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Chapter 19 - Maintenance and Preservation of Ancillary Features

19.1 Utilities

19.1.1 Record of Utility Installation History

Bridge maintenance crews are not typically responsible for the maintenance of utilities on bridges, but will need to govern their work to avoid disrupting them. Bridge maintenance operations requiring interruption to utility services should be coordinated with the utility operator. Bridge maintenance crews should also check the condition of utilities mounted on the bridge for any obvious signs of deterioration, notify the utility owner if deterioration is identified and be familiar with any agreements between the bridge and utility owners.

New utility installation or re-configurations should be reviewed and/or field verified prior to any new documentation entry. Utility attachments should not be allowed if the bridge load rating would be reduced below the legal limit. Any requests, or actions, to add or modify utilities should be coordinated with the bridge office. Methods of attachments and any additional loads due to the utilities should be reviewed by the bridge office.

Bridge utility occupancies should be identified and recorded on a “Bridge Information Data Sheet”. The current “What, Where, and How” information should be documented, as shown in the example data sheet in Figure 19.1. It can be beneficial for bridge owners to provide coordination between the Bridge Management System and Bridge Maintenance Management Systems so that maintenance workers and inspectors have the most up-to-date information.

BRIDGE DATA SHEET
(FOR ALL STRUCTURES)

Prepared By: Date:

DESCRIPTION

1. Bridge Identification Number (BIN)
2. County:
3. Town:
4. City/Village

GENERAL

5. Over Roadway Description
   a. State/County/Local Highway Name
   b. Route/Road Number
   c. Functional Classification NHS System
   d. Design Speed
   e. Truck Traffic %
   f. Traffic Year
   g. Traffic Data/ AADT
   h. Seismic Performance Criteria
6. Under Roadway Description
   a. State/County/Local Highway Name
   b. Rout/Road Number
   c. Functional Classification NHS System
   d. Design Speed
   e. Truck Traffic %
   f. Traffic year
   g. Traffic Data/ AADT
   h. Minimum Vertical Clearance
   i. Minimum Horizontal Clearance
7. Maintenance of Existing Traffic
   a. Is there vehicular traffic which must be maintained?
   b. If yes, how will it be maintained?
   c. If a temporary detour structure is required, what liveloading should be used?
   d. Does pedestrian traffic need to be maintained?
   e. If yes, how will it be maintained?
   f. Is the bridge part of a designated bicycle route?

EXISTING STRUCTURE

8. Structure Description:
9. Original Construction Contract No.(s)
10. Type of structure, span, and skew
11. Are plans available? Do they accompany submittal?
12. Is there any asbestos on the existing bridge?
13. Is the bridge within or adjacent to an area of contaminated material
14. Are there sidewalks on the bridge
15. Specify any utilities carried on structure
    a. Do any of these utilities need to be kept in service at all times?
    b. Can any of these utilities be interrupted for a given period of time?

Figure 19.1 Example Bridge Data Sheet

19.1.2 Utility Ownership Identification

A wide variety of utility occupancies may be present on or around a bridge structure. The utility type, location, approximate location and contact information for the utility department responsible for the carried facility should be documented. This information will assist in notifying the responsible party when problems or deficiencies are encountered with or affecting a utility facility or its support structure.

19.1.3 Utility Types

Many types of utility facilities may exist on, around, or under a bridge structure. Communication lines for telephone, cable TV, or highly delicate fiber optic cables may be visibly present or encased in a protective conduit, as shown in Figure 19.2 through Figure 19.4.

Figure 19.2 Visible Electric Lines Above and Under a Bridge Structure

Figure 19.3 Communication Lines Encased in Protective Conduit

Figure 19.4 Water Line Crossing Mounted to Bridge

Overhead lines may be present near the bridge structure, as shown in Figure 19.5. High voltage electric lines may need to be de-energized prior to the operation of cranes and booms within prescribed distances from the facility. Overhead lines may approach a bridge structure and then transition underground with the use of a riser assembly located on adjacent poles, an example of which is shown in Figure 19.6. Street lighting, traffic signal conductors, ITS sensors and similar systems owned by the transportation agency may also be attached to the structure. An example of bridge lighting attached to a bridge structure is shown in Figure 19.7.

Figure 19.5 Example of Overhead Lines Near Bridge Structures

Figure 19.6 Examples where Overhead Lines Transition Underground

Figure 19.7 Example of Street Lighting Attached to Bridge Structure

Many times an older structure may have electric or telecommunication utilities provided in tiles in sidewalk. Before any bridge rehab work is done, crews need to verify or review the bridge plans to make sure there is no conflict.

Fluids, such as sewer and high pressure water lines, and flammables, such as natural gas or oil transmission lines, may be attached to the top, fascia, or underside of the structure. Figure 19.8 shows examples of fluids which are (a) attached to the fascia overhang, (b) suspended from diaphragms, and (c) mounted to bridge fascia.

(a)

(b)

(c)

Figure 19.8 Examples of Fluid and Flammable Lines

Signage or stamped lettering may detail the type of facility and/or its contents to make all aware of the potential dangers connected with the utility encountered. Examples of signs designating potential dangers are shown in Figure 19.9. Some hazards may not be clearly labeled, but should be communicated to personnel working with or near the carried facility.

- Older conduits may consist of asbestos reinforced cement, or “transite”. Cutting, breaking and machining asbestos-containing transite elements releases carcinogenic asbestos fibers into the air.
- Energized utilities can present an electrocution hazard, either through direct contact or stray voltage.

