# 10 DYNAMIC MESSAGE SIGNS (DMS) SUPPORT STRUCTURE

## 10.1 Definitions

DMS support structures consist of a single vertical support with horizontal arms supporting electronic signs and access walkways. They are galvanized steel structures mounted on a concrete foundation with anchor bolts.

Other common terms which may be used when discussing DMS support structures include:

- **Dynamic Message Sign:** Programmable electronic signs that are located along highways and provide real-time information to drivers.
- **Walkway:** Horizontal steel structures with grating and supporting frame that provide walkable access to the DMS and supporting structure. Walkways may have moveable railings that enable their positioning as needed for inspection and maintenance.

### 10.1.1 INVENTORY ITEMS

The inspector shall record the height of the vertical support column from the base and the length of the truss arm, both in feet. The inspector shall also identify the type of foundation, e.g., six anchor bolts, twelve anchor bolts, and note the presence of the cabinet and handhole. Take photos of the required inventory items listed in Section 10.2.2.

A complete list of inventory items is provided in the Ancillary Structures Data Dictionary.

### 10.1.2 ELEMENTS

DMS support structures are divided into three components: foundation, vertical structure, and the horizontal structure.

The foundation is further divided into elements: concrete foundation and anchor bolts and leveling nuts.

The vertical structure is further divided into elements: the base plate, vertical support column (upright), and vertical structure connections.

The horizontal structure is divided into two elements: the arm or truss members, horizontal structure connections, sign and sign connections, and walkway and walkway connections.

The following guidelines for consistent location notation provide the framework for rating a DMS support structure element in accordance with the condition rating tables.

- Vertical Structure Locations – Distress locations along the DMS structure vertical support are referenced by using offsets measured from the base plate as measured in inches and prominent features (e.g., top chord connection).
- Horizontal Element Locations – Distress locations along the horizontal arm length are referenced by using offsets measured from the vertical support. Facing the front of the DMS structure, indicate the side of the distress (i.e., left or right) in reference to the vertical support.

- Other – When possible, identify other elements in relation to the defined elements above. Otherwise, photograph location and document distress. A combination of both the entire element or structure and a close-up view would be best practice. Comments to support each photo should be provided.
- Create maps for nodes when necessary. Identify nodes by number and relative location to front of truss arm, e.g., “UF@N3” for upper front at node 3.

**Table 10-1: DMS Support Structure Components and Elements**

| Component | Element | Element Code | Unit of Measure |
|---|---|---|---|
| Foundation | Concrete Foundation | 20101 | Each |
| Foundation | Anchor Bolts and Leveling Nuts | 20102 | Each bolt and nut unit |
| Vertical Structure | Base Plate | 20201 | Each |
| Vertical Structure | Vertical Support Column (Upright) | 20202 | Length, feet |
| Vertical Structure | Vertical Structure Connections | 20203 | Each |
| Horizontal Structure | Arm or Truss Members | 20301 | Each |
| Horizontal Structure | Horizontal Structure Connections | 20302 | Each |
| Horizontal Structure | Sign and Sign Connections | 20303 | Each |
| Horizontal Structure | Walkway and Walkway Connections | 20304 | Each |

### 10.1.3 COMPONENTS

DMS Support Structures are divided into three main components: the foundation, the vertical structure, and the horizontal structure.

Component ratings for DMS Support Structures are based on the following:

- ***Foundation*** – Consider the structure’s foundation effect on overall stability of the DMS Support Structure.
- ***Vertical Structure*** – Consider if the vertical structure may have damage that compromises the structural capacity such as fractures, significant twisting or kinking, corrosion, section loss, or stress cracks in the metal.
- ***Horizontal Structure*** – Consider fractures in welds or base metal, impact damage, corrosion, section loss, or buckling of truss compression members as critical to the overall horizontal structure.

See Section 1.7 for discussion on component ratings, element ratings, and condition states. A representation of the rating structure for DMS support structure is provided in Figure 10-1.

**Figure 10-1: Rating structure for DMS Support Structures**

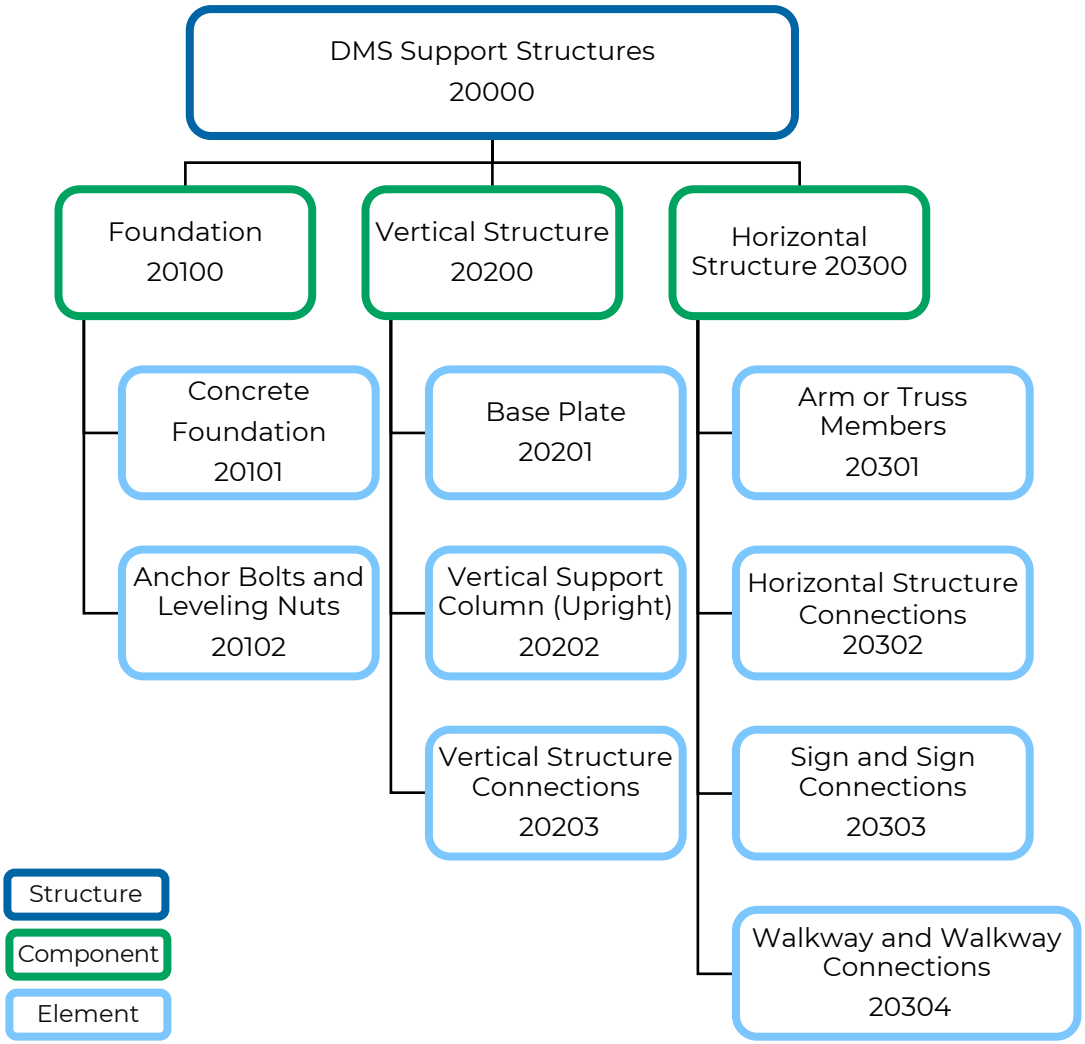
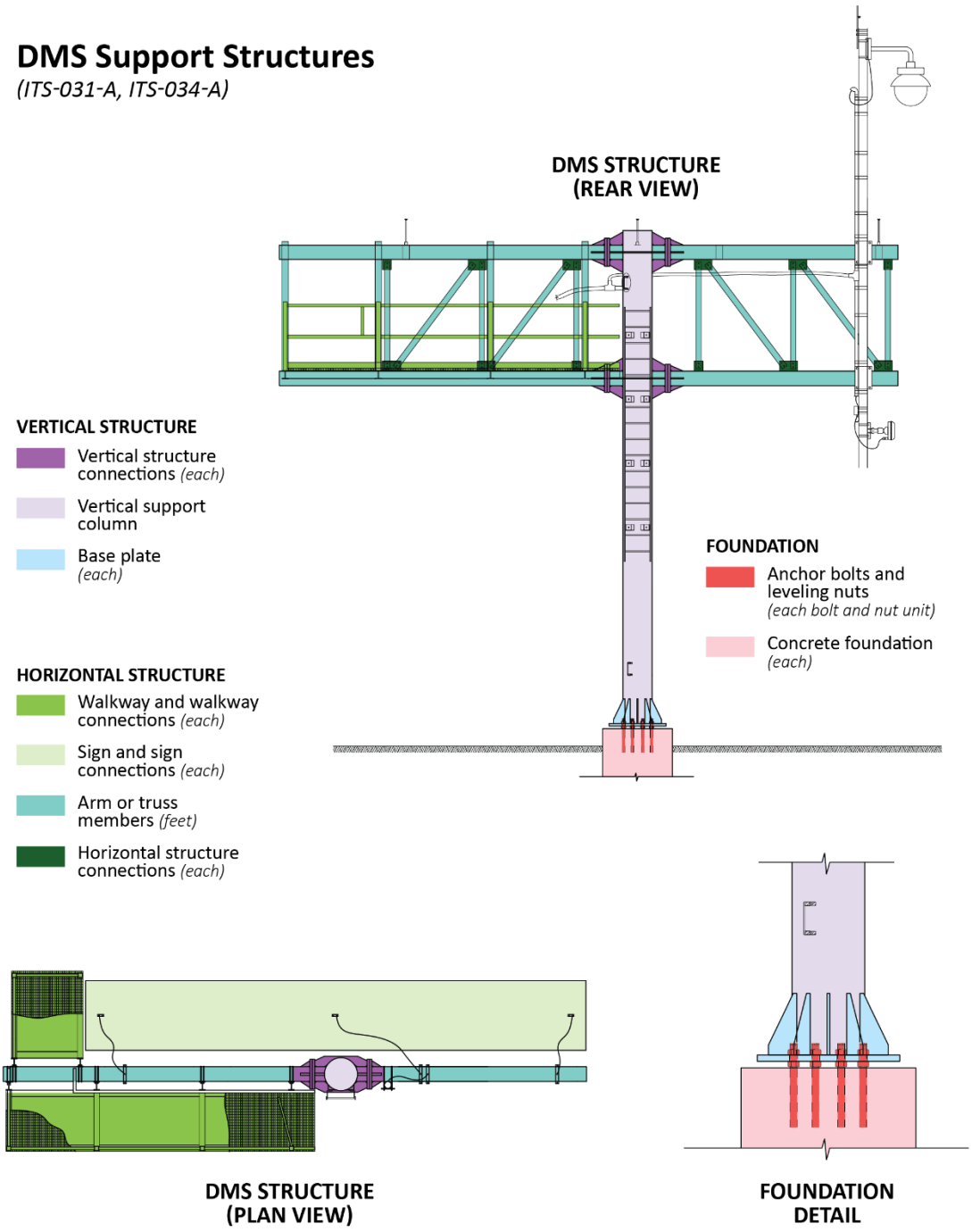


