Overhead Sign Structures Inspection and Inventory Manual

SCDOT

OVERHEAD SIGN STRUCTURE INSPECTION AND INVENTORY MANUAL

South Carolina Department of Transportation

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I. TABLE OF FIGURES

1.0 INTRODUCTION

The purpose of this manual is to provide guidance for the in-service inspections of overhead sign structures and high mast light towers and management of the database developed for the South Carolina Department of Transportation (SCDOT). The intent of this manual is not to rewrite procedures described in other overhead sign and bridge inspection manuals, but rather to highlight specific items and details of the SCDOT inspection and data management program. This manual should be used in conjunction with Federal Highway Administration (FHWA) Publication No. FHWA NHI 05-036, "Guidelines for the Installation, Inspection, Maintenance and Repair of Structural Supports for Highway Signs, Luminaires, and Traffic Signals," dated March 2005. The FHWA document will be referenced throughout this manual as the *Guidelines*. The inspection and database work for the structures is managed by the Traffic Section of the SCDOT. The inspection project that contributed to the development of the manual consisted of a complete inventory of all qualifying sign structures and high mast light structures located on or near roadways maintained by the SCDOT. The project was conducted from May 2011 to May 2013. Qualifying structures included the following types:

- Bridge-Mounted Sign Frames

- Bridge Sign Structures (simple span)

- Cantilever Sign Structures (includes mast arm type structures)

- Butterfly Sign Structures

- High Mast Light Towers (>80 ft tall)

Structures used to support traffic signals (mast arm or cable) were not included in the inventory and thus not inspected or included as part of this manual.

1.1 INSPECTION TYPES

Refer to Section 8.1 of the *Guidelines* for various inspection types. This project consisted of In-Depth (hands-on) inspections of all structures in the inventory. An inspection program was conducted from 2000 to 2002, but the inspections under the 2011 to 2013 project were considered initial.

It is recommended that initial In-Depth inspections be performed on all structures that will be added to the inventory in the future. If they are performed prior to the contractor receiving final approval and

leaving the site, the inspection findings can serve as a punch list where the observed defects are corrected by the contractor almost immediately. This also reduces the burden on the SCDOT to correct defects observed after the contractor has received approval and has demobilized from the site.

1.2   INSPECTOR QUALIFICATIONS

Refer to Section 11.1 of the *Guidelines* for suggested inspector qualifications.

1.3   INVENTORY

The inventory was developed by surveying (driving) all state-owned and maintained roadways and listing all observed qualifying structures. Refer to the list of qualifying structures in Section 1.0 and to the detailed inventory information gathered during this survey in Section 2.

1.4   DATABASE DEVELOPMENT

A comprehensive database was created to facilitate the storage and retrieval of all inventory and inspection data collected. The database will be used to manage the inventory and inspection data and to generate paper reports as needed. The tools were developed using products approved by the SCDOT Applications Development Group. The program interfaces are web-based and developed using Visual Studio 2010 and SQL Server 2008. The field inventory collection system software was installed on Trimble Nomad G series GPS units, which were used to collect the inventory and inspection data. See 5.0 for additional information on the Sign Structures Database.

1.5   TRAFFIC CONTROL

This type of work is inherently dangerous because it is performed along and over highways. All work shall satisfy Maintenance and Protection of Traffic (MOT) safety requirements while controlling costs within acceptable limits. All traffic control shall be conducted in accordance with the instructions set forth in a letter from the State Traffic Operations Engineer, dated March 9, 2001, as well as the current

editions of the South Carolina Work Zone Safety Guidelines and Part V of the South Carolina Manual on Uniform Traffic Control Devices for Streets and Highways.

All operations shall be coordinated with the project manager and the appropriate District Traffic Engineer to ensure that inspections are conducted during off-peak hours and do not interfere with other construction zones in the work area. A schedule shall be set up for work notifications per the SCDOT project manager. Be aware that some counties or SCDOT districts may have more stringent rules than the Standards.

Inspections can be performed over live traffic. All tools and other items carried by the inspector shall be properly secured to his/her harness, such that no objects can fall into traffic. All safety equipment and climbing operations shall be conducted in accordance with OSHA Standard 3146, Fall Protection in Construction.

2.0 INVENTORY

This chapter will cover description of the types of sign structures, identification of structures and their geometry, and required measurements and photographs for structure inventory.