Figure 19.9 Various Signs Designating Potential Dangers

19.1.4 Utility Attachments

Utility facilities may be attached to a bridge structure in a variety of ways. Mounting hardware such as straps, bands, or hangers may be utilized to attach the carried facilities to bridge rails, parapets, abutments, sidewalks, structural slabs, or bridge superstructure components. Examples of utility hangers on a bridge structure are shown in Figure 19.10. Utility lines are generally run through a conduit or protective casing which is attached via an accessible connection system, as shown in Figure 19.11. The utility casing or mounting hardware should not present a hazard to the public or be detrimental to the bridge structure condition.

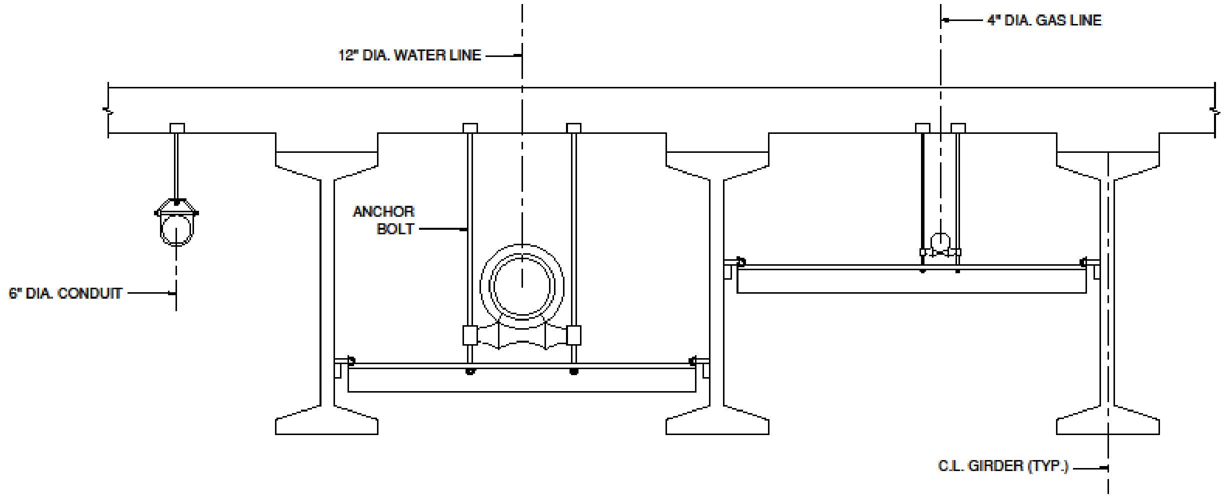


Figure 19.10 Utility Hangers on Bridge Structure

Figure 19.11 Utility Lines Running through Conduit (left) or Protective Casing (right)

19.1.5 General Maintenance Activities and Responsibility

Items to look for include:

What To Look For

- Deficiencies with the mounting hardware
- Breaks or cracks in conduit casing and connection joints
- Abnormal wear or deterioration
- Evidence of rust or staining
- Expansion or contraction problems
- Collision damage to the utility or support system
- Any damage to the bridge components

During routine bridge inspections things to look for and note are deficiencies with the mounting hardware, breaks or cracks in conduit casing and connection joints, abnormal wear or deterioration, evidence of rust or staining, expansion or contraction problems, collision damage to the utility or support system and any damage to the bridge components. Bridge Inspectors should be inspecting the utility carrier members and the support system, and should note any problems encountered with the bridge structure connections and/or its functionality. Note that the maintenance worker should also be on the lookout for these situations.

For gas mains, it should be noted that if the inspector, contractor, or maintenance worker encounters any of the following issues: natural gas odor, obvious corrosion to exposed gas pipe, or mechanical/structural damage to the gas main facility, they should immediately notify the gas company involved and call for an on-site inspection. Examples of corroded gas pipes are shown in Figure 19.12.

Figure 19.12 Examples of Corrosion at Exposed Gas Pipe

A check for water leakage from the bridge structure, either directly or in-directly, should be included to protect the utility from damage. If leakage is detected, it should be corrected by the bridge owner. If water penetration of a utility facility is evident, it should be corrected by the utility owner. An example of water leakage under a bridge structure is shown in Figure 19.13.

Figure 19.13 Water Leakage under Bridge Structure

For electrical or communication lines, a check for poor insulation coverage, stray current or loose wires if visible, is prudent to prevent potential shock events. Bridge movement due to operational vibrations, or environmental effects such as wind, temperature change, settlement, etc., should be considered in a utility placement. Earthquakes can cause sudden and sometimes drastic movements to a bridge structure. The utility facility and mounting system should be designed to be flexible enough to withstand these movements and displacements resulting from both normal operation and extreme events. An example of signs of damaged that need to be fixed is shown in Figure 19.14.

Figure 19.14 Signs of Damage Should Be Fixed to Prevent Electrical Shock

The utility facility and its support system should operate in harmony with bridge expansion devices or have a support system that acts independently of bridge movement and can facilitate the anticipated movement. Periodic monitoring with routine inspections is recommended to assure that movement events are being accommodated. Bridge Inspectors should be inspecting the utility carrier members and the support system, and should note any problems encountered with the bridge structure connections and/or its functionality. Again, the maintenance worker (in addition to the inspector) should be on the look-out for these situations.

19.1.6 Maintenance Operations and Affected Utilities

When maintenance activities or necessary bridge work will be in close proximity to a utility facility, a "Utility Protection Call Center" should be contacted and the utility owner notified by the project manager or field foreman. An example of a "Utility Protection Call Center" sign is shown in Figure 19.15.