Figure 10-2: Components and elements for DMS Support Structure




## 10.2 Inventory Record Photographs

Inventory photos are captured during a routine inspection, saved as part of the inventory database, and follow the naming convention in *Table 10-2*.

### Dynamic Message Sign Support Structure Required Photos:

- General view of the entire structure

- Each foundation
- Each vertical-to-horizontal connection
- Structure number stenciled on support

**Table 10-2: Dynamic Message Sign Support Structure Photograph Naming Convention**

| Photo Name | Description |
|---|---|
| **DMS_Entire_Front** | Entire DMS and Structure from Front |
| **DMS_Entire_Back** | Entire DMS and Structure from Back |
| **DMS_Foundation** | Foundation |
| **DMS_VH#_Connection*** | Vertical to horizontal connection |
| **DMS_ID** | Old ID and new structure number |
| *** where # is a sequential number ranging from 1-X. One image will be accepted if all connections can be captured in a single image that provides enough detail to determine connection type and bolts/nuts. If this level of detail cannot be obtained in a single image, then take photos needed to provide this level of visibility.** | |

## 10.3 Inspector Minimum Technical Qualifications

At least one member of the field inspection crew shall possess the following certifications and training:

- A minimum experience of two projects with a minimum of 20 structures total inspecting DMS support structures or other cantilevered structures. Multiple structure types shall have been inspected as part of the total project experience. Bolt inspection on cantilever or truss structures, or other ancillary structure types is required as part of the total projectexperience.
- Ancillary structures inspection procedures training
- Working knowledge of inspection tools, their use, application, and limitations for the structure type being inspected
- Certified Welding Inspector – American Welding Society, Certified Welding Inspector (CWI) (Current)
- Ultrasound qualification – Current ASNT Level II (ASNT or per ASNT TC-1A guidelines) qualification in straight beam ultrasonic testing. In conditions where a weld needs ultrasonic testing (UT) then Level II in shear wave is required
- MDOT structural bolting workshop for initial field installation verification
- Magnetic Particle Test (MT) – If a follow-up MT inspection is required for verification, then ASNT Level II (or per TC-1A) MT certified Level II is required
- Dye Penetrant Test (PT) – If a follow-up PT inspection is required for verification, then ASNT Level II (or per TC-1A) PT certified Level II is required

## 10.4 Routine Inspection

DMS support structure consist of a single vertical support with horizontal truss arms on either/both side of the vertical structure supporting electronic signs and access walkways. They are galvanized steel structures mounted on concrete foundations with anchor bolts. The truss arms are comprised of two or more chords supporting all diagonal and vertical members within the two-dimensional horizontal plane. Loading is transferred from the horizontal members to vertical members through welded and bolted connections.

DMS support structure standard inspection frequency is once every 4 years, unless otherwise identified for more frequent inspection.

The acceptable tolerance for intervals of less than 24 months for the next inspection is up to two (2) months after the month in which the inspection was due. The acceptable tolerance for intervals of 24 months or greater for the next inspection is up to three (3) months after the month in which the inspection was due. Exceptions to the inspection interval tolerance due to rare and unusual circumstances should be approved by MDOT's Ancillary Structures Program Manager in advance of the inspection due date plus the above tolerances.

It is recognized that severe weather, inspector safety, inspection quality, resource optimization, technological difficulties, or other unique situations may be a reason to adjust the scheduled inspection date. In these situations, the adjusted inspection date should not extend more than two (2) months after the month the inspection was due for any inspection interval less than 24 months and not extend more than three (3) months after the month the inspection was due for any inspection interval 24 months or greater. Inspection interval tolerances are intended to provide some flexibility. When tolerances are applied, the longest time period prescribed between inspections is the applicable interval plus the prescribed tolerance. For example, a routine inspection on a 12-month interval could be performed during the 14th month if the tolerance is applied. Repeatedly applying the tolerance to the next inspection will create inspection date creep and may impact an owner's ability to perform future inspections in a timely manner due to other limitations (e.g. available resources, inspection workload, schedule, seasonal weather conditions, technological difficulties, etc.). Exceptions to inspection interval tolerances due to rare and unusual circumstances should be approved by MDOT's Ancillary Structures Program Manager in advance of the inspection due date, plus the tolerance. For example, if an inspection with an interval of 24 months is due on June 17, an exception request should be approved by MDOT's Ancillary Structures Program Manager before the end of the 3-month tolerance (i.e. September 30). However, a request for exception should be made when the potential for not meeting the tolerance becomes known to provide MDOT's Ancillary Structures Program Manager with adequate time for review and approval.

**Figure 10-3: Dynamic Message Sign Support Structure**

Table 10-3 provides guidance for inspecting reinforced and prestressed concrete cracking.

**Table 10-3: Standard Cracking Widths**

| Description | Reinforced Concrete | Prestressed Concrete |
|---|---|---|
| **Hairline (HL)** | <1/16” (0.0625”) | < (0.004”) |
| **Narrow (N)** | 1/16” to 1/8” (0.0625” to 0.125”) | (0” to 0.009”) |
| **Medium (M)** | 1/8” to 3/16” (0.125” to 0.1875”) | (0.010” to 0.030”) |
| **Wide (W)** | >3/16”<br>> (0.1875”) | > (0.03”) |

Source: FHWA Bridge Inspector’s Reference Manual (Publication No. FHWA NHI 03-001, October 2002)

## 10.4.1 FOUNDATION ROUTINE INSPECTION

The routine inspection assesses the foundation’s ability to safely support the structure and transfer all loads to the surrounding soil or subsurface materials. If safety concerns such as significant erosion, settlement or lateral displacement are noted, initiate an RFA. The routine inspection is performed on a regularly scheduled basis with frequency determined by AS type and includes the foundation component rating as determined by the element condition ratings of the concrete foundation and steel anchor bolts and nuts. It consists of observations and measurements needed to determine the physical and functional condition of the foundation, to identify any changes from initial or previously recorded conditions, and to ensure that the foundation continues to satisfy present service requirements. All elements of the component shall be visually inspected at a distance that is close enough to determine the overall condition and to detect deficiencies.

A sample foundation routine inspection would consist of:

- Note vegetation growth impeding access to the structure.
- Inspect ground line for any material washing out around foundation.
- Examine the foundation visually and by sounding with a standard inspection hammer.
- Verify anchor bolt diameter and length, then scan for defects.
- Examine anchor bolts for tightness and embedment using a standard inspection hammer. Inspect visually for corrosion, section loss, and plumbness.
- Examine anchor bolts for any eccentricity. Note any noticeable eccentricity measurements.
- Perform ultrasonic testing of anchor bolts to note any breaks and verify lengths.
- Rate Component.
- Rate Elements.

