less. Weight limit signs should conform to the Texas Manual on Uniform Traffic Control Devices. The recommended signs are R12-2Tb or R12-4Tb except if the axle load is noted "*" use signs R12-2Tc or R12-4Tc.

EXAMPLE 1
35' Simple Span Slab & Girder Bridge, H14 Rating
Axle = 14 x 1,450 =20,300 lbs.
Post 21,000 tandem axle (Signs R12-2Tc)

EXAMPLE 2
120' Pony Truss, H7 Rating
Axle = 7 x 1,450 = 10,100 lbs.
Gross = 7 x 2,300 = 16,100 lbs.
Post 10,000 lbs. Axle or tandem and 16,000 lbs. Gross (sign R12-4Tb)

EXAMPLE 3
30'-40'-30' Continuous Slab Bridge with
25' slab approach spans, H10 Rating.
0.80 x 40' = 32'>25' = Use 32' span
Axle = 10 x 1,480 =14,800 lbs.
Post 15,000 lbs. Axle or tandem (Sign R12-2Tb)

EXAMPLE 4
25' Simple Span Timber Bridge, H2 Rating
Axle = 1,550 x 2 = 3,100 lbs.
Recommendation: Close bridge until repair increases capacity.



R12-2Tb R12-2Tc (24" x 36") R12-4Tb R12-4Tc (24" x 42")

SPAN	RATING MULTIPLIER	
	AXLE OR TANDEM	GROSS
FEET	LBS. H-TON	LBS. H-TON
≤ 20	1,600	
25	1,550	
30	1,500	
35	1,450	
40	1,450	3,100
45	1,450	2,950
50	1,450	2,800
60	1,450	2,600
70	1,450	2,500
80	1,450	2,450
90	1,450	2,400
100	1,450	2,350
120	1,450	2,300
140	1,450	2,250
160	1,450	2,200

LOAD INCREMENTS FOR AXLE OR TANDEM LBS.	LOAD INCREMENTS FOR GROSS LBS.
5,000	8,000
7,500	10,000
10,000	12,000
12,500	14,000
15,000	16,000
17,500	20,000
21,000*	24,000
24,000*	28,000
28,000*	32,000
32,000*	36,000
	40,000
	44,000
	48,000
	52,000
	60,000
	68,000
	76,000

*Axle load exceeds 20,000 lbs. Single axle limit, therefore post for tandem axle (Signs R12-2Tc or R12-4Tc).

Figure 8-1. Simplified Load Posting Procedure

Section 6 — Data Submittal

General Data Submittal Requirements

Provide monthly submissions of files unless otherwise directed by the District Bridge Inspection Office. Bridge folders (hardcopy documentation) may be submitted to the District Bridge Inspection Office by mail or delivered in person.

Bridge Folders prepared by TxDOT personnel must be documented, signed, sealed, and dated in the same format as herein described.

All data included in the Bridge Folder are prepared to meet the requirements given in the various controlling regulations given in Appendix A. An important portion of Section 650.315 (b), (c), and (d) of the Code of Federal Regulations requires that updates to the electronic Bridge Inventory File be made within 90 days for on-system bridges and 180 days for off-system bridges. This includes updating inspection findings, adding new bridges to the inventory, documenting modifications to existing bridges, and making changes to the status of bridges (load posting changes and closures).

Photographs

Provide photo documentation using digital photographs having a resolution of 1200 x 1800 (2.1 megapixels). The photos must be true aspect prints with a minimum dimension of 4" on the short side. Present the photos on 8 ½ in. x 11 in. paper, with 2 photos per page. Include a caption noting the direction, location, and description of each photo. Import the photo documentation into PonTex.

Include the following photographs in each bridge file (minimum):

- **Roadway View.** Photograph along the centerline of roadway showing a view of the bridge as seen from the roadway. If the bridge is load restricted, take a photograph from each approach along centerline of roadway showing a view of the bridge as seen from the roadway. The photograph must be taken from a point of reference that includes the weight limit signs that are present, damaged, or missing. Weight limit signs must be legible in any photos that are taken.
- **Elevation View.** Photograph the bridge showing the overall length. (It may be impossible to show the entire structure length on long structures. In these cases, use an oblique angle at a further distance to attempt to capture an overall picture. Do not submit multiple pages of photographs attempting to show every part of a long structure.)
- **Underside View.** Photograph the bridge showing the type of superstructure and typical condition. (Bridges with several types of superstructures will require additional photographs.) The underside photo of the superstructure is not required for box culvert structures.