Figure 19.15 An Example of a "Utility Protection Call Center" Sign

The utility owner should be advised on the necessary work and have the appropriate location mark-out identifications completed prior to the start of work. This notification should occur at least one week prior to the commencement of work, but not beyond two weeks of lead time, due to the potential changes that may occur through the utility owner's work that may be planned in the work area. Uniform Color Codes for Temporary Marking of Underground Facilities have been established by the American Public Works Association (APWA). The color codes are shown in Table 19.1.

Table 19.1 AWPA Uniform Color Codes for Temporary Marking of Underground Utilities

Color Code	Underground Utility
Red	Electric lines, cables, conduit, and lighting cables
Orange	Telecommunication, alarm or signal lines, cables, or conduit
Yellow	Natural gas, oil, steam, petroleum, or other gaseous or flammable material
Green	Sewers and drain lines
Blue	Drinking water
Purple	Reclaimed water, irrigation, and slurry lines
Pink	Temporary survey markings, unknown/unidentified facilities
White	Proposed excavation limits or route

19.1.7 Broken Utility Components and Responsibility

If broken supports, attachments, mounting hardware, damaged conduit or facility apparatus are encountered by either inspectors or maintenance workers, the utility owner should be notified and repairs promptly made by the utility owner representative. An example of damaged supports that require attention is shown in Figure 19.16.

Figure 19.16 Example of Damaged Supports Requiring Attention

Cracked, splintered, or severely checked wood poles and supports, such as those shown in Figure 19.17, should be noted and repaired or replaced by the owner as soon as practical.

Figure 19.17 Examples of Cracked and Splintered Wood Poles (left) and Supports (right)

If the bridge owner causes damage to a utility component or attachment while performing routine maintenance work, it is the bridge owner who is responsible to repair the damage at the direction and guidance of the utility owner representative. An example of such damage and the ensuing repair are shown below in Figure 19.18.

Figure 19.18 Example of Incidental Damage (left) and Resultant Repair (right)

19.2 Bridge Mounted Sign Structures

This section provides a brief coverage of maintenance activities related to bridge mounted sign structures. For readers responsible for the maintenance of sign structures and other ancillary highway structures, more comprehensive coverage can be found in the FHWA publication "Guidelines for Installation, Inspection, Maintenance and Repair of Structural Supports for Highway Signs, Luminaries, and Traffic Signals". This report can be found at the following FHWA web link: http://www.fhwa.dot.gov/bridge/signinspectiontoc.cfm.

19.2.1 Record of Sign Inventory

FHWA strongly recommends (but does not currently mandate) that agencies responsible for sign structure maintenance maintain an inventory of overhead and bridge mounted structures and perform regular inspections. Sign inventory data is a collection of structure specific information, maintained for the benefit of the owner's planning, maintenance and operational endeavors related to each sign structure. Sign structures should be uniquely numbered for easy field identification and record keeping. Numbers should be assigned during design, fabrication, or installation and should be stenciled, etched, or printed on the sign structure in clear view, as shown in Figure 19.19.

Figure 19.19 Example of Sign Structure Identification

In order for the collected data to be searchable and sortable; entry is preferably entered through drop-down menus.

19.2.2 Collected Inventory Information

Historical data such as record plans or as-built drawings are typically difficult to obtain for bridge mounted sign structures. For this reason collection of inventory data is critical to the management of the structures. A wide variety of sign data may be collected and maintained in a sign structure inventory database, depending on the needs of the database users (maintenance forces, highway designers, traffic safety groups, oversized load permitting, inspection, etc.). Some data points that may be of interest to a maintaining agency would include:

- Route number and direction
- Milepost location
- Political Unit (County/Town)
- Maintenance Jurisdiction

- GPS coordinates
- Erection Date and Contract #
- Material (Aluminum/Galvanized Steel/Weatherized Steel)
- Sign text & reflectivity
- Sign panel dimensions and location
- Inspection frequency
- Inspection date
- Inspection element ratings
- Significant findings and repair recommendations
- History of repairs
- Horizontal and vertical clearances
- Geometry data

Elements on sign structures can be highly repetitive. To aid in the tracking and locating of defects between inspection and maintenance, a common naming and numbering convention should be employed.

19.2.3 Database Inventory Information

The collected bridge sign data should be made available to all interested parties. The data should be presented in a simple format that all can utilize to sort, prioritize, or categorize as needed for the management and the continued safe operation or eventual removal/replacement of the structure.

19.2.4 Sign Inspections

FHWA does not currently mandate inspection of sign structures, however many jurisdictions follow FHWA's recommendations regarding sign structure inspections as described in publication FHWA NHI 05-036, *Guidelines for the Installation, Inspection, Maintenance and Repair of Structural Supports for Highway Signs, Luminaires and Traffic Signals*. If possible, bridge mounted sign structures should be inspected in conjunction with the bridge on which they are mounted.

Sign inspections can be broken down into five categories:

1. Initial Inspection – a "hands-on" inspection which takes place shortly after installation to check fabrication and erection and to collect inventory information.
2. Routine Inspection - Simple ground level inspection on an assigned frequency or after a potentially damaging event to view overall condition and screen for deficiencies or structural deterioration requiring a more detailed inspection. Visual aids such as binoculars may be used to improve coverage. Some inventory data may be collected or updated during a routine inspection. This level of inspection may be scheduled at the beginning of sign structure assessment program or immediately after a regional high-wind event.
3. In-Depth Inspection - a "hands-on" inspection activity performed at regular intervals to inspect the structural and safety element and to collect/update inventory information. All elements including bolts and welds are visually and tactically inspected.