2.1 STRUCTURES INCLUDED IN INVENTORY

The inspection program consisted of a complete inventory of all qualifying sign structures and high mast light structures located on or near roadways maintained by the SCDOT. Qualifying structures included the following types:

- Bridge-Mounted Sign Frames

- Bridge Sign Structures (simple span)

- Cantilever Sign Structures (includes mast arm type structures)

- Butterfly Sign Structures

- High Mast Light Towers (80 - 150 ft tall)

Structures used to support traffic signals (mast arm or cable) were not included in the inventory and were not inspected.

Structures were coded to provide a quick description of their major features. The coding system described the type of vertical support and type of horizontal span support. Following are photographs of typical structure types and their specific codes.

CODE	STRUCTURE TYPE	CODE	UPRIGHT TYPE	CODE	SPAN TYPE	CODE	MATERIAL
BM	BRIDGE MOUNT	1P	SINGLE POST	2C	TWO CHORD	GS	GALVONIZED STEEL
BR	BRIDGE	2F	TWO FRAME	3C	TRI-CHORD	AL	ALUMINUM
CA	CANTILEVER	4F	FOUR FRAME	4C	FOUR CHORD	WS	WEATHERING STEEL
BF	BUTTERFLY	NA	NOT APPLICABLE	MA	MAST ARM	PS	PRESTRESSED CONCRETE
HM	HIGH MAST			NA	NOT APPLICABLE		

FIGURE 2.1 TABLE OF STRUCTURE CODES

Bridge: BR_1P_4C

Bridge: BR_1P_3C

Bridge: BR_1P_2C

Bridge: BR_1P_2C

Bridge: BR_2F_4C

Bridge: BR_2F_4C

Cantilever: CA_1P_3C

Cantilever: CA_1P_2C

Cantilever: CA_1P_2C

Cantilever: CA_1P_1C

Cantilever (VMS): CA_1P_4C

Cantilever: CA_4P_4C

Butterfly: BF_1P_2C

Butterfly: BF_1P_2C

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2.2 STRUCTURE IDENTIFICATION AND LOCATION

Each structure shall receive an identification number. This number is a 5-digit number comprised of a 2-digit county code and a 3-digit consecutive number. High mast light poles have a "P" in the identification number between the two sets of digits. For example, the 4th inventoried sign in Anderson County is labeled 04004 and the 1st inventoried high mast light pole in Charleston County is labeled 10P001. The county code number is per the SCDOT county code list:

1	Abbeville	13	Chesterfield	25	Hampton	37	Oconee
2	Aiken	14	Clarendon	26	Horry	38	Orangeburg
3	Allendale	15	Colleton	27	Jasper	39	Pickens
4	Anderson	16	Darlington	28	Kershaw	40	Richland
5	Bamburg	17	Dillon	29	Lancaster	41	Saluda
6	Barnwell	18	Dorchester	30	Laurens	42	Spartanburg
7	Beaufort	19	Edgefield	31	Lee	43	Sumter
8	Berkeley	20	Fairfield	32	Lexington	44	Union
9	Calhoun	21	Florence	33	McCormick	45	Williamsburg
10	Charleston	22	Georgetown	34	Marion	46	York
11	Cherokee	23	Greenville	35	Marlboro		
12	Chester	24	Greenwood	36	Newberry		

A written identification number and a barcode sticker shall be placed on the upright of each structure, located approximately near eye level. The identification number shall be written on the upright using an oil-based paint marker similar to the uni PAINT brand. A barcode sticker label shall be placed near the written number. The SCDOT has the barcode label device, but in case a new device is used, the barcodes shall be "Code 3 of 9 Full ASCII."

The location of each structure shall be described by the road on which it is found, the direction along the route and a short position description along the route. The route is described by its type (I, US, SR,

Local), route number, and the type of roadway such as mainline, ramp or business. The position description typically lists the estimated distance from the nearest major route or the nearest crossing route. Following are some examples:

I-526 WB, mainline, 900 Ft W/O the Don Holt Truss (W/O is "west of")

SC-461 NB, mainline, on the I-526 EB Bridge

I-385 SB, mainline, 0.67 Mi. N/O Pleasantburg Rd

I-385 SB, ramp, at I-85 ramp split

Note that the cell for the location in the database should only contain the position description since the route number, direction and type are entered in separate data cells.