- **Stream or Roadway below the Bridge.** Photograph the bridge from below showing the stream or roadway as it passes under the bridge. The photos of the stream should show evidence of scour if applicable.
- **Upstream and Downstream Channel View.** Photograph the condition of the channel upstream and downstream of the bridge. Take these photos from the bridge.
- **Detail Photographs for Component Ratings of 4 or less.** Photograph in detail all components rated 4 or less on the Bridge Inspection Record. Note details of the component rating on the photograph caption.
- **Photographs of Recommended Immediate Maintenance Needs.** Photograph previously unphotographed recommended maintenance needs that should be performed immediately.

Presentation of Documents

Ensure that all inspection results submitted to the District Bridge Inspection Coordinator are typed, using the current versions of the electronic forms where applicable, and are of such quality that legible reproductions can be made on a typical office copy machine. Provide the State with the following information, in list format, at the end of the Work Authorization. Include in the list format the facility carried, as well as the NBI number.

- **A list of bridges recommended for special inspections.** Include only bridges to be added to the District's current fracture critical or underwater list. All current fracture critical and underwater (requiring scuba diver) bridges should be previously coded. Send a copy of this list to the Bridge Division Inspection Branch.
- **A list of all bridges that the condition rating has lowered to a 4 or less.** Include any bridge with a rating of 4 or less, which is not currently rated a 4 or less, or less on any component on the Bridge Inspection Record.
- **A list of all bridges requiring changes in operational status.** Include the bridges that do not meet State Load Posting Policy and require load restrictions. Sort and group these bridges by local jurisdiction if not on-system bridges.
- **A list of all recommended changes in vertical clearance signs.** (off-system only)
- **A list of bridges with missing or inaccurate coordinates.** Include new coordinates collected by a hand held GPS unit and provide them in a decimal format. Sub-meter, differentially corrected data is not required. Send a copy of this list to the Bridge Division Inspection Branch.

On-System Data

Submit one original file for each on-system bridge, using a six-sided folder. Incorporate the order of the various forms within the file uniformly in all Districts, as shown below, with no exceptions. Include the originals of all documents and photographs. Duplicate folders are no longer required and should not be submitted.

Off-System Data

Submit one (1) set of original files and (1) set of summary packages for each off-system bridge. Relate the items to be included in the summary package to each local jurisdiction as detailed below. Summarize the bridge conditions, load posting requirements, and needed maintenance repairs of all bridges within that jurisdiction. Duplicate folders are no longer required and should not be submitted.

Summary Packages

Prepare a standard Off-system Summary Package (one copy) for each jurisdiction (e.g. each city, county, precinct, contact point, etc., as agreed upon with the District Bridge Inspection Office). The packages are intended to be summary reports for bridge inspection findings, maintenance items needed, and load posting requirements. Assemble the package in either a six-sided folder or a three-ring binder and transmit it to the District Bridge Inspection Office.

The format will be designated by the District Bridge Inspection Office and forwarded to the owning jurisdiction by the State. Include the following for each bridge in this summary package "book":

- Color copies of photos
- Bridge Inspection Record
- Bridge Summary Sheet
- Summary of Needed Load Posting Materials

Scour Records and Reports

Many bridges are susceptible to scour of the foundations and abutments from flowing water. These bridges are screened and classified for their potential for scour. Various scour reports, calculations, and photos are necessary to document the scour potential. Include the scour information directly in the Bridge Record, or cross-reference the location of external scour files in the Bridge Record if the scour data is extensive. If there is extensive scour data, cross-reference the location of external scour files in the Bridge Folder. The District Bridge Inspection Coordinator will determine the amount of scour documents to be included with each Bridge Folder. Add any pertinent scour documentation to PonTex.

Section 7 — The Bridge Folder

Folder Information (for on- and off-system bridges)

Keep the original records, sketches, plans if available, and latest information on each bridge on the Texas highway system are kept in a consistent and regular manner. Historically this information was kept in hardcopy format. With the introduction of the bridge data management system PonTex, this information is now stored in electronic format as well. Make every effort to include all bridge related data in the PonTex system so that eventually hardcopy versions of bridge inventory and inspection data can be eliminated. Until eliminated, organize hardcopy folders as indicated below.

Folder Assembly

Use a folder with three (3) dividers and six (6) sides to which documents can be fastened, beginning with the inside surface of the front cover (side 1) and ending with the inside surface of the back cover (side 6). Reflect the most current bridge designation information on the file label in the format established by the district. Items are listed in a top to bottom order. Make the order identical in all districts.