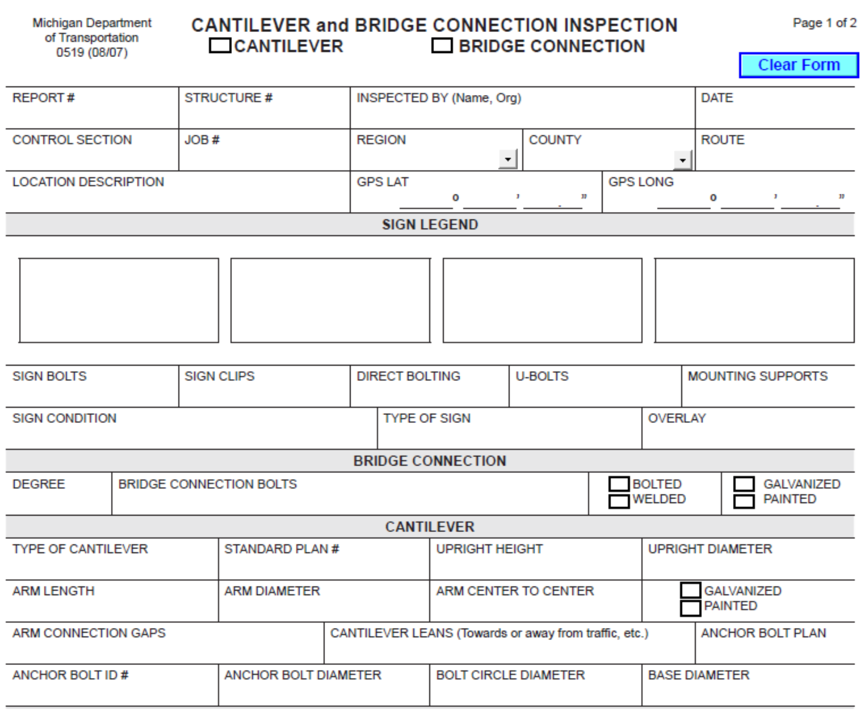
4. Interim Inspection – a "hands-on" inspection activity focused on tracking previously identified critical defects or deficiencies between the regularly scheduled In-Depth inspection intervals.
5. Damage Inspection – a "hands-on" inspection activity scheduled shortly after vehicular impact to visually and tactically inspect all elements along the impact's load path that may be affected by the event.

The frequency of inspections is determined by the responsible maintenance agency and should consider several factors, including:

- Material type
- Structural redundancy
- Bridge inspection schedule
- Traffic control needs
- Historical performance of similar structures in the inventory

Inspection reports should describe the observed deficiencies on all critical elements, where a critical element is defined as a portion of the structure that alone can affect the stability or capacity of the structure. All significant deficiencies should be noted, located, photographed and described in a manner that can easily be found by maintenance forces or used for comparison by future inspectors. A formal numerical scale, defined by the owner, is typically used to rate and track each structural and safety element.

Figure 19.20 below shows an example form that could be used to collect bridge mounted sign inspection information. Information to be collected includes how the sign is mounted to the bridge, type of sign, sign legend, and inventory information.


Michigan Department of Transportation 0519 (08/07)

CANTILEVER and BRIDGE CONNECTION INSPECTION

☐ CANTILEVER ☐ BRIDGE CONNECTION

Page 1 of 2

Clear Form

REPORT #	STRUCTURE #	INSPECTED BY (Name, Org)	DATE
CONTROL SECTION	JOB #	REGION / COUNTY	ROUTE
LOCATION DESCRIPTION		GPS LAT ° ' "	GPS LONG ° ' "

SIGN LEGEND

SIGN BOLTS	SIGN CLIPS	DIRECT BOLTING	U-BOLTS	MOUNTING SUPPORTS
SIGN CONDITION	TYPE OF SIGN	OVERLAY		

BRIDGE CONNECTION

DEGREE	BRIDGE CONNECTION BOLTS	☐ BOLTED ☐ WELDED	☐ GALVANIZED ☐ PAINTED

CANTILEVER

TYPE OF CANTILEVER	STANDARD PLAN #	UPRIGHT HEIGHT	UPRIGHT DIAMETER
ARM LENGTH	ARM DIAMETER	ARM CENTER TO CENTER	☐ GALVANIZED ☐ PAINTED
ARM CONNECTION GAPS	CANTILEVER LEANS (Towards or away from traffic, etc.)	ANCHOR BOLT PLAN	
ANCHOR BOLT ID #	ANCHOR BOLT DIAMETER	BOLT CIRCLE DIAMETER	BASE DIAMETER