- Provide photographs for all Poor or Severe condition state defects and submit the applicable Work Recs or RFAs.

### *10.4.1.1 Foundation Component Rating*

The component rating for the foundation depends on the condition of the foundation concrete and surrounding soil, and the anchor bolts and nuts that connect the structure to the foundation. Assessing these factors with respect to the overall ability of the foundation to safely support the structure, along with the element condition ratings, provides the appropriate component rating. Note that the base plate is considered as part of the vertical structure component.

**Table 10-4: Foundation Component Rating Guidelines for DMS Support Structure**

| Component Rating | Condition | Material | Description |
|---|---|---|---|
| **9** | **NEW** | All | No deficiencies in any of the structural components that will affect long term performance. |
| **8** | **VERY GOOD** | All | All structural components are sound and functioning as designed. There may be superficial cracking or weathering of protective components and/or dirt contamination of structural components. |
| **7** | **GOOD** | Concrete | Insignificant cracks or moderate cracks that are sealed. |
| | | Soil | Insignificant displacement or erosion of soil. |
| | | Steel | Protective coating failure in very small and scattered locations. |
| | | All | All components retain full section properties and function as designed. |
| **6** | **SATISFACTORY** | Concrete | Unsealed moderate-width or map cracks. Minor delamination or spalling. |
| | | Soil | Minor displacement or erosion of soil. |
| | | Steel | Protective coating failures is limited to less than 10% of the surface area with no loss of section. |
| | | All | Minor deterioration affecting structural components. Minor misalignment. |
| **5** | **FAIR** | Concrete | Moderate delamination or spalling. |
| | | Soil | Moderate displacement or erosion of soil. Minor gaps may be present between pole and embedment material. |
| | | Steel | Minor loss of section. Loose fasteners may be present, but the connection is in place and functioning as intended. |
| | | All | Moderate deterioration affecting structural components including minor settlement, or |

| Component Rating | Condition | Material | Description |
|---|---|---|---|
| | | | impact damage. Moderate misalignment. All members continue to function as designed. |
| 4 | POOR | Concrete | Considerable cracking and spalling. |
| | | Soil | Considerable displacement or erosion of soil. |
| | | Steel | Protective coating failure and less than 25% loss of section of anchor bolts and leveling nuts. Loose anchor bolts or leveling nuts may be present but are in place and functioning as intended. |
| | | All | Considerable deterioration or misalignment affecting structural members. Structural review may be warranted. |
| 3 | SERIOUS | Concrete | Extensive cracking and spalling. |
| | | Soil | Extensive displacement or erosion of soil. Large gaps may be present between tower and embedment material. |
| | | Steel | Measurable loss of section in excess of 25%. Missing or broken anchor bolts and leveling nuts. |
| | | All | Considerable deterioration or damage affecting structural members. Structural evaluation, is necessary to determine if the structure can continue to function without repairs. |
| 2 | CRITICAL | All | Deterioration has progressed to the point where the structure will not support design loads and emergency repairs, or removal is required. |
| 1 | IMMINENT FAILURE | All | Road is closed to traffic due to imminent failure, but corrective action may put it back in service. |
| 0 | FAILED | All | Road is closed due to condition. Notify Region and the Bureau of Bridges and Structures. |

### *10.4.1.2 Foundation Element Condition States*

The foundation stabilizes and secures the entire structure. The purpose of inspection is to identify and record any minor to severe deficiencies throughout the lifespan of the foundations. Inspect the condition of the concrete foundation, noting any cracking, spalling, voids, and general deterioration. Typical issues include cracking throughout the foundation, spalling, chipping, delaminated or broken sections of the foundation, exposed aggregate and rebar, and soil erosion around the foundation.

**Table 10-5: DMS Support Structure Concrete Foundation Element Distresses**

| Element Number | Element | Description | Associated Distresses |
|---|---|---|---|
| **20101** | Concrete Foundation | DMS support structure foundations | Cracking |
| | | | Spalling, delamination, and patching |
| | | | Exposed rebar |
| | | | Embedment erosion |
| | | | Impact damage |
| **Unit of Measure: Each foundation, note number of foundations within each condition state. Typically, a single foundation which will then be rated as a single condition state.** | | | |

Details on the condition state rating schema are in Section 10.7, linked below:

DMS Support Structure Condition State Tables

## Cracking

Concrete cracking can be either nonstructural or structural and can be caused by different factors. Nonstructural cracking is most often related to volumetric changes in concrete caused by fluctuations in moisture content and/or temperature during curing or while in service. Structural related cracking is often related to loading on the concrete being beyond its tensile capacity. Concrete can also crack if the embedded reinforcing bars are corroding. Inspect the foundation for cracking and investigate whether any observed cracking appears non-structural or structural in nature. Document the approximate location, orientation, width, and spacing of the cracking.

## Spalling, Delamination, and Patching

Concrete spalling is a surface failure in which concrete breaks off from the underlying concrete substrate. Like cracking, spalling may occur when the steel reinforcing embedded within the concrete member undergoes corrosion. Inspect and document the extent and location of spalling and reinforcing bar corrosion. Estimate the extent of any section loss.

Concrete delamination can be identified as a thin layer of concrete separation from its substrate. Unlike spalling, delaminated concrete does not break away but remains attached to the structure.

Inspect the foundation for delamination by sounding areas that are exhibiting signs of distress to determine the limits of deterioration. Document the approximate location of delamination or spalling.

## Exposed Rebar

Indicate if reinforcement is exposed.

**Figure 10-4: DMS support structure foundation, minor spalling**

### Embedment Erosion

Soil erosion may cause instability of the foundation. Document the extent of erosion including the depth.

### Impact Damage

Inspect the concrete foundation for vehicular damage. Document the location and degree of damage.

#### *10.4.1.3 Anchor Bolt and Leveling Nuts Foundation Element Condition States*

The anchor bolts transfer load from the structure into the foundation. The purpose of anchor bolt inspection is to identify any degradation of the nuts, flat washers, leveling nuts, and anchor bolts above and below the vertical support (upright) base throughout the lifespan of the structure. Typical issues include corrosion, damaged threads, loose connections, missing or damaged anchor nuts and leveling nuts, soil or debris between the upright base and concrete foundation, ultrasound indications, excessive leveling nut to foundation standoff distance, bent or warped base plates, and bent or warped anchor bolts. All nuts should be tight and fully bear on connected surfaces. Loose nuts, nuts that don't fully bear on adjacent steel, nuts not fully engaged, or damaged or cracked anchor bolts can lead to connection movement, load redistribution, and ultimately failure.

Inspection of the anchor bolts includes a visual inspection of the anchor bolts, anchor nuts, and leveling nuts, a sounding test, and a straight beam ultrasound scan (UT test) of 10 inches into the anchor bolts. Published procedures for the sounding and UT test are provided in references found in Section 10.4.5. Visually inspect the structure base looking for missing or damaged anchor bolts or nuts. Note any damage or corrosion and any bolts that show signs of bending. Inspect the anchor bolts for corrosion. Check for any gaps between the nuts, washers, and base plate. Check for excessive standoff distance between the underside of the leveling nut and the top of the foundation (or the top of sound concrete in cases of foundation deterioration).

The standoff distance is an indication of whether or not the anchor bolts are subjected to bending moment stress. For double-nut connections, if the clearance between the bottom of the leveling nuts and the top of the concrete foundation is less than or equal to one bolt diameter, bending stresses in the anchor bolts can be disregarded (AASHTO LRFD Specifications for Structural Supports, sec. 5.16.3.1). Any distance greater than one bolt diameter may be cause for concern.

**Figure 10-5: Standoff measurement for a sound foundation (left) and standoff measurement with foundation concrete deterioration (right)**

**Table 10-6: DMS Support Structure Anchor Bolt and Leveling Nuts Element Distresses**

| Element Number | Element | Description | Associated Distresses |
|---|---|---|---|
| **20102** | Anchor Bolts and Leveling Nuts | Anchor bolts and leveling nuts | Corrosion or coating damage |
| | | | Loose or missing anchor nut |
| | | | Cracked bolt |
| | | | Standoff distance |
| | | | Impact damage |
| **Unit of Measure: Each, note quantity of anchor bolt and nut units within each condition state** | | | |

Details on the condition state rating schema are in Section 10.7, linked below:

DMS Support Structure Condition State Tables

Examples of common distresses associated with anchor bolts and leveling nuts are shown in *Figure 10-6* through *Figure 10-8*.