Side 1	
Top	1.) Location Map with bridge highlighted 2.) All current inspection photos (including deterioration photos) 3.) All other photos from previous inspections in chronological order
Side 2	
Top	4.) Bridge Summary Sheet (off-system) 5.) Bridge Inspection Follow-Up Action Worksheet (on-system) 6.) Bridge Inspection Record 7.) Current Load Rating Calculations (or copies of design plans and/or indexing information) 8.) Bridge Inventory Record (must include detailed sketch if plans are not in file), and Revision to Bridge Inventory Record form(if applicable)
Side 3	

Top	9.) Underclearance Sketch (if applicable) 10.) Channel Cross-Section Measurements (if applicable) 11.) Channel Cross-Section Sketch (if applicable)
Side 4	
Top	12.) NBI Sheet 13.) Secondary Scour Screening Form (if applicable) 14.) Form 113.1 (previously completed if applicable) 15.) Any scour-related reports/documents (or indexing information, if applicable) 16.) All scour photos
Side 5	
Top	17.) Elemental Data Detail Listing Report(field forms are not required) 18.) Special Inspection Records and Reports (Underwater Inspection, Fracture Critical Inspection, etc)
Side 6	
Top	19.) Bridge Structural Condition History Sheet 20.) Previous inspections and all attachments in chronological order 21.) Plans

Chapter 9 — Quality Control/Quality Assurance Program

Contents:

Section 1 — Introduction of QC/QA Program

The Federal Highway Administration (FHWA) has developed the National Bridge Inspection Standards (NBIS) that require the Texas Department of Transportation to develop and implement a Quality Control/Quality Assurance (QC/QA) program for all bridge inspection activities. The bridge inspection process is the source of data used for the management of the state bridge inventory. The data produced from this inspection process is used to make decisions concerning public safety, improving new bridge design, and in the allocation of funds for the maintenance, repair, and replacement of bridges. The quality of those decisions is only as good as the quality of the data collected and recorded. Consistently maintaining reliable and accurate inspection data is critical to the long-term health of the bridge inventory and to the daily protection of the public safety. Inconsistencies in the inspection results can have many sources, including variations between inspectors; subjectivity of condition rating scales; differences in training, education and experience; incomplete or ambiguous procedures and practices; or unclear program requirements. Any of these variables can affect the quality of the data.

The focus of the QC/QA program is to provide independent inspections, reviews, and evaluations of the state bridge inspection procedures, practices, and results in an effort to minimize the inconsistencies and variations in the data collected. The information gathered from this program will be used to improve the final quality of the data and reports available to manage the state bridge inventory.

The QC/QA program seeks to establish and define quality in terms of measureable variations from established procedures, practices, and requirements. As per the Code of Federal Regulations (CFR), included in the program will be "periodic field reviews of inspection teams, periodic bridge inspection refresher training for program managers and team leaders, and independent review of inspection reports and computations". The objectives of the program are:

- Generate a greater consistency of the data collected
- Standardize the interpretation and prioritization of inspection findings
- Establish and monitor the qualifications of the personnel involved
- Identify unclear or misleading information in the guides and manuals
- Increase communication between all Consultants, Districts and Divisions

Quality Control

Quality Control (QC) is the implementation of procedures intended to maintain the quality of the statewide bridge inspection program at or above a specified level. Effective Quality Control procedures will increase the statewide uniformity of inspection and recording methods, and will ensure quality reports. This is a daily operational function performed by any entity carrying out inspection operations, whether it is consultant forces, Districts or the Bridge Division. Quality Control procedures help to assure that the public safety is maintained at each bridge, that inspections are performed in accordance with NBIS standards, that bridge files are complete and accurate, and that the documentation of these daily activities is maintained.

Quality Assurance

Activities for assuring the adequacy and effectiveness of the Quality Control procedures are defined as Quality Assurance (QA). The objective of Quality Assurance activities is not to identify and correct deficiencies within a specific inspection report or bridge folder, but rather to monitor and modify as necessary the statewide bridge inspection program requirements to ensure the overall quality levels are maintained. To be a constructive process, it is important for Quality Assurance procedures to be independent, well documented, and clearly understood by all personnel involved.

Reviews

Quality Control reviews need to be conducted by Consultants, Districts and the Bridge Division on inspections that each perform. Consultants should review their work, and the work of their subconsultants, as described in the firm's QC/QA program that is submitted and approved by the Bridge Division. Districts need to review the consultant's work as part of the district's Quality Assurance review plan for the purpose of finding and correcting errors, inconsistencies, or omissions from a specific bridge inspection or consultant submission. The Bridge Division should perform Quality Control reviews on inspections performed by the Bridge Division, as well as perform Quality Assurance reviews on procedures used by the Districts and consultants working directly for the Bridge Division. These Quality Assurance reviews should focus on determining the quality of the procedures used by Districts and Consultants to assure the quality of inspections and data, and identify whether there is a need to correct any inaccuracies in a specific inspection report.