Figure 19.20 Example Bridge Mounted Sign Inspection Form

19.2.5 Common Mountings

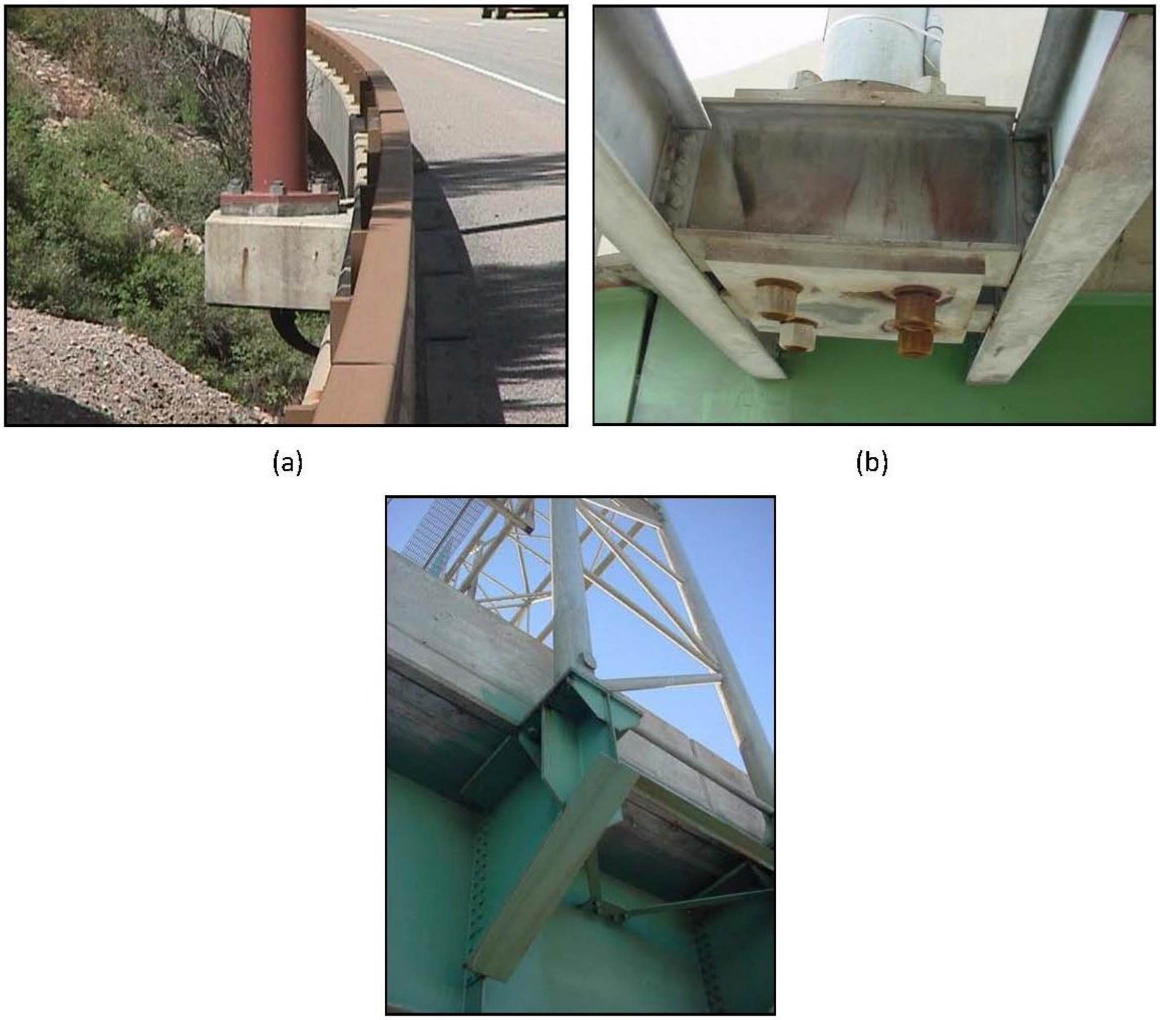
Sign structures are typically mounted to bridges using one of two configurations:

1. Signs viewed from the under roadway can be mounted to the fascia girder and the side of the concrete deck or parapet in jurisdictions that permit this configuration (examples are provided in Figure 19.21). Concrete anchorages can be achieved through pre-installed anchors, grouted anchors or through-bolting; however the use of through-bolting should consider the potential for vehicular or plow blade damage from the over roadway. Steel anchorage should be accomplished with high-strength bolted connections to the fascia girder web or stiffener plate of the fascia girder. Welded connections are highly discouraged due to fatigue concerns. Where encountered, welded connections should be inspected regularly for cracking.
2. Signs viewed from the over roadway are typically mounted to the top of the concrete deck / parapet or cantilevered off the fascia girders (examples provided in Figure 19.22 (a) concrete bridge deck extension, (b) steel frame between 2 bridge fascia beams, and (c) steel bridge fascia beam).

Anchor rods are used to attach the structure to concrete bridge elements and high strength bolts are used to connect the structure to steel bridge elements.

(a) (b) (c)

Figure 19.21 Examples of Sign Mountings for Viewing from Under Roadway



(a) (b)

(c)

Figure 19.22 Signs Mounted to Various Bridge Components

Bridge mounted structures are subject to premature failure due to two primary mechanisms, as described below:

1. Repeated deflection of the supporting bridge elements under truck loading leads to additional fatigue cycles on the sign structure elements. This condition is more critical when the structure is mounted near mid-span locations.
2. Structures supporting signage viewed from the over roadway can be elevated a great distance above the surrounding ground level, subjecting them to increased wind velocity and pressure. Wind pressure is the primary load mechanism for sign support structures.

Bridge mounted sign structures may be located near electric facilities or be used as a conduit for electric circuits serving sign lighting or other attached devices. There have been situations where sign structures have been used as a conduit of convenience for electric crossings. This practice is not recommended as it presents an electrocution hazard if there is a high load impact. Proper clearances from sign structures to existing utility facilities should be checked and maintained as per established OSHA and National Electric Code guidelines to prevent potentially dangerous electrical shock or explosions. Prior to any work being performed, structures should be checked for stray voltage and communication with the associated utility company should be made to obtain the necessary knowledge of voltages and work clearances to avoid potential hazards and code violations.

19.2.6 Bolts and Fasteners

High Strength Bolts, Anchor Rods, Stainless Steel or Aluminum Fasteners, U-Bolts, and Bolted Clips are some of the types of connection hardware used on sign structures. Structural connections generally utilize high strength bolts or anchor rods, while secondary connections are made with U-Bolts, Clips, Stainless Steel or Aluminum Fasteners. For an example of connection equipment, please see Figure 19.23. Installation tension requirements and corrosion potential should be considered when selecting connection hardware.