**Figure 10-6: Anchor bolts and leveling nuts, corrosion in anchor bolt below upright base with section loss**

**Figure 10-7: Anchor bolts and leveling nuts, anchor nut without fully engaged threads**

**Figure 10-8: Leveling nut and anchor bolt corrosion with section loss**

## 10.4.2 VERTICAL STRUCTURE ROUTINE INSPECTION

The uprights support the horizontal elements that directly support the DMS, walkways, or other attachments. The routine inspection assesses the vertical structure's ability to safely support the horizontal structure and transfer all loads to the foundation. The routine inspection is performed on a regularly scheduled basis, with frequency determined by AS type, and includes the vertical structure component rating as determined by the baseplate,

vertical support column (upright), and vertical structure connections element condition ratings. It consists of observations and measurements needed to determine the physical and functional condition of the vertical structure and connections, to identify any changes from initial or previously recorded conditions, and to ensure that the vertical structure and connections continue to satisfy present service requirements. All elements of the component shall be visually inspected at a distance that is close enough to determine the overall condition and to detect deficiencies. A bucket truck is required for inspection when closer access from the ground is not possible.

A sample vertical structure routine inspection would consist of:

- Inspect the base plate and welds for cracks, deficiencies, and corrosion. Note and measure any warping or deformations of the base plate.
- Inspect the vertical alignment of the pole with a 4 ft level or similar. Note that some poles may be tapered and checking at several points around the perimeter at the same elevation may be necessary to obtain the complete picture of any misalignment.
- Inspect the protective coating – galvanizing and/or paint and note any corrosion or section loss of the steel. An ultrasonic testing device or thickness gauge should be used to verify the wall thickness when significant corrosion is present.
- Check for any cracks or deformations in the steel noting the size of deficiencies.
- Verify the handhole cover is securely fastened in place and check for cracks around the frame of the handhole.
- Check for signs of vehicle impact damage noting that impact in one location may affect the structure in other locations as well.
- Inspect the connection to the pole of the horizontal structure – mast arms, luminaire arms, and other arms. This includes band clamps, brackets, and other bolted assemblies. Check for connections that are loose, missing, deteriorated or otherwise deficient.
- Pay particular attention to the mast arm connections to the pole: Inspect the tightness of bolts and look for gaps. Check welds in the connections for any cracks or deficiencies. Check for any signs of slippage in the connections which may be evidenced by damage to the protective coating.
- Provide photographs for all Poor or Severe condition state defects and submit the applicable Work Recs or RFAs.

#### *10.4.2.1 Vertical Structure Component Rating*

The component rating for the vertical structure depends on the condition of the baseplate, vertical upright(s), and the connection(s) to the horizontal structures. Assessing these factors with respect to the overall ability of the vertical structure to safely support the horizontal structure and transfer loads to the foundation provides the appropriate component rating.

**Table 10-7: Component Rating Guidelines for DMS Support Structure Vertical Structure**

| Component Rating | Condition | Material | Description |
|---|---|---|---|
| 9 | NEW | All | No deficiencies in any of the structural components that will affect long term performance. |
| 8 | VERY GOOD | All | All structural components are sound and functioning as designed. There may be superficial cracking or weathering of protective components and/or dirt contamination of structural components. |
| 7 | GOOD | Concrete | Insignificant cracks or moderate cracks that are sealed. |
| | | Soil | Insignificant displacement or erosion of soil. |
| | | Steel | Protective coating failure in very small and scattered locations. |
| | | All | All components retain full section properties and function as designed. |
| 6 | SATISFACTORY | Concrete | Unsealed moderate-width or map cracks. Minor delamination or spalling. |
| | | Soil | Minor displacement or erosion of soil. |
| | | Steel | Protective coating failures is limited to less than 10% of the surface area with no loss of section. |
| | | All | Minor deterioration affecting structural components. Minor misalignment. |
| 5 | FAIR | Concrete | Moderate delamination or spalling. |
| | | Soil | Moderate displacement or erosion of soil. Minor gaps may be present between pole and embedment material. |
| | | Steel | Minor loss of section. Loose fasteners may be present but the connection is in place and functioning as intended. |
| | | All | Moderate deterioration affecting structural components including minor settlement, or impact damage. Moderate misalignment. All members continue to function as designed. |
| 4 | POOR | Concrete | Considerable cracking and spalling. |
| | | Soil | Considerable displacement or erosion of soil. |
| | | Steel | Protective coating failure and less than 25% loss of section. Cracks may be present. Fasteners may be loose, missing, or considerably deteriorated. Considerable impact damage. |

| Component Rating | Condition | Material | Description |
|---|---|---|---|
| 3 | SERIOUS | All | Considerable deterioration or misalignment affecting structural members. Structural review may be warranted. |
| | | Concrete | Extensive cracking and spalling. |
| | | Soil | Extensive displacement or erosion of soil. Large gaps may be present between pole and embedment material. |
| | | Steel | Measurable loss of section in excess of 25%. Missing or broken fasteners or extensive cracking in pole. |
| | | All | Considerable deterioration or damage affecting structural members. Structural evaluation, is necessary to determine if the structure can continue to function without repairs. |
| 2 | CRITICAL | All | Deterioration has progressed to the point where the structure will not support design loads and emergency repair or removal is required. |
| 1 | IMMINENT FAILURE | All | Road is closed to traffic due to imminent failure, but corrective action may put it back in service. |
| 0 | FAILED | All | Road is closed due to condition. Notify Region and the Bureau of Bridges and Structures. |

### *10.4.2.2 Base Plate Element Condition States*

Visually inspect for any damage to the base plate welds and gusset plates, such as gouges, distortion, impact damage, or warping. Note galvanizing damage and the degree of corrosion present. Areas of galvanizing that appear to have been repaired are monitored closely throughout the lifespan of the structure. If that area was not thoroughly cleaned prior to repair, corrosion might not show through the repair immediately but could appear in later years.

Perform a visual inspection of the gusset welds and base weld looking for cracks or other weld defects. Document questionable fillet or groove weld discontinuities. The base weld is a full-penetration weld and any crack identified in the toe or throat of the weld is considered as severe, and the appropriate procedure such as an RFA or Work Rec initiated.

**Table 10-8: DMS Support Structure Base Plate Element Distresses**

| Element Number | Element | Description | Associated Distresses |
|---|---|---|---|
| **20201** | Base Plate | Base plate for DMS support structure | Corrosion or coating damage |
| | | | Weld defect or crack |

**Unit of Measure: Each, percentage of base plate within each condition state**

Details on the condition state rating schema are in Section 10.7, linked below:

DMS Support Structure Condition State Tables

An example of base plate distress is shown *Figure 10-10*.

**Figure 10-9: Vertical supports, rust underneath galvanizing repair**

**Figure 10-10: Corrosion in bonding clamp along bolt of base plate stiffener**

### *10.4.2.3 Vertical Support Column (Upright) Element Condition States*

Verify that the inventory number label is securely affixed on the front of the upright (facing traffic) and is still legible. If no label is present, install an inventory label on the vertical support (upright). If the existing label is in poor condition the label should be replaced. The upright should also be inspected for any vertical misalignment. A mechanical lift such as bucket trucks, climbing or other means of working at heights (i.e., UAS) are utilized for inspecting the tops of vertical supports. Note any galvanizing damage on the upright, including the ladder. Also record the degree of damage, including any corrosion on the base metal. A hand hole is located near the base of the pole to allow for access to electrical components and there are typically additional electrical entry and exit ports higher on the pole. The handhole should be free from excess moisture and debris. The handhole cover should be securely fastened and the hand hole frame inspected for any cracks in the welds, along with any other welded components. If any type of impact damage is present (gouges, dents), clean the area and visually inspect for any cracks. An in-depth inspection may be needed to explore suspect visual indications by performing a magnetic particle inspection, liquid penetrant test or other appropriate non-destructive examination

methods. Additional measures may be needed if the corrosion protection included painting over galvanizing. If nothing of note was found, spray “cold galvanizing” compound or zinc rich paint, after properly cleaning or preparing the surface, on any area where galvanizing was removed.

**Table 10-9: DMS Support Structure Vertical Support Column (Upright) Element Distresses**

| Element Number | Element | Description | Associated Distresses |
|---|---|---|---|
| **20202** | Vertical Support Column (Upright) | Vertical Support (Upright) for DMS support structure | Corrosion or coating damage |
| | | | Weld defect or crack |
| | | | Out of plumb |
| | | | Impact damage |
| | | | Handhole defects |
| **Unit of Measure: Length, inch of vertical support within each condition state** | | | |

Details on the condition state rating schema are in Section 10.7, linked below:

DMS Support Structure Condition State Tables

An example of vertical support distress is shown in *Figure 10-11*.

**Figure 10-11: Vertical structure column (upright) with minor coating damage**

### *10.4.2.4 Vertical Structure Connections Element Condition States*

Most connections are either bolted or welded. Typical issues include loose bolts and nuts, weld discontinuities, galvanizing damage, flange connection gaps, missing washers, and missing end caps. Bucket trucks are required for inspecting the connections of vertical supports when closer access from the ground is not possible. Note any gaps between steel in the bolted connections, cracked welds, and cracks at the ends of gusset plates. Record

any bolting components that are missing, deteriorated, or damaged. Record any signs of corrosion.