Summary

This QC/QA program is meant to establish procedures and practices that are practical, pertinent to the statewide bridge management program, and a part of the effort to improve the quality of the TxDOT bridge inspection program. Because these objectives focus on improvement, this program will be updated and changed over time.

Section 2 — Quality Control

Program Personnel Qualifications

An effective program begins with adequately qualified personnel. The National Bridge Inspection Standards (NBIS) are very specific about the qualifications of the personnel involved in a bridge inspection program. The Code of Federal Regulations, Title 23, part 650, Subpart C, section 650.309, (23 CFR 650.309) lists the qualifications of personnel. Personnel in the Bridge Division, District and working for the Consultants will have different qualifications based on the job duties they perform.

Bridge Division

The Bridge Division is not only responsible for managing the bridge inspection program, but also performs underwater and fractures critical inspections, as well as routine inspections at the Districts' request. The division also performs special and in-depth inspections as well as performs load ratings. The roles for these actions are different depending on what is needed, but each must meet the qualifications as described in the Federal Code. TxDOT requires all program managers and team leaders to attend a mandatory refresher course every four years, NHI Course No. 130053. This course is designed to: refresh the skills of practicing bridge inspectors in fundamental visual inspection techniques; review the engineering background detailing how bridge structures function; review proper condition and appraisal rating practices; communicate issues of national significance relative to the nation's bridge infrastructures; and review the professional obligations of the bridge inspectors. It is recommended for succession planning and program continuity, that all personnel associated with the bridge inspection office attend an FHWA approved comprehensive bridge inspection training course, as well as take the refresher course every four years.

Program Manager – Pursuant to the Federal Code, each state transportation department must designate an individual who meets the qualifications of Program Manager as described in the Federal Code of Regulations to oversee the Bridge Inspection Program for the State. This individual is responsible for the statewide bridge inspection policies and procedures, quality assurance and quality control, preparation and maintenance of a bridge inventory, bridge inspections, reports, load ratings and other requirements found in the Federal Code. The Bridge Division must ensure that the individual overseeing the Bridge Inspection Program for the State meets the qualifications of Program Manager as described in the Federal Code.

Underwater Inspections – Pursuant to the Federal Code, at least one Team Leader, who meets the qualifications of Team Leader as described in the Federal Code, must be present at each underwater inspection. In addition to the Team Leader requirements, the Federal Code requires that individuals performing underwater inspections meet certain requirements. The Bridge Division ensures that the individuals performing underwater inspections meet these requirements.

Fracture Critical Inspections – Pursuant to the Federal Code, at least one Team Leader, who meets the qualifications of Team Leader as described in the Federal Code, must be present at each fracture critical inspection. The Bridge Division requires that the Program Manager and Team Leaders take a fracture critical inspection course, NHI Course No. 130078, in addition to the other federal requirements for these positions. The Bridge Division ensures that the individual performinig fracture critical inspections for the Division meets the requirements of the Federal Code.

Other Inspections – Pursuant to the Federal Code, at least one Team Leader, who meets the qualifications of Team Leader as described in the Federal Code, must be present at each initial, routine and in-depth inspection. The Bridge Division ensures that the individual performing other inspections meets the requirements of the Federal Code.

Load Rating Engineer – Pursuant to the Federal Code, the individual charged with the overall responsibility for load rating bridges must be a registered professional engineer. The Bridge Division ensures that the individual who performs load ratings for the Division meets the requirements of the Federal Code.

Districts

District Personnel – The personnel in the districts manage the inspection work of the consultant by assigning work, reviewing the work performed and ensuring that the work is updated to the data base. In addition, district personnel may perform initial, routine and special inspections. The individual reviewing the work of the consultants and/or the individual performing an initial, routine or other bridge inspections should meet the requirements of Team Leader as described in the Federal Code. All team leaders are required to attend a mandatory refresher course every four years, NHI Course No. 130053 mentioned above.

Consultant Oversight – The individual responsible for the assignment and review of the work of the consultants should meet the qualifications of Team Leader as described in the Federal Code. This individual is responsible for ensuring that inspections are performed correctly and that the information supplied by the consultant accurately reflects the condition of the structures being inspected. Oversight involves reviewing inspection documentation submitted by consulting firms, reviewing qualifications of inspection personnel operating in the district, and field reviews of bridges that were inspected.

Performing Inspections – The districts can be responsible for performing bridge inspections such as initial inspections, inspections after extreme events and inspections to bridges after repairs have been made. The individual performing these inspections must meet the requirements of Team Leader as described in the Federal Code. When district personnel perform routine inspections, documentation should be consistent with the “Services to Be Provided” in the most recent active statewide bridge inspection contracts.