2.3   ROADWAY/ACCESS FEATURES

The inventory of each sign structure shall include collection of data addressing the roadway features and inspector access features. Following is a list of the features and a brief description/explanation:

- Total Lanes – List the total number of lanes of the roadway in the direction of travel for the sign. If the structure is a Bridge Structure spanning both roadway directions, then include lanes for both directions. The placement of the signs is irrelevant. For cantilever or butterfly structures, only include the lanes pertinent to the direction of travel for viewing the front of the sign. If the butterfly sign has panels on both sides, then include lanes for both directions.
- Total Lanes Under – List the total lanes located under the span using the same general rules above for Total Lanes. If the cantilever or butterfly span does not cross over a lane, then this shall be NA.
- Guardrail – Note the presence of a guardrail, barrier, or other immovable obstruction located between the vertical support of the structure and the roadway. Do not consider a curb or light-duty fence, such as a chain link fence, an immovable obstruction. For a cantilever structure, only note the obstructions near the support. If there is a guardrail in the median, but the structure is on the right, then indicate NA for LEFT and MID.
- Set Up – Indicate the potential placement of the lift vehicle, which will assist with the type of MOT required. The options are: +15 FT, BEHIND G/RAIL, BEYOND CURB, ON SHLD, IN LANE, OFF-RAMP LANE

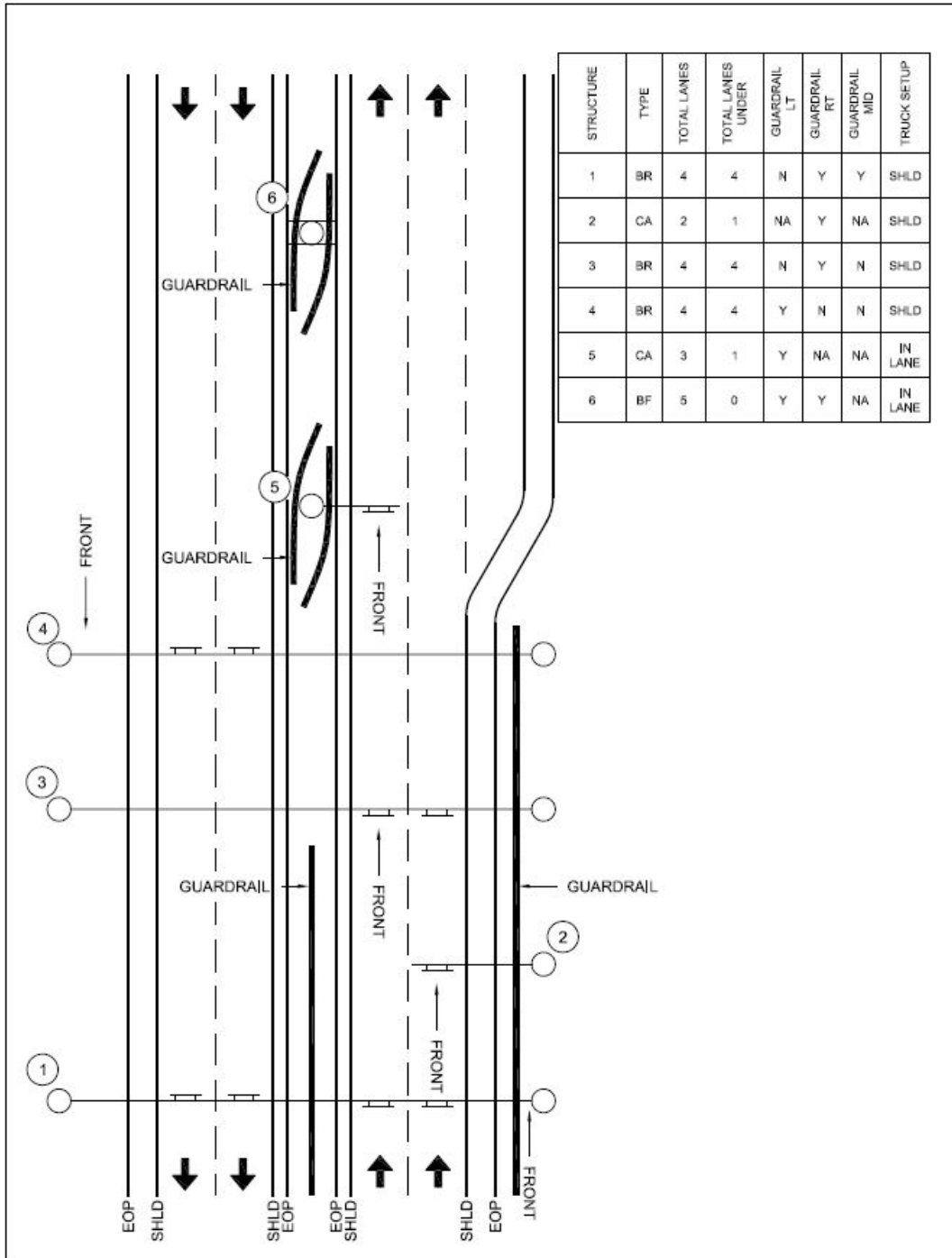Refer to FIGURE 2.2 on the following page for examples.