**Table 10-10: DMS Support Structure Vertical Structure Connection Element Distresses**

| Element Number | Element | Description | Associated Distresses |
|---|---|---|---|
| **20203** | Vertical Structure Connection | Connections to support column | Weld defects or cracks |
| | | | Corrosion or coating damage |
| | | | Loose, missing, or failing hardware |
| | | | Impact damage |

**Unit of Measure: Each connection quantity within the condition state**

Details on the condition state rating schema are in Section 10.7, linked below:

DMS Support Structure Condition State Tables

Connection types are described in the following sections. The bolted and welded connection inspection guidance below applies to both truss connections and cantilever connections, as applicable.

## Bolted Connections

Visually inspect the horizontal arm connection to the vertical support. Identify any missing flat washers. Look for fully compressed lock washers, when present, and note any that are not. Check for misalignment of the bolts. Identify and measure any gaps between the nut or the head of the bolt and the washer. Note any gaps between the bolted flanges, loose, or missing hardware, missing caps, and cracks at the ends of gusset plates. Using a 16- to 24-oz hammer, hit the nuts on the flat portion, in multiple directions if possible, listening for a dull sound or a sharp ringing sound. A dull sound may indicate that the nuts are not properly tightened or that the bolt is cracked or broken. While sounding, look for any shift of the bolt within the bolt hole or movement of the nut. Note any signs of corrosion.

**Figure 10-12: Vertical structure connection, missing flat washer on head side of bolt**

**Figure 10-13: Vertical structure connection, loose bolt/lock washer not fully compressed**

## Welded Connections

Visually inspect the welds through the galvanizing for any indication of weld defects. In many cases, the galvanizing will be too thick to accurately see the surface of the weld. In this case, there may be indications in the galvanizing itself that are a sign of weld discontinuities or cracks, such as areas along the toe of the weld where the galvanizing did not bond properly to the base metal, which can give the impression of a crack. If rust is bleeding through the galvanizing, chip off the galvanizing (wire brush and the ball peen side of a hammer works well) for a better visual inspection of the weld. If the weld looks acceptable, use “cold galvanizing” compound or zinc-rich paint to repair the area where the galvanizing was removed. If a visual indication in the weld has appeared, note the area and type of indication.

**Figure 10-14: Vertical structure connection, rust bleeding through galvanizing at welded gusset plate arm to vertical structure upright**

## 10.4.3 HORIZONTAL STRUCTURE ROUTINE INSPECTION

The horizontal elements directly support the signs, walkways, or other attachments. The routine inspection assesses the horizontal structure's ability to safely support the all the attachments and transfer loads to the vertical support structures. The routine inspection is performed on a regularly scheduled basis, with frequency determined by AS type, and includes the horizontal structure component rating as determined by the element condition ratings. It consists of observations and measurements needed to determine the physical and functional condition of the horizontal structure, to identify any changes from initial or previously recorded conditions, and to ensure that the horizontal structure continues to satisfy present service requirements. All elements of the component shall be visually inspected at a distance that is close enough to determine the overall condition and to detect deficiencies. A mechanical lift such as bucket truck or climbing or other means of working at heights (i.e., UAS) are utilized for inspecting the horizontal structures.

A sample horizontal structure routine inspection would consist of:

- Inspect the vertical clearance of the horizontal structure, the alignment, and the operational function.
- Check for corrosion or section loss on the arms or any other portions of the horizontal structure.
- Inspect arms for any cracked welds, or other deterioration.
- Check attachments to the horizontal structure for connections that are loose, missing, deteriorated or otherwise deficient.

### *10.4.3.1 Horizontal Structure Component Rating*

The component rating for the horizontal structure depends on the condition of the horizontal members, their internal connections, the attachments, and connections to the attachments. Assessing these factors with respect to the overall ability of the horizontal structure to safely support the attachments and transfer loads to the rest of the structure provides the appropriate component rating.

**Table 10-11: Component Rating Guidelines for DMS Support Structure Horizontal Structure**

| Component Rating | Condition | Material | Description |
|---|---|---|---|
| **9** | **NEW** | All | No deficiencies in any of the structural components that will affect long term performance. |
| **8** | **VERY GOOD** | All | All structural components are sound and functioning as designed. There may be superficial cracking or weathering of protective components and/or dirt contamination of structural components. |
| **7** | **GOOD** | Steel | Protective coating failure in very small and scattered locations. |
| | | All | All components retain full section properties and function as designed. |

| Component Rating | Condition | Material | Description |
|---|---|---|---|
| 6 | SATISFACTORY | Steel | Pole protective coating failures is limited to less than 10% of the surface area with no loss of section. Surface corrosion with no section loss of span wire or attachment connections. |
| | | All | Minor deterioration affecting structural components. |
| 5 | FAIR | Concrete | Moderate delamination or spalling. |
| | | Steel | Minor loss of section. Loose fasteners may be present but the connection is in place and functioning as intended. |
| | | All | Moderate deterioration affecting structural components including minor settlement, or impact damage. Moderate misalignment. All members continue to function as designed. |
| 4 | POOR | Steel | Up to 25% loss of section. DMS support structure may be mis-aligned or attachments may have less than 17 ft of vertical clearance. Fasteners may be considerably deteriorated. |
| | | All | Considerable deterioration affecting structural members. Structural review may be warranted. |
| 3 | SERIOUS | Steel | Section loss in excess of 25%. Missing or broken fasteners or excess displacement of mast arm. |
| | | All | Considerable deterioration or damage affecting structural members. Structural evaluation, is necessary to determine if the structure can continue to function without immediate repairs. |
| 2 | CRITICAL | All | Deterioration has progressed to the point where the structure will not support design loads and emergency repairs or removal is required. |
| 1 | IMMINENT FAILURE | All | Road is closed to traffic due to imminent failure, but corrective action may put it back in service. |
| 0 | FAILED | All | Road is closed due to condition. Notify Region and the Bureau of Bridges and Structures. |

### *10.4.3.2 Arm or Truss Members Element Condition States*

DMS Support Structure horizontal members directly support the signage. Horizontal members comprise of the horizontal arm, and the two chords with all truss members within the plane.

Visually inspect all the truss chords or arm members for corrosion, cracking, and impact damage. Note any galvanizing damage and the degree, if any, of corrosion on the base metal. If any type of impact damage is present (gouges, dents), clean the area and visually inspect for any type of deficiency. If nothing of note was found, spray “cold galvanizing”

compound or zinc-rich paint on any area where galvanizing was removed. Bucket trucks are required for inspecting arms or truss members when closer access from the ground is not possible.

**Table 10-12: DMS Support Structure Arm or Truss Members Element Distresses**

| Element Number | Element | Description | Associated Distresses |
|---|---|---|---|
| **20301** | Arm or Truss Members | Arm members and truss chords and bracing for DMS Support Structures | Cracking |
| | | | Corrosion or coating damage |
| | | | Impact damage |
| **Unit of Measure: Length, feet along member which apply to each condition state** | | | |

Details on the condition state rating schema are in Section 10.7, linked below:

DMS Support Structure Condition State Tables

### *10.4.3.3 Horizontal Structure Connections Element Condition States*

Truss chord splice connections stabilize and secure the truss sections to each other longitudinally. Truss bracing connections stabilize and secure the truss chord sections to each other transversely. Bucket trucks are used to inspect horizontal structure connections when closer access from the ground is not possible.

Truss chord splice and bracing connection bolts require a flat washer and lock washer on the nut end. Visually inspect the chord splice and bracing (horizontal, vertical, and diagonal) connections. Note any lock washers that are not fully compressed. Record any loose, missing, or broken hardware, missing caps, cracked welds and cracks at the ends of gusset plates. Gaps may be present within connections due to fabrication tolerances and bolts will not squeeze plates together at every location. Use wrench to inspect bolt connection to ensure gaps in connections are not due to loose bolts. Record any signs of corrosion.

**Table 10-13: DMS Support Structure Horizontal Structure Connection Element Distresses**

| Element Number | Element | Description | Associated Distresses |
|---|---|---|---|
| **20302** | Horizontal Structure Connections | Connections of the horizontal structure for all DMS Support Structures. Connections may include splices, chord splices. Or bracing. | Cracking |
| | | | Corrosion or coating damage |
| | | | Loose, missing, or failing hardware; gap at connection |
| | | | Impact damage |
| **Unit of Measure: Each connection quantity within the condition state** | | | |

Details on the condition state rating schema are in Section 10.7, linked below:

DMS Support Structure Condition State Tables

**Figure 10-15: Horizontal structure connection, gap between arm connection flanges**

### *10.4.3.4 Sign and Sign Connections Element Condition States*

Sign connections stabilize and secure signs to the structure. The purpose of inspection of the sign connections is to ensure the sign panels are secured in place and do not fall onto the roadway. Sign connections inspected on DMS signs include I-Beam connections to the sign panels, and U-bolt connections of the I-beams to the horizontal chords of the DMS Support Structure.