Consultants

The Consultants are responsible for performing bridge inspections and providing documentation to the State. There are two main roles for the consultant work force. Depending on the size of the firm, these roles may be held by the same individual performing the different roles as the circumstances dictate. A larger firm may have individuals dedicated to the separate roles. The individuals performing these roles must meet the qualifications as described in the Federal Code. All program managers and team leaders are required to attend a mandatory refresher course every four years, NHI Course No. 130053 mentioned above.

Project Manager – Each firm must have an individual designated as Project Manager. The Project Manager manages the work of their firm and the sub-consultants who work for them. The Project Manager coordinates with the State to perform bridge inspections as described in the "Services to Be Provided" in the contract. The Project Manager ensures the quality of the data and that the data is submitted in a timely manner. The Project Manger oversees the work of the Team Leaders and inspectors working directly for their firm, as well as oversees the work of the sub-consultants who perform work for the Project Manager's firm. The firm's Project Manager must meet the qualifications of Program Manager as described in the Federal Code.

Team Leader – Pursuant to the Federal Code, at least one individual who meets the qualifications of Team Leader must be present at each bridge inspection. The consulting firm must ensure that a Team Leader who works for their firm or for a sub-consultant is present at each bridge inspection.

Fracture Critical Inspections – Pursuant to the Federal Code, at least one Team Leader, who meets the qualifications of Team Leader as described in the Federal Code, must be present at each fracture critical inspection. The Bridge Division requires the Program Manager and Team Leaders for each firm under contract to perform fracture critical inspections to take a fracture critical inspection course, NHI Course No. 130078, in addition to the other federal requirements for these positions.

Underwater Inspections – Pursuant to the Federal Code, at least one Team Leader, who meets the qualifications of Team Leader as described in the Federal Code, must be present at each underwater inspection. In addition to the Team Leader requirements, the Federal Code requires that individuals performing underwater inspections meet certain requirements. The Bridge Division ensures that the individuals performing underwater inspections meet these requirements.

Load Rating Engineer – Pursuant to the Federal Code, each inspection contract requires the individual charged with the overall responsibility for load rating bridges to be a registered professional engineer.

Record of Personnel Qualifications – The Bridge Division will keep a list of approved Project Managers and Team Leaders for firms under contract as part of providing statewide bridge inspection services. The Bridge Division will also maintain records documenting qualifications and training of individuals approved as Project Managers and Team Leaders. It is the responsibility of the Engineer in charge of the bridge inspection unit, whether district or consultant forces, to provide information updates to the Inspection Office of the Bridge Division whenever there is a change in personnel or other items affecting personnel qualifications. The file will include each person's job description, education, professional registration or certifications, years and type of bridge inspection experience, bridge inspection training completed, and any special technical courses. Attachment 1 is an example of the form that can be used to document personnel qualifications.

Review Procedures

In addition to these programmatic requirements, the Quality Control program defines specific procedures for the review and validation of inspection reports and data. The TxDOT Bridge Inspection Manual requires Districts to review consultant submissions of office work and field work.

Documentation is one of the most important elements of an effective quality control program. Thoroughly document all review activities. Keep together one copy (either electronic or paper) of the documentation of all office and field reviews together, clearly marked as the review of a specific submission for later access or review by a Quality Assurance team, auditor, or FHWA reviewer.

Office Review - Review a minimum of 10% of the submitted folders and reports for legibility, accuracy, completeness and uniformity. Specific information is required for the bridge folders. A detailed list can be found in Chapter 8 of this manual. Randomly select the sample review folders, as it is the inspector and his process that are being reviewed, not the bridges. Random selection ensures that folders for smaller culverts are reviewed as well as folders for larger structures, structures of different superstructure types, and structures of differing materials. Include thorough documentation of this review process, a list of the folders reviewed and a checklist for each folder reviewed. Attachment 2 is an example of a folder review log and checklist form that can be used. This is a very detailed checklist. Make every effort to do a substantive review of the folder, instead of a simple visual check of the folder contents

Field Review - The field review consists of two activities that comprise a total of at least 7% of the consultant submission. First, co-inspect a minimum of 2% of the submission with the consultant inspection team to verify and document the inspection team members, their qualifications, and review their inspection processes. Scheduling the sampling of this activity is dependent on the consultant availability. It is not a review of the bridge, but of the consultant inspection team. Attachment 3 is an example of the documentation required for these co-inspections.

Second, perform an independent, on site re-inspection of at least 5% of the consultant submission. Take copies of submitted inspections to the bridge site. Independently complete all condition and appraisal ratings, and reviews other items for correctness. Prepare specific notes of changed conditions or significant differences from the last inspection. Prepare documentation of the bridges inspected and findings on forms similar to those in Attachment 4.