STRUCTURE	TYPE	TOTAL LANES	TOTAL LANES UNDER	GUARDRAIL LT	GUARDRAIL RT	GUARDRAIL MID	TRUCK SETUP
1	BR	4	4	N	Y	Y	SHLD
2	CA	2	1	NA	Y	NA	SHLD
3	BR	4	4	N	Y	N	SHLD
4	BR	4	4	Y	N	N	SHLD
5	CA	3	1	Y	NA	NA	IN LANE
6	BF	5	0	Y	Y	NA	IN LANE

FIGURE 2.2 ROADWAY / ACCESS FEATURES

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2.4   PHOTOGRAPHS

Photographs shall be taken for inventory and inspection purposes. Following are the minimum photographs to take for inventory purposes:

- O/A Front – Overall Front photograph shall show the entire structure within nearly the entire photograph border limits (not too far away)
- O/A Rear – Overall Rear photograph shall show the entire structure within nearly the entire photograph limits (not too far away)
- Foundation – One photograph of each foundation shall be close enough to show the basic configuration of the anchor rods and far enough to show the area around the foundation.
- Sign Panel(s) – One photograph of each sign panel with the panel taking up nearly the entire photograph border. The words and symbols shall be able to be read.

Deficiency Photographs – One or more photographs shall be taken of deficiencies that are unique and uncommon. If a photograph will be helpful in presenting and describing the condition, then one shall be taken. Typical photographs shall be taken of common conditions such as light to moderate corrosion, missing panel clips, corroded catwalk hardware, etc. These typical conditions do not require photographs for every occurrence.

2.5   MEASUREMENTS

The following measurements shall be obtained during each inspection:

- UPRIGHT HEIGHT – Measure (to the nearest foot) the distance from the top of the base plate to the top of the upright (use the tallest upright of a frame if the uprights are not the same height).
- SPAN – Measure (to the nearest foot) the distance from upright to upright for a bridge structure and from the upright to the farthest span element (chord or sign panel) for a cantilever. Use the sign panel width or chord length for a butterfly, whichever is longest.
- HORIZONTAL CLEARANCE – Measure (to the nearest 0.1 of a foot) the distance from the exterior lane stripe to the first obstruction. An obstruction shall be considered as any object that is either designed to stop or slow a wayward vehicle, or will most likely perform that function. Obstructions would include, but are not limited to, items such as guardrails, cables, barriers, sound walls, masonry walls, etc. Items that would not be considered obstructions include, but are not limited to, items such as curbs, chain link fences, etc.

- VERTICAL CLEARANCE – Measure (to the nearest 1/10th of a foot) the distance from the pavement to the lowest point on the span. Only one measurement needs to be recorded (minimum distance), but sometimes several may need to be taken to find the minimum. The inspector shall consider the roadway cross slope and superelevation, as well as varying low points on the span due to catwalks, luminaires and varying sign panel heights and positions.
- SIGN DIMENSIONS – Measure (to the nearest ¼ of a foot) the horizontal and vertical distances from edge to edge of each sign panel. The typical extruded panel sections are 1 foot high, and the stitch bolts are typically spaced at 1 foot on-center (some panel sections have holes spaced at 6 inches, but bolts were installed at a spacing of 1 foot on-center). Typically the vertical heights and horizontal widths are at even 1 foot dimensions or 0.5 foot dimensions. Occasionally the horizontal distances are at 0.3 foot dimensions depending upon the distance from the last stitch bolt to the panel edge.
- ANCHORAGE – The number of anchor rods and their diameter shall be recorded. Note that on some bridge signs, the anchor rod diameters may not be the same at each side. Typically anchor rods are the following sizes (in inches): 1, 1.25, 1.5, 1.75, 2.0, 2.25, 2.5, 3.0. It is rare to find an anchor rod diameter in a 1/8 inch increment. Verify the measured diameter with the nut height. Typically the nut height matches the rod diameter, but there are exceptions.
- ANCHORAGE STANDOFF – Measure (to the nearest 1/10th of an inch) the distance from the top of the foundation to the bottom of the leveling nut. Many times this distance will vary from anchor location to anchor location, even at the same foundation. Record an average value for the database. Add notes if the distances vary considerably. If the leveling nut is not visible because of the presence of a grout pad, then measure the distance from the top of the foundation to the bottom of the base plate and subtract one anchor bolt height to estimate the standoff. The purpose of measuring the standoff is to assist in assessing potential bending stresses in the anchor rods.