Figure 19.23 Example of Connection Equipment

Anchor Rods are generally set into the concrete slab or parapet, and are usually installed during the initial concrete pour. Leveling nuts are placed under the base plate and a top nut is installed with sufficient proof load to elongate the rod and create a permanent clamping force on the plate. Washers should be installed under both nuts and the “turn-of-the-nut” or other prequalified proof-load methods should be used to tighten double-nutted anchor bolt connections.

19.2.7 Tightness of Bolts

Sign structures on bridges are subject to constant vibrations due to fluctuating wind loads and bridge movements, sometimes leading to the loosening of connection hardware. In other cases, improper installation procedures can be the cause of loose hardware. Regardless of the cause, loose and missing hardware is of significant concern, as it can lead to a falling debris hazard, the overstressing of remaining connection elements (Figure 19.24) and reduced fatigue life for the connection. Sign structure failures are commonly attributed to loose anchor rod nuts leading to bolt fracture. When improperly installed, galvanized, high-strength bolts are difficult to tighten due to the loss of factory applied lubricants. Retightening efforts have been known to fracture anchor bolts. For this reason, it is recommended that loose nuts be replaced using the following repair procedure:

Suggested Procedure

Loose Anchor Bolt Nut Replacement

1. Provide temporary support in order to remove loading from the support.
2. Insert finger shims under any loose leveling nuts
3. Remove loose nuts (hydraulic nut splitter may be required)
4. Clean the exposed bolt threads with a wire brush and apply bees wax lubricant
5. Tighten the replacement nut using an approved proof load method (turn-of-the-nut, direct tension indicating washers, etc.)

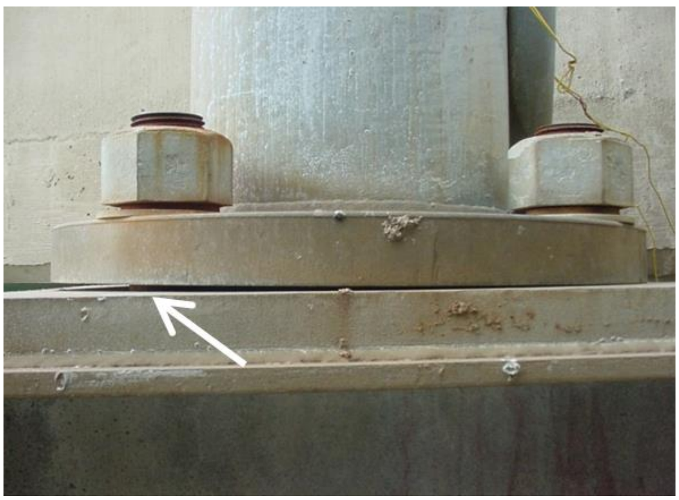


Figure 19.24 Loose Anchor Bolts Revealed by Gap Under the Base Plate

Loose or missing hardware should be replaced and tightened with the proper lubrication and an approved tension verified proof-load tightening method (e.g., turn-of-the-nut method), unless it can be determined that sufficient redundancy exists in the connection. When possible, it is recommended to temporarily support the connected elements, remove the loose nut, clean and lubricate the bolt threads and install a new, lubricated nut. Proper nut tightening procedures will vary depending on the bolt material/diameter and the equipment used. Care should be exercised when tightening non-lubricated nuts to prevent permanent damage to the bolt due to thread and nut face friction.

If nuts are not fully engaged, they may not be able to transmit the intended load. An example of this situation is shown in Figure 19.25 (left). An example of a situation using supplemental anchor bolts is shown in Figure 19.25 (right).

Some or all of the following repair options may be available depending on the connection configuration.

Suggested Procedure

Partially Engaged Anchor Bolt Nuts – Repair Options

1. Evaluate not repairing if more than 75% of the threads are engaged.
2. Lower the base plate if anchor rod thread is available under the leveling nuts.
    a. Lower both sides of a span structure.
    b. Verify that minimum roadway clearances will remain available.
3. Remove the top of the parapet concrete and install a threaded coupler to extend the anchor.
4. Enlarge the base plate hole and install a specially machined shoulder nut.
5. Add additional fasteners (see Figure 19.25 right).
6. For bolts not embedded in concrete, such as a bridge mounted sign attached to a girder web, a simple solution might be replacing the bolt with a longer shank.

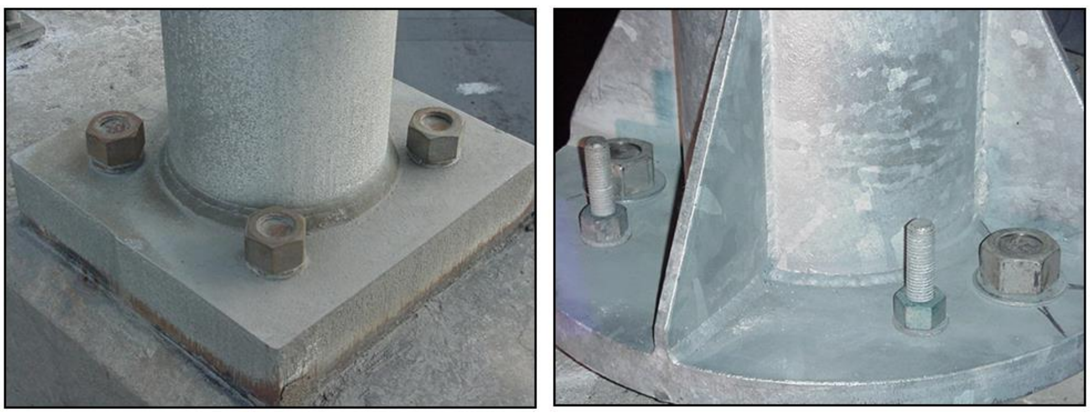


Figure 19.25 Examples of Nut Tightening Procedures

19.2.8 Epoxy Anchors

When to Call the Engineer

Call the Engineer if there is any indication of movement or damage to anchors or to surrounding substrate of anchors in continuous tension.