Typical issues include sign deterioration or failure, impact damage, corrosion or coating damage, missing elastomeric pads, and loose, missing, or failing hardware. Bucket trucks are used to inspect the signs and sign connections.

Inspect the general appearance of the sign panel and record any deterioration, or physical damage due to vehicular impact. Vehicular impact may also affect the connections of the sign to the horizontal structure. Document any corrosion or coating damage of any of the sign or hardware elements. Elastomeric or rubber pads are used between dissimilar metals, usually steel and aluminum, to prevent a corrosion cell from forming.

Verify that rubber pads separating dissimilar metals have been placed between the steel truss chords and the aluminum mounting supports and that the U-bolts project through the holes in the pads. Also verify that the rubber pads have been placed between the steel mounting supports and the aluminum sign cabinet to prevent reactions between dissimilar metals. Record any deficiencies.

Inspect the sign panel mounting bolts connecting the aluminum I-beam to the sign panel. Visually check snug-tightness and note any loose bolts or nuts that are not fully engaged. Check for gaps between the vertical I-beam mounting supports, the steel truss chords, and the U-bolts.

**Table 10-14: DMS Support Structure Sign and Sign Connections Element Distresses**

| Element Number | Element | Description | Associated Distresses |
|---|---|---|---|
| **20303** | Sign and Sign Connections | Sign and Sign Connections for DMS Support Structure | Corrosion or coating damage |
| | | | Loose, missing, or failing hardware |
| | | | Sign collapse or separation |
| | | | Deterioration of legibility or reflectivity |
| | | | Missing elastomeric pads between dissimilar metals |
| | | | Impact Damage |
| **Unit of Measure: Length, feet along arm or truss which can be rated at each condition state** | | | |

Details on the condition state rating schema are in Section 10.7, linked below:

DMS Support Structure Condition State Tables

Details on the connection types are noted in the following sections.

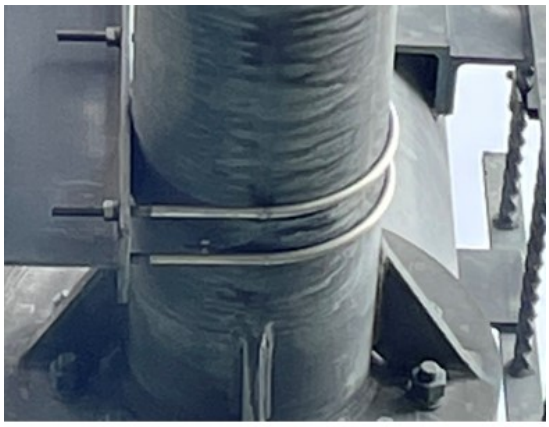
## I-beam Connections to the Sign Panels

I-Beams are fastened to the sign panels by four bolts at the top and bottom of the I-beam. I-Beams are part of the critical load path, so several missing or loose bolt connections to the sign panels could impact the functionality of DMS Support Structure and public safety.

## U-bolt Connection of the I-beams to the Horizontal Chords

Inspect the U-bolts connecting the sign I-beams to the horizontal members. The dynamic message sign is attached to the horizontal chords through U-bolt pairs. These are the most critical connection on a sign installation as they involve the primary load path to attach the sign to the DMS Support Structure. Inspectors should consider if the sign vibrates or separates from the chord connection when traffic passes below or in windy conditions.

**Figure 10-16: Horizontal structure connection, broken U-bolt connection at the nut end**



### *10.4.3.5 Walkway and Walkway Connections Element Condition States*

The walkway system comprises of the metal grating platform which is the walking surface, and the railing which protects against fall accidents. Walkway connections stabilize and secure walkways to the structure. The purpose of inspection of the walkway connections is to ensure the walkways are secured in place and are safe for personnel use. The connections consist of the grating welded connections to the arm or truss members and connections to the horizontal structure with galvanized fasteners. Walkway brace connections also uses spacer bar tack welded to walkway grating.

Bucket trucks should be used as needed to inspect the walkway and walkway connections when closer access with equipment or climbing is not possible. Inspect the walkway for deterioration of any member, and vehicular impact that may have affected the structure and its connections. Inspect the grating for irregular surfaces, tripping hazard, or misaligned members. Also record any damage or misalignment of the railings.

Inspect structure for loose, missing, deformed or misaligned connection with horizontal arm or truss members. Visually check snug tightness of fasteners used for attaching walkway grating to flange members and note any looseness observed in bolts or nuts. Inspect the grating weld connections to bracing and vertical flanges. The welded connections should be free of cracking, incomplete or excessively ground, or poor welds that can contribute to stress in the weld. Document damages to the weld connections and any corrosion or coating damage of any part of the walkway. The extent of section loss should also be determined and documented.

**Table 10-15: Walkway and Walkway Connections Element Distresses**

| Element Number | Element | Description | Associated Distresses |
|---|---|---|---|
| **20304** | Walkway and Walkway Connections | Metal grating platform, railing, and connections which secure the | Corrosion or coating damage |
| | | | Loose, missing, or failing hardware |

| | | |
|---|---|---|
| | walkway to the DMS Support Structure. | Walkway collapse or separation |
| | | Impact Damage |

**Unit of Measure: Length, feet along arm or truss which can be rated at each condition state**

Details on the condition state rating schema are in Section 10.7, linked below:

DMS Support Structure Condition State Tables

### 10.4.4 I-BEAM CONNECTIONS TO THE SIGN PANELS

Connections between the I-beam(s) and sign panels is critical to the safe performance of the sign and could be considered an RFA if several bolts were loose or missing, causing the sign panel to vibrate against the I-beam.

#### For U-bolt Connections of the I-beams to the Horizontal Chords

Loose, missing, or broken U-bolts may require an RFA if multiple U-bolts need tightening or replacement, and the sign is not firmly secured to the chord. Inspectors should consider if the sign vibrates or separates from the chord connection when traffic passes below or in windy conditions. Isolated loose bolts would typically be a Work Rec.

### 10.4.5 REFERENCES

MDOT DMS Support Structure Installation Inspection Procedure, describing UT and Sounding Testing

MDOT Traffic and Safety Standards and Special Details

| | |
|---|---|
| ITS-030-series | LH Master DMS Structure |
| ITS-031-series | RH Master DMS Structure |
| ITS-032-series | DMS Sign Support Foundation |
| ITS-034-series | DMS Structure Mount CCTV MVDS |

AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 2015 (AASHTO Signs)

## 10.5 Work Recommendation Guidance

DMS support structure Work Recs are recorded to initiate preventive maintenance actions. These Work Recs are presented on the Ancillary Structures (AS) Inspection Report Form. Loose bolts are frequently the cause of Work Recs. Typically, isolated or limited loose or missing bolts would qualify as a Work Rec but could increase to an RFA if bolt conditions worsened with time.

Additional guidance for creating Work Recs pertaining to sign connection defects is provided below for specific connection types. Sign plumb/out of plumb and whether loose bolts are equally loose should be noted on a work recommendation. Note dimensions if possible. Photographs should include the entire rear of the sign with loose, missing, or

broken bolts marked on the photo. Close-up photos of each loose connection to support the full view of the sign connections with connection deficiencies marked on the photo should be provided.

### I-beam Connections to the Walkway

Connections between the I-Beam(s) and sign panels is critical to the safe performance of the sign. If several bolts are loose or missing, causing the sign panels to vibrate against the I-Beam, these defects would not be considered Work Recs and would instead require an RFA.

### U-bolt Connections of the I-beams to the Horizontal Chords of the DMS Support Structure

Isolated loose bolts would typically be a work recommendation. If multiple U-bolts need tightening or replacement, and the walkway is not firmly secured to the chord, these deficiencies would not be considered Work Recs and would instead require an RFA. Inspectors should consider if the walkway vibrates or separates from the chord connection when traffic passes below or in windy conditions.

Work Recs are identified, but not limited to, actions such as repairs to guardrail, web member angle supports, vertical supports, splice connection bolts, or truss chords. Repairs to galvanizing are also a Work Rec. Work Recs may also consist of correcting the erosion at the foundation to prevent undermining or to otherwise repair or monitor the foundation. A Work Rec may be to tighten items such as U-bolts, leveling nuts, or DMS panel bolts. Installation of elastomeric pads may be a Work Rec. Removal of graffiti or removal of non-MDOT attachments to structures may be recommended. Work Recs can also consist of recommendations to replace various types of bolts, end caps, clamps, connections, spacers, DMS panels, or connection assemblies. Weld repairs may be a Work Rec. Repair or replacement of the ID stencil on the upright is a Work Rec.

The Work Recs are not meant to be all-inclusive and other Work Recs may be added to supplement those noted.