Choose the bridges to be independently re-inspected with care. This is an opportunity to make in-depth site visits to a sample of bridges in the District. Some of the criteria for bridge selection for review include but are not limited to:

- New bridges
- Bridges already on a reduced inspection frequency
- Bridges recommended for load posting
- Bridges with a significant change in the condition ratings
- Bridges with critical findings or recommended significant maintenance
- Different types of bridges and culverts
- Bridges not on the last QC review list

The procedures above also apply to review procedures utilized by districts reviewing inspections conducted by in-house forces.

Section 3 — Quality Assurance

Quality Assurance Overview

Effective Quality Assurance procedures are based on objective, quantitative data. Qualitative information is anything not represented numerically, and can include general observations, personal comments, and subjectivity or bias. Quantitative data is represented numerically; it can be summarized and used for independent analysis and comparison. Examples of quantitative data are the specific number of errors per bridge inspection, or the difference in a condition state rating between the most recent routine inspection and an independent Quality Assurance review of the bridge inspection.

Characteristics of comprehensive Quality Assurance programs also include provisions for corrective actions and mechanisms for continual improvement. Corrective actions directed at the source of the variability, inconsistency, or misunderstanding will raise the level of quality throughout the bridge inspection program. Corrective actions may be very specific, such as changing the description or definition of an inspection term to provide clarity, or more general such as changes in personnel descriptions and qualifications. Corrective actions may be systemic such as making adjustments to the numbers of bridges included in the review process. Annual review and discussion of the QC/QA program to determine if corrective actions recommended in the statewide activities have actually been implemented is an essential part of the program, and an example of a mechanism for continual improvement.

Quality Assurance activities include the complete inspection program. Quality Assurance activities monitor the process and results of the visual inspections of all bridges by continually reviewing an office and a field component of the consultant submissions, and the District Quality Control reviews of these submissions. The Quality Assurance reviews and discussions focus on the basic understanding of the statewide inspection procedures and practices as outlined by the NBIS, BIRM and this manual. The program contains continuing education requirements, including attendance at periodic district reviews and training session for all inspection personnel. Documentation of personnel and their qualifications can be used to make sure no one is lacking the training and education required. The Quality Assurance program helps with the practical comprehension of the program requirements through open discussions at meetings, through group review of the bridge inspections that are a collaborative event, and through district specific reviews with opportunities for questions and answers.

An important part of this process is the independent review of all documented activities by inspection teams, District Team Leaders, supervisors, and District Engineers to make certain that all levels of the organization are aware of any problems or inconsistencies throughout the bridge inspection program. Quality Assurance procedures validate Quality Control activities and documentation through independent review of a sampling of the Quality Control documentation reports. The Quality Assurance review activities focus on determining if the Quality Control efforts are equally effective across different work groups; all work groups should undergo the same level of review and participate in discussion and re-review with other levels. Documentation of review results at each level should be shared, reviewed and discussed, and any comments should be incorporated. This ensures that needed corrective actions can be identified during the review process and that mistakes in the process are not repeated for lack of awareness. This structure provides redundancy in the process and increases the effectiveness of the QC/QA process at all levels.

Quality Assurance District Reviews

At least once every inspection cycle (24 months), a Quality Assurance Review will be conducted at each district. Typically, this will be a three day event - one day for an office review, one day for independent on-site field inspections, and one day to discuss the review and findings.

A Quality Assurance Engineer from the Bridge Division will conduct a comprehensive office review of the District Quality Control process and documentation. The TxDOT District Quality Control process is well defined. The Quality Assurance office review will focus on the overall completeness, legibility, and accuracy of the Quality Control review documentation. The Engineer will also review several bridge folders that were part of the District Quality Control to focus on the specific quality of the folder review. Checklists will be reviewed to ensure the folder review is a thorough, thoughtful review rather than a simple visual check of the folder contents. Any questions or discrepancies in the consultant submission discovered by the District can be reviewed and discussed at this time. The QA office review will also determine if the folders include documentation for appropriate action taken according to the follow-up action reports.

The Quality Assurance Engineer also will conduct a new, independent re-inspection of a sample of bridges as determined in advance. The review will use new forms and identify all the elements in the bridge, the appropriate condition states, and the NBI data. This inspection will be a collaboration between the Bridge Division and District personnel, with on-site discussions of elements, condition states, ratings, and any follow-up action recommendations.

The sample of bridges should be from the sample used in the District Quality Control re-inspection. There should be a representation of the different types of bridges commonly found in the District, including a variety of bridge types, complexity, span numbers, and span lengths. Also, consider bridges with critical findings or recommended load ratings and postings, any bridges needing rehabilitation or follow-up actions, and new structures (to check initial routine inspections).