3.0 INSPECTION

This chapter will cover the elements and components to be inspected at each structure. Refer to Appendix A for an example inspection form.

3.1   GENERAL

The inspection of overhead sign structures shall be in-depth using a "hands-on" approach. This typically involves climbing and being within an arm's reach of the components for visual examination. The inspection is element-based, but at the time of this writing, does not include element quantities that would be typical of a PONTIS-type element-level inspection.

The typical inspection approach and procedures has been developed and are provided in the *Guidelines* so they will not be rewritten in this document. Please refer to Sections 8 through 15 in the *Guidelines* for further information. The remainder of this section shall cover the descriptions of the elements to be inspected at each structure and a listing of the components that are considered part of each specific element that shall be rated within.

3.2   ELEMENTS AND COMPONENTS

S.01 Foundation – This element shall include the concrete foundation and grout pad. In addition to these components, any erosion of the surrounding grade shall be evaluated. Refer to Figure 3.1 for components of this element.

S.02 Anchor Rod – This element shall include the anchor rods and all associated washers and nuts. The nuts and washers located on the underside of the base plate shall be labeled as leveling nuts and washers. The washers and nuts located on the top side of the base plate shall be labeled anchor nuts and washers. If a second nut is placed on top of the anchor nut, it shall be labeled jam nut. Refer to Figure 3.2 for components of this element.

S.03 Base Plate – This element shall include the base plate and sole plate (if present). Refer to Figure 3.3 for components of this element.
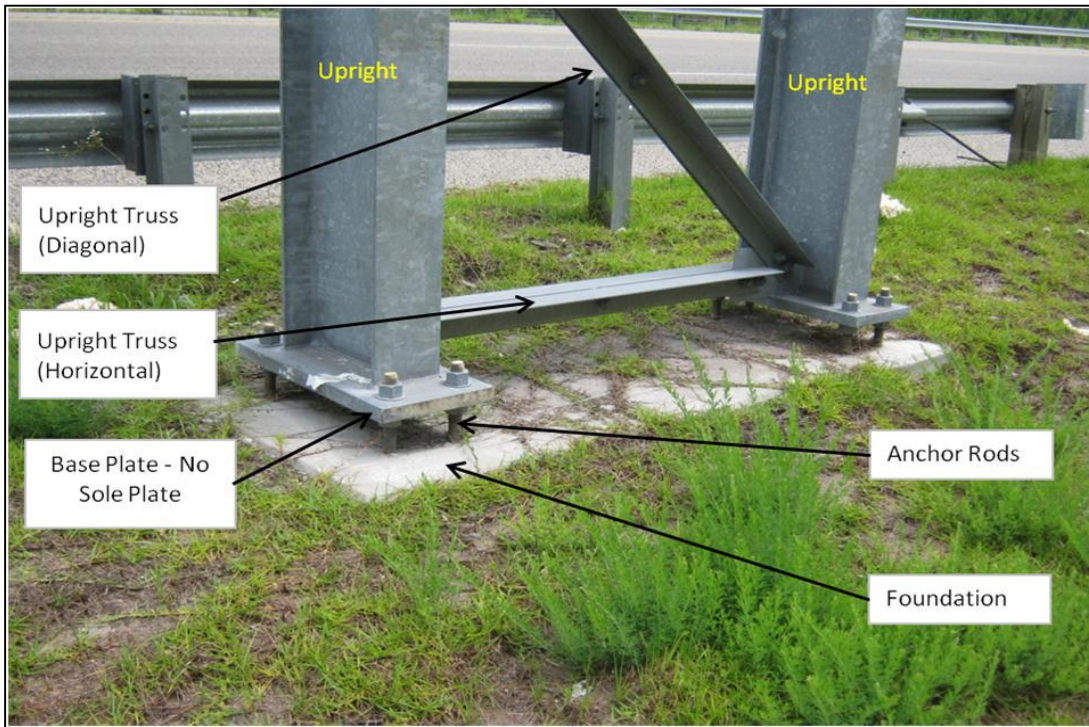
FIGURE 3.1 FOUNDATION AND UPRIGHT ELEMENTS