Photographs should include sufficient information to determine the relationship of the defect to the element or component or entire structure. Close-up photos of each defect with connection deficiencies marked on the photo should be provided.

**Table 10-16: DMS Support Structure Work Recommendations**

| Code | Name | Material involved | Quantity/Unit of Measure |
|---|---|---|---|
| **1** | Repair Guardrail (protecting foundation and pole) | Galvanized Steel | Linear Feet |
| **2** | Correct erosion at foundation (prevent undermining) | Stone/Soil | Cubic Feet |
| **3** | Repair/Monitor foundation | Concrete | Cubic Feet |
| **4** | Tighten leveling nut | Galvanized Steel | Each nut |
| **5** | Install/replace U-bolt | Galvanized Steel | Each assembly |
| **6** | Tighten U-bolt | Galvanized Steel | Each |

| Code | Name | Material involved | Quantity/Unit of Measure |
|---|---|---|---|
| **7** | Secure U-bolt spacer | Galvanized Steel | Each |
| **8** | Replace sign connection assembly | Galvanized Steel | Each assembly |
| **9** | Repair web member angle supports | Galvanized Steel | Each angle |
| **10** | Repair vertical sign support | Galvanized Steel | Linear Feet of Upright |
| **11** | Repair galvanizing | Galvanic Paint | Square inch |
| **12** | Repair chord | Galvanized Steel | Linear Foot |
| **13** | Replace end cap | Galvanized Steel | Each cap |
| **14** | Replace end cap bolt | Galvanized Steel | Each bolt |
| **15** | Tighten leveling nut | Galvanized Steel | Each nut |
| **16** | Address loose bolts | Galvanized Steel | Each bolt |
| **17** | Weld repair | Steel | Each weld |
| **18** | Replace arm/chord to upright bolted connection bolts | Galvanized Steel | Each bolt |
| **19** | Replace bolted connection bolts for internal truss connections (vertical or horizontal) | Galvanized Steel | Each bolt |
| **20** | Replace sign panel bolts | Galvanized Steel | Each bolt |
| **21** | Tighten sign panel bolts | Galvanized Steel | Each bolt |
| **22** | Remove graffiti from steel structural element | N/A | Square Foot |
| **23** | Remove graffiti from sign | N/A | Square Foot |
| **24** | Repair/replace ID stencil on upright | Paint | Each stencil |
| **25** | Replace elastomeric pads between dissimilar metals | Elastomeric Pad | Each pad |
| **26** | Repair railing/walkway | Galvanized Steel | Pound (lb) |

## 10.6 Request for Action Guidance

Guidance for creating an RFA pertaining to DMS Support Structure defects is provided below for specific situations which may occur.

Sign plumb/ out of plumb and whether loose bolts are equally loose should be noted for an RFA. Note dimensions if possible. Photographs should include the entire rear of the sign with loose, missing, or broken bolts marked on the photo. Close-up photos of each loose

connection to support the full view of the sign connections with connection deficiencies marked on the photo should be provided.

Examples of applicable priority level items include, but are not limited to:

## Priority 1 Level Items

a. Major foundation deterioration including concrete cracking/spalling/delamination, thread damage, steel reinforcement corrosion, anchor bolt corrosion, ultrasonic test failure, failure of anchor bolts, and significant section loss of steel reinforcement or anchor bolts
b. Major soil erosion or undermining of the foundation element evidenced by lateral displacement or vertical out of plumbness
c. Major corrosion, section loss or failure of high strength bolts where load-path redundancy is minimal
d. Major base plate distortion or section loss around anchor bolts
e. Multiple loose or missing bolts in a high strength bolted connection, anchor bolt connection, or sign connection
f. Multiple loose or missing bolts where connections do not have load-path redundancy and bolt tensioning is not possible
g. Standoff distance more than twice the bolt diameter, where bending of anchor bolts is evident
h. Major cracks present in the base metal or weld(s) on the base plate to column connection or for single column supports or the column to cantilever arm connection
i. Cracking in single column supports at gusset plate welds where the cracking is major, or when minor cracking at gusset plate welds is present at two or more gusset plates in a connection
j. Major section loss due to corrosion of a main element which impacts the capacity or short-term resiliency of the element or structure
k. Presence of major cracks or active corrosion on main members (base metal) or connections (bolted or welded) where presence of new or recent cracking shows non-corroded, minimally corroded, or progressively corroded-cracked steel surfaces is observed as opposed to heavily corroded and/or cracked surfaces which have been present for some time
l. Major structural damage to foundation, anchor bolts, upright, or other elements, which impacts capacity or function, clearance, safety, or short-term resiliency of the structure

## Priority 2 Level Items

a. Significant foundation deterioration including concrete cracking/spalling/delamination, steel reinforcement corrosion and section loss
b. Significant soil erosion or undermining of the foundation
c. Pole is significantly out of vertical alignment
d. Significant base plate distortion or section loss around anchor bolts
e. Standoff distance more than twice the bolt diameter where no bending of anchor bolts is evident

f. Anchor nuts are engaged with some gaps and/or bolts are misaligned
g. Multiple loose or missing bolts in a high strength bolted connection, anchor bolt connection, or sign connection where there is acceptable load-path redundancy, but significant impact to capacity or durability
h. Significant weld deficiencies that have not initiated cracking but do not meet current code or will lead to Priority Level 1, but acceptable redundancy and/or resiliency is present
i. Significant corrosion of primary elements or connections is present
j. Significant misalignment of elements at the column to chord connection where significant corrosion or damage is also present to one or more elements
k. Structural cracks in secondary members that could potentially propagate through welded connections into main members
l. Incident resulting in significant structural damage

## Priority 3 Level Items

a. Localized moderate foundation deterioration including concrete cracking/spalling/delamination, or exposed steel reinforcement, but section loss is negligible
b. Moderate erosion around the foundation
c. Moderate corrosion of the anchor bolt connections or high strength bolted connections
d. Moderate corrosion of the base plate, which includes moderate section loss
e. Pole is moderately out of vertical alignment
f. Moderate weld deficiencies, which do not meet code but do not impact function where significant redundancy is also present
g. Missing nuts or other elements of a bolted connection where there is adequate redundancy and moderate impact to structural capacity or durability
h. Anchor bolt standoff distance more than one bolt diameter but less than two bolt diameters with no anchor bolt bending present
i. Missing elastomeric pads between dissimilar metals where moderate corrosion is present

## 10.7 Element Condition States

| Element Number | Element | Condition States Defects Note | Link to Discussion in Section 10 |
|---|---|---|---|
| **20101** | Concrete Foundation | Use the appropriate condition state table | Foundation Element Condition States |
| **20102** | Anchor Bolts and Leveling Nuts | Use the appropriate condition state table. Use UT testing result to assist in the condition assessment. | Anchor Bolt and Leveling Nuts Foundation Element Condition States |
| **20201** | Base Plate | Use the appropriate condition state table | Base Plate Element Condition States |
| **20202** | Vertical Support Column | Use the appropriate condition state table | Vertical Support Column (Upright) Element Condition States |
| **20203** | Vertical Structure Connections | Use the appropriate condition state table | Vertical Structure Connections Element Condition States |
| **20301** | Arm or Truss Members | Use the appropriate condition state table | Arm or Truss Members Element Condition States |
| **20302** | Horizontal Structure Connections | Use the appropriate condition state table | Horizontal Structure Connections Element Condition States |
| **20303** | Sign and Sign Connections | Use the appropriate condition state table | Sign and Sign Connections Element Condition States |
| **20304** | Walkway and Walkway Connections | Use the appropriate condition state table. Inspectors are not required to access walkway. | Walkway and Walkway Connections Element Condition States |

## Element 20101 – Concrete Foundation

| | | | | |
|---|---|---|---|---|
| **Description** | This element defines a concrete foundation for a mast arm pole, regardless of foundation type such as drilled shaft or reinforced concrete pile | | | |
| **Quantity Calculation** | The quantity for this element is measured as “each.” | | | |
| | **Condition State Descriptions** | | | |
| **Defect Type** | **Good** | **Fair** | **Poor** | **Severe** |
| **Concrete Foundation Defects** | The concrete shows no deterioration. Superficial cracking, discoloration, or efflorescence may be present. No exposed reinforcing, and free from impact damage. | Minor cracks and/or spalls may be present in the concrete. No exposed reinforcing or embedment erosion, and free from impact damage. | Moderate cracks and/or spalls may be present. Some reinforcing may be exposed. Incidental loss of section or surface pitting of reinforcing may be present. Element shows evidence of some embedment erosion or impact damage. | Major cracks and/or spalls are present. Major corrosion of exposed reinforcing. Extensive steel and/or concrete loss of section. Embedment erosion or impact damage is present. |