Once the independent field reviews are complete, the Quality Assurance Engineer will schedule a close out meeting with District Bridge Inspection personnel to cover the findings and any recommendations for improvement. The District Bridge Engineer and District Engineer are encouraged to join the meeting. Issues to be covered include how District Quality Control inspection results compare with QA findings and the most recent routine consultant inspections. The comparison will focus on appropriate assignment of elements, reasonable consistency with element conditions, states, and the NBIS condition ratings. Specific limits for the expected consistency between the two inspections should be discussed. Every effort will be made to define the results quantitatively. For example, document the number of errors per bridge inspection when compared to the Quality Assurance review; document the number of coding errors per submission; document the number of errors or omissions per review by the Quality Control review process; document the number of folders missing data for load rating or load posting calculations. The current threshold for "adequate consistency" is two errors per bridge. The original inspection team condition ratings are also considered out-of-tolerance if they vary more than +/- 1 from the condition ratings compiled by the Quality Assurance Engineer. An important item for discussion is to identify the sources of discrepancies and solutions. Another item for discussion is whether the recommended follow-up actions have been addressed - which repairs can be done by in-house maintenance crews, which will need a maintenance contract for greater rehabilitation, and which will require bridge replacement.

A Quality Assurance Report will be written following the review. This report will be forwarded to all participants and the original consultant program managers for review and comment. This report will include the dates of the Quality Assurance review; the names, Districts, and qualifications of the review team members; a summary of the review procedures; a list of the structures re-inspected; office review findings; field review findings; a summary of the quantitative results for the District Quality Control Review and the consultants routine inspections compared to the Quality Assurance Review; and any recommendations for increasing quality of future inspections. Documentation will include a field review checklist sheet and an office review checklists for every bridge inspected. After this report has been reviewed and comments have been incorporated, it will be signed and sealed by the Bridge Division Inspection Branch Manager and sent to the District Engineer and the Administration.

Quality Assurance Meetings

In addition to Quality Assurance reviews of every District, the Bridge Division will hold periodic bridge inspector's meetings, either in person or via webinar. These meetings will serve as continuing education for TxDOT bridge inspection personnel to increase consistent statewide understanding of the bridge inspection program. Each District Bridge Inspection Coordinator will be required to attend, and all other bridge inspection personnel are encouraged to attend. Consulting firms will be encouraged to attend portions of the meeting to promote more dialogue between consultants, districts, and the Bridge Division.

These meetings will focus on changes to procedures and policies that result from the Quality Assurance process, such as modifications to the bridge inspection manual, consultant contract requirements, etc. The meeting format will allow for interchange between participants regarding the appropriateness and effectiveness of the recommended changes. If the participants agree to these changes, then the changes are implemented for the next cycle of inspections.

Another focus of these meetings will be to discuss various topics such as: inspection practices and ways to reduce variations in results from different teams, consistent implementation of program requirements between districts, the differences between real world inspection practices and the published works on inspection procedures, completeness and clarity of the Bridge Division manuals and inspection publications, and any problems not addressed in the other Quality Assurance activities.

Summary

The safety of highway bridges in Texas depends on the effective management of our 50,000-plus bridges in the National Bridge Inventory (NBI). Critical to our ability to maintain public safety is to accurately and consistently inspect the condition of in-service bridges, evaluate and document deterioration, and create recommendations for maintenance, rehabilitation, or replacement so our bridges meet service requirements. TxDOT cannot successfully manage our state bridge inventory in terms of safety and resource allocation without quality bridge inspections. The quality level can be measured, documented, and improved by specific procedures within the QC/QA program. Thus the main focus of the QC/QA program is to identify and correct any deficiencies in the process, while building on the program strengths.

Appendix A — State and Federal Regulations

Bridge Inspection Guidelines

Three regulations and codes have particular bearing on bridge inspection.

Regulations Affecting Bridge Inspection

Regulation	WWW Link
Code of Federal Regulations	http://www.fhwa.dot.gov/legsregs/ directives/fapg/ cfr0650c.htm
U.S. Code for Bridge Inspection	http://www.fhwa.dot.gov/legsregs/ title23.pdf
Texas Transportation Code	http://www.statutes.legis.state.tx.us/Docs/TN/htm/ TN.545.htm

Code of Federal Regulations Highlights

Section 650.301, Application of standards. This section states that all sections in this part (Subpart C) apply to all structures defined as bridges. It also restates the current AASHTO definition of a bridge. This section was first added to the Federal Register in 1979, and it was amended in 1986.