Fascia mounted sign structures are commonly anchored to the side of the concrete bridge deck or parapet rail. Anchor bolts set with epoxy (or other adhesives) into existing concrete can be considered to be a good, strong, connection if properly installed. When selecting anchorage options, it is important to ensure that the selected system is intended for the horizontally-inclined orientation under consideration. Installation of adhesive anchors subjected to continuous tension loading or used for overhead installations (see Figure 19.26) requires specialized training. See the FHWA Technical Advisory *Use and Inspection of Adhesive Anchors in Federal-Aid Projects* at https://www.fhwa.dot.gov/bridge/t514030.cfm.

Recent failures of adhesive anchors in the transportation industry have focused attention on the training and certification of workers installing these systems. Certification programs are available through the Concrete Reinforcing Steel Institute. More information regarding certification programs can be found at the following web link:
http://www.concrete.org/Certification/CertificationPrograms.aspx.

Figure 19.26 Example of Adhesive Anchors Subjected to Continuous Tension Loading

Upon identification of an anchorage failure (see example in Figure 19.27), a structure removal evaluation should be performed. If it is determined that the structure is safe to remain in service, repairs should be designed by a qualified professional engineer. Patching of ruptured concrete around an anchor is not an effective repair technique.

Figure 19.27 Epoxy Anchorage Failure

19.2.9 Dissimilar Metals

Utilization of various types of metal materials and connection hardware can lead to galvanic or bimetallic corrosion. This is a fast-acting, localized corrosion reaction which attacks the junction or region where different construction metals are attached to one another. For this corrosion to occur, three conditions need to be present:

1. Metals are far apart on the galvanic scale (such as aluminum & steel)
2. Metals must be in contact with each other
3. The metal to metal junction is bridged by an electrolyte (such as water)

To protect against galvanic (bimetal) corrosion:

1. Don't mix metals if at all possible
2. Prevent direct contact by using non-conductive spacers, gaskets, sleeves, etc.
3. Prevent moisture contact at the junction by installing a weather guard, using a sealant or protective coating, or providing proper drainage to guide water away from the junction.

19.2.10 Bridge Lighting

There are various types of lighting that may be present on and around a bridge structure. Lights may be mounted on poles to illuminate the over roadway, on concrete pier elements or structural steel elements to illuminate the under feature, as aids to waterway navigation, or as architectural adornment to illuminate the bridge itself. Some examples of these lighting situations are presented in Figure 19.28, including (a) pole-mounted over roadway, (b) mounted on pier or steel elements for under the roadway, and (c) architectural adornment.

(a)

(b)

(c)

Figure 19.28 Examples of Various Types of Lighting

In addition to the common maintenance activities that bridge mounted lighting shares with bridge mounted signs (anchorages, connection bolts, etc.) agencies should plan for the additional requirements associated with electrified elements. These include repairs to damaged conduits, circuits, and lenses and the replacement of bulbs and other expired electrical components.

Bridge environments are collectors of road debris, animal nesting/droppings and road salts. Electric access locations should be sealed or otherwise isolated from these contaminants as well as from bridge washing activities to prevent deterioration and malfunction.

It is not uncommon for light poles to be fabricated from aluminum. Aluminum structures are susceptible to fatigue failure, which can be amplified when mounted to bridges (Figure 19.29 left). Aluminum welds should be visually inspected on a regular basis. Areas of concern include the pole-to-base connection and the hand-hole frame connection to the post (Figure 19.29 right). Visual inspection may be supplemented with non-destructive testing methods such as dye-penetrant or eddy-current. Magnetic Particle methods are not effective on aluminum structures.

Figure 19.29 Examples of Potential Areas for Fatigue Cracking in Aluminum Light Poles

19.2.11 Impact Damage

Collision or impact damage to a bridge lighting or sign system element needs to be inspected and evaluated immediately to determine if there is a hazard to the public (example shown in Figure 19.30). Common impact areas are the bottoms of sign panels and the posts. Damage may not be isolated to the immediate impact location. Care should be taken to inspect all load path components between the impact location and the bridge anchorage.

Common post-impact repairs include replacing broken hardware and replacing bent, cracked or torn structural elements. In many cases, a crane may need to be mobilized to remove damaged sign panels or the entire structure from service.