## Element 20102 – Anchor Bolts and Leveling Nuts

| | | | | |
|---|---|---|---|---|
| **Description** | Anchor bolts and leveling nuts attaching the upright to the foundation. | | | |
| **Quantity Calculation** | The quantity for this element is each anchor bolt and nut unit. | | | |
| | **Condition State Descriptions** | | | |
| **Defect Type** | **Good** | **Fair** | **Poor** | **Severe** |
| **Anchor Bolts and Leveling Nuts Defects** | There is no deterioration. The elements are fully engaged and the sounding test produces a sharp ringing sound. Anchor bolt standoff distance is less than 1”. No | Minor corrosion of the elements may be present. The elements are fully engaged and functioning as intended. The sounding test produces a sharp ringing sound. Anchor bolt standoff distance is less than 1”. No | Moderate corrosion/ section loss of the elements may be present. Anchor nuts may not be fully tightened. The sounding test produces a dull sound. Anchor bolt standoff distance is greater than 1” but less than two times the bolt diameter. | Severe corrosion/section loss of the elements may be present. Nuts are loose/missing. The sounding test produces a dull sound. Anchor bolt standoff distance is greater than two times the bolt diameter. UT testing indicates cracks or breaks in bolts. Major evidence |

| Description | Anchor bolts and leveling nuts attaching the upright to the foundation. | | | |
|---|---|---|---|---|
| **Quantity Calculation** | The quantity for this element is each anchor bolt and nut unit. | | | |
| | **Condition State Descriptions** | | | |
| **Defect Type** | **Good** | **Fair** | **Poor** | **Severe** |
| | evidence of impact damage. | evidence of impact damage. | Minor evidence of impact damage may be present. | of impact damage may be present. |

## Element 20201 – Base Plate

| Description | Base plate which connects the upright element to the anchor bolt and leveling nut element. | | | |
|---|---|---|---|---|
| **Quantity Calculation** | The quantity for this element is each base plate. | | | |
| | **Condition State Descriptions** | | | |
| **Defect Type** | **Good** | **Fair** | **Poor** | **Severe** |
| **Base Plate** | No evidence of active corrosion. Surface coating is sound. | Minor surface corrosion may be present. Protective coating failure with no section loss. Base element welds have no evidence of defects. | Moderate corrosion/section loss may be present. Protective coatings are failing. Base element welds have no evidence of defects and/or cracking. Base plate may exhibit minor warping. | Major corrosion/section loss is present. Base element welds may have cracks/defects. Base plate has moderate to major warping. |

## Element 20202 – Vertical Support Column (Upright)

| | | | | |
|---|---|---|---|---|
| **Description** | This element is defined by uprights supporting dynamic message signs, regardless of material type or protective coating. | | | |
| **Quantity Calculation** | The quantity is collected in length in feet of vertical support. | | | |
| | **Condition State Descriptions** | | | |
| **Defect Type** | **Good** | **Fair** | **Poor** | **Severe** |
| **Vertical Support Column (Upright) Defects** | No evidence of active corrosion. Surface coating is sound. | Minor corrosion or superficial damage of the elements may be present. Protective coating failure with no section loss. No element weld defects or cracking are evident. | Moderate corrosion/section loss may be present. Protective coatings are failing. Element welds have no evidence of defects and/or cracking. Support may be moderately out of plumb. | Major corrosion/section loss is present. Protective coatings are significantly failing. Element welds may have cracks/defects. Support may be majorly out of plumb. |
| **Impact Damage** | No damage caused by vehicular impact. | The element has minor damage caused by vehicular impact. | The element has moderate damage caused by vehicular impact. | Impact damage is major and affects the integrity of the structure. |
| **Handhole Defects** | Handhole cover and attachment to pole is securely fastened. The inside of the pole is free of excess moisture, and debris. | Handhole cover is in place but loosely fastened or minimally damaged. Handhole attachment to pole may have minor deficiencies. The inside of the pole may contain minor moisture and debris. | Handhole cover is moderately damaged or missing fasteners. Handhole attachment to pole may have moderate deficiencies. Moisture and debris may be present inside the pole creating moderate corrosion and/or section loss of material. | Handhole cover is missing or majorly damaged. Handhole attachment to pole is failing. Moisture or debris inside the pole is creating major corrosion and/or section loss of material. |

## Element 20203 – Vertical Structure Connections

| | | | | |
|---|---|---|---|---|
| **Description** | This element consists of the connections along the DMS support structure for various attachments. | | | |
| **Quantity Calculation** | The quantity to be collected includes each connection location. | | | |
| | **Condition State Descriptions** | | | |
| **Defect Type** | **Good** | **Fair** | **Poor** | **Severe** |
| **Vertical Structure Connection Defects** | Pole clamps, saddles, bracket assemblies, and other connection hardware are functioning as intended with no evidence of wear or corrosion. | Minor surface corrosion or wear may be present. Pole clamps, saddles, bracket assemblies, and other connection hardware are functioning as intended. | Moderate corrosion/section loss or wear is present. Pole clamps, saddles, bracket assemblies or other connection hardware may be loose, but the conditions do not significantly affect serviceability and/or function. | Major corrosion/section loss is present. Protective coatings are significantly failing. Members may have cracks/defects or major wear. Hardware is loose or missing. Connection is not functioning as intended. |

## Element 20301 – Arm or Truss Members

| | | | | |
|---|---|---|---|---|
| **Description** | This element defines all arm members, truss chords and bracing for DMS Support Structures. It may include tension and compression members and includes all protective coating types. | | | |
| **Quantity Calculation** | The quantity is collected in length in feet of horizontal member. | | | |
| | **Condition State Descriptions** | | | |
| **Defect Type** | **Good** | **Fair** | **Poor** | **Severe** |
| **Arm or Truss Member Defects** | New or like-new condition with no deficiencies. | Minor corrosion of the elements may be present. Superficial damage to the component parts. | Moderate corrosion/section loss or damage is present. Arm cap may be missing. No weld defects or cracks. | Multiple or major element defects or section loss are present. Arm or Truss Members have propagating cracks. Loose or missing hardware. Major impact damage may be present. |

## Element 20302 – Horizontal Structure Connection

| | | | | |
|---|---|---|---|---|
| **Description** | This element consists of the connections of the horizontal structure for all DMS Support Structures. Connections may include splices, chord splices or bracing. | | | |
| **Quantity Calculation** | The quantity to be collected includes each connection location. | | | |
| | **Condition State Descriptions** | | | |
| **Defect Type** | **Good** | **Fair** | **Poor** | **Severe** |
| **Horizontal Structure Connection Defects** | New or like-new condition with no deficiencies | Minor surface corrosion, wear, or superficial damage may be present. The connection is functioning as intended. Hardware is fully engaged. No gaps are present. | Moderate corrosion/section loss or wear is present. Hardware is fully engaged. The conditions do not significantly affect serviceability and/or function. | Major corrosion/section loss is present. Protective coatings are significantly failing. Members may have cracks/defects or major wear. Hardware is loose or missing. Connection is not functioning as intended. |

## Element 20303 – Sign and Sign Connections

| | | | | |
|---|---|---|---|---|
| **Description** | This element consists of the sign and sign connections for all DMS Support Structures. | | | |
| **Quantity Calculation** | The quantity to be collected includes each connection location, which may contain one or more anchored connections, bracing, or bolts. It includes general structural condition of the dynamic message sign. | | | |
| | **Condition State Descriptions** | | | |
| **Defect Type** | **Good** | **Fair** | **Poor** | **Severe** |
| **Sign and Sign Connections Defects** | New or like-new condition with no deficiencies | Minor surface corrosion, wear, or superficial damage may be present. Hardware is fully engaged. No gaps are present. | Moderate deficiencies, deterioration/legibility or impact damage to panels or connecting parts and hardware. Multiple loose or improperly assembled connection hardware and/or corrosion is present. Missing elastomeric pads between dissimilar metals. | Multiple or major element defects that may significantly affect the serviceability or integrity of the structure. Major impact damage, loose, missing or failing hardware, corrosion, collapse, or separation is present. |

## Element 20304 – Walkway and Walkway Connections

| | | | | |
|---|---|---|---|---|
| **Description** | This element consists of the metal grating platform, railing, and connections which secure the walkway to the DMS Support Structure. | | | |
| **Quantity Calculation** | The quantity is measured in length in feet along arm or truss. | | | |
| | **Condition State Descriptions** | | | |
| **Defect Type** | **Good** | **Fair** | **Poor** | **Severe** |
| **Walkway and Walkway Connection Deficiencies** | New or like-new condition with no deficiencies. | Minor surface corrosion, wear, or superficial damage may be present. Hardware is fully engaged. | Moderate corrosion/section loss, wear or damage is present. Evidence of multiple loose or improperly assembled connection hardware and minimal impact damage may be present but the conditions do not significantly affect serviceability and/or function. | Major corrosion/section loss is present. Protective coatings are significantly failing. Members may have cracks/defects or major wear and damage. Loose, missing or failing hardware. Gaps are present. Connections are not functioning as intended. |