Section 650.303, Inspection procedures. This section requires each state transportation department to have an organization that is capable of performing bridge inspections and preparing reports and ratings in accordance with the AASHTO Manual for Maintenance Inspection of Bridges. It further requires that each structure be rated to determine safe load capacity, and it gives the criteria at which the structure must be load-restricted. This section makes TxDOT responsible for determining the safe load capacity of each bridge in the inventory. This section was first added to the Federal Register in 1971 and amended in 1979 and 1988.

Section 650.305, Frequency of inspections. This section defines the maximum interval between bridge inspections. This section was first added to the Federal Register in 1971 and amended in 1974, 1988, and 1992.

Section 650.307, Qualifications of personnel. This section gives the minimum qualifications for individuals conducting bridge inspections and administering a bridge inspection program. This section was first added to the Federal Register in 1971 and amended in 1979 and 1988.

Section 650.309, Inspection report. This section requires standard forms to be used for reporting bridge inspections. This section was first added to the Federal Register in 1974.

Section 650.311, Inventory. This section requires each state to maintain an inventory of all the bridges in the state. It also stipulates that the maximum allowable time states have to update the inventory is 90 days after any change in the status of a structure. This section was first added to the Federal Register in 1979 and amended in 1988.

U.S. Code for Bridge Inspection Highlights

Section 116, Maintenance. This section states that if any project, including bridges, constructed under the provisions of this chapter is found not being properly maintained, including inspections and load posting of bridges, then the state has 90 days after the problem is called to its attention to correct the problem. If nothing is done, then approval of further projects can be withheld. This section is used to justify withholding federal funds to local entities that do not comply with the National Bridge Inspection Standards.

Section 144, Highway Bridge Replacement and Rehabilitation Program. This section states that it is of vital interest to the nation to establish a bridge rehabilitation and replacement program to address those structures that are unsafe due to structural deficiencies, physical deterioration, or functional obsolescence. As part of this program, the state must inventory all on- and off-system bridges and classify them for serviceability, safety, and essentiality for public use. This section was used to require each state to establish a bridge inspection program. It requires that the rehabilitation and replacement program be based on the number of unsafe bridges in each state. It also requires the inventory, retention, rehabilitation, adaptive reuse, and future study of historic bridges. A historic bridge is any bridge that is listed on or eligible for listing on the National Register of Historic Places.

Section 151, National Bridge Inspection Program. This section requires the state transportation departments to establish standards for the procedures used to make bridge inspections. These standards must establish methods, frequencies, qualifications for inspectors, reporting procedures, and a procedure for national certification and training of bridge inspectors.

Texas Transportation Code Highlights

Section 201.803, Information for Road Construction and Maintenance. Subsection (e) allows TxDOT to request from county and municipal officials any information necessary for performance of the department's duties under this section. Therefore, if the department first requests the information, it should have no problem obtaining as-built plans. However, in almost all cases, the department does not have prior knowledge of the construction of an off-system bridge. Often, by the time the structure is first located by the department, the plans have disappeared.

Section 201.8035, Inspection of County and Municipal Bridges. This section deals with the inspection of off-system bridges. Subsection (a) requires TxDOT to notify local jurisdictions when a bridge qualifies for a lower load rating. Subsection (b) requires that local entities post notices on the roadway approaching the bridge. This section gives TxDOT the authority and responsibility to require posting of off-system bridges by counties and municipalities. This section holds TxDOT accountable for ensuring that off-system bridges are capable of safely carrying loads. Local entities should provide the information necessary for TxDOT to carry out this duty.

Section 621.301, County's Authority to Set Maximum Weights. This section allows a county to establish load limits for a county road or bridge only with the concurrence of the department. If a county determines that the load limit of a county bridge should be different from the load limit supported by a department inspection, the county must submit the proposed load limit to the district engineer. A request for a load limit must be accompanied by supporting documentation that is sealed by an engineer and that includes at a minimum calculations supporting the proposed limit and a structural evaluation report documenting the condition of the bridge. The district engineer concurs with a county's proposal in writing. If the department does not indicate concurrence or non-concurrence in writing within 30 calendar days of receipt by the department of a request that includes all required documentation, the proposed load limit is deemed concurred with by the department. The department may review the load limit and withdraw this concurrence at any time by providing written notification to the county. A county may appeal the decision of the district engineer by submitting a written request, along with the required documentation, to the executive director. The executive director will review the request and determine if department concurrence will be granted. The executive director's decision is final.

Appendix B — Links to Coding Guidelines

Elements: Field Inspection and Coding

Refer to the Elements: Field Inspection and Coding Manual for guidelines for coding element-specific data on bridges.

Bridge Inspection Coding Guidelines

Refer to the Coding Guide for guidelines for maintaining data in the computerized Bridge Inventory, Inspection, and Appraisal files.

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