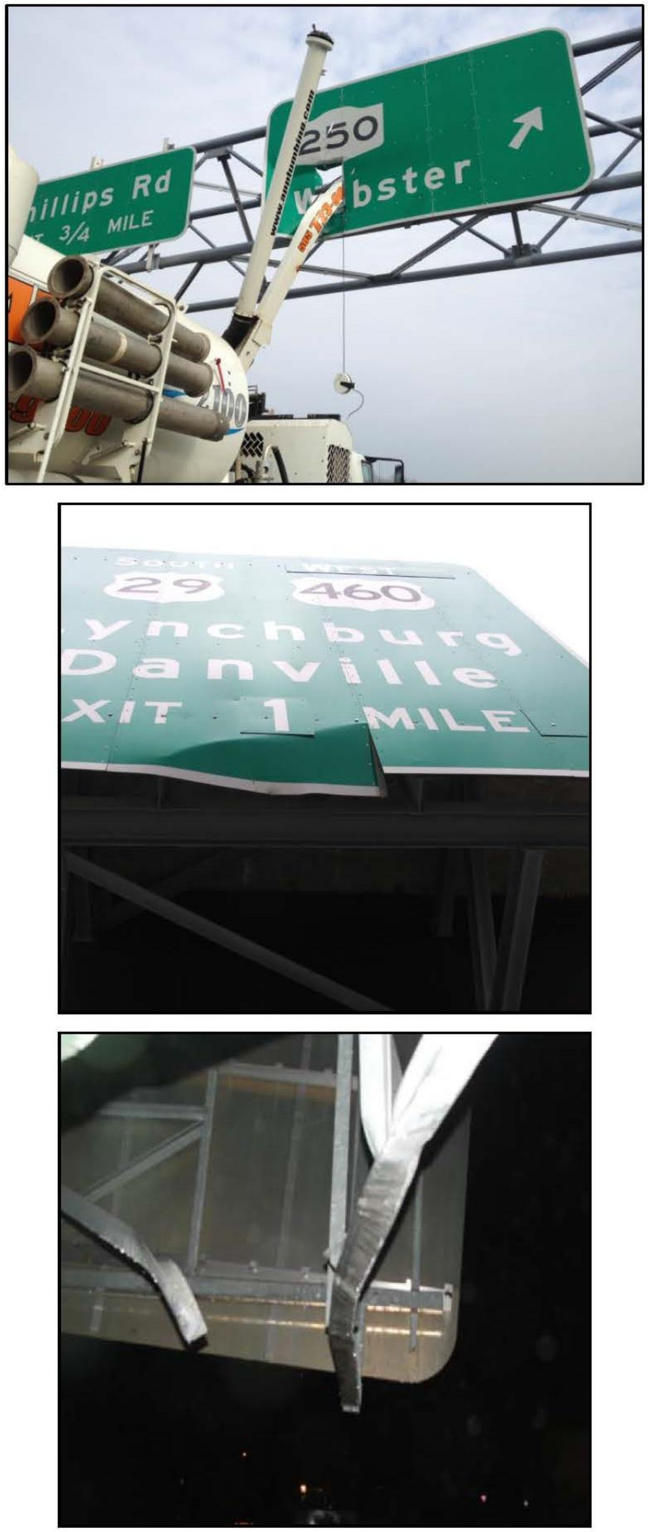


Figure 19.30 Examples of Impact Damage to Sign System Elements

19.2.12 Fiber Reinforced Polymer (FRP) Repairs

FRP products are an effective way to repair steel members damaged by corrosion or aluminum welds damaged by fatigue. Oxygen is the fuel for corrosion action and encasement with an FRP product can both strengthen and isolate the element from future corrosion.

FRP repairs have been effectively used to repair cracked secondary sign truss connections with minimal disruption to traffic, an example of which is shown in Figure 19.31. Originally intended as a temporary solution, non-destructive testing has proven the method's long term performance. An NDT example of an FRP crack repair is shown in Figure 19.32.

Figure 19.31 FRP Repair of Cracked Secondary Truss Connection

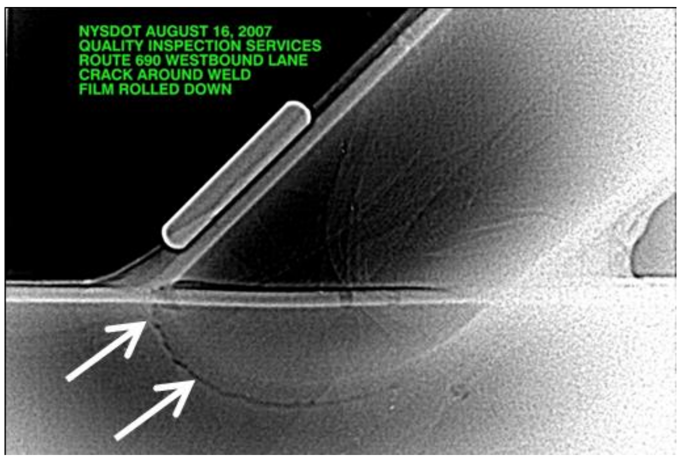


Figure 19.32 NDT of FRP Repair. Crack at Weld Indicated by Arrows.

When to Call the Engineer

If FRP repair is being installed, the Engineer should be consulted for the design of the repair.

FRP structural repairs should be designed by a qualified professional engineer to provide a strength equal to or greater than the member being repaired. The repair should be performed in accordance with the FRP manufacturer's recommendations. As FRP repairs age, repairs to the wrap may be required. Typical repair procedures for FRP wraps are detailed below.

Suggested Procedure

Repair of Surface Cracks or Damage in Existing FRP Wrap

1. Obtain a repair procedure from a qualified engineer.
2. Clean the surface with a solvent approved by the FRP manufacturer.
3. Apply a resin approved by the FRP manufacturer.
4. Apply one layer of compatible FRP over the existing FRP using manufacturer's recommended installation methods.
5. If the resin does not contain an ultraviolet light (UV) inhibitor, apply an opaque, weather resistant, UV protective paint compatible with the FRP materials.

Suggested Procedure

FRP Wrap – Repair for Delamination Between Wrap and Underlying Metal

1. Obain a repair procedure from a qualified engineer.
2. Remove the existing FRP wrap from the structure, being careful not to damage the base metal.
3. Prepare the surface in accordance with the manufacturer's installation procedures.
4. Apply new FRP material repair materials in accordance with the manufacturer's recommendations.

19.3 Chapter 19 Reference List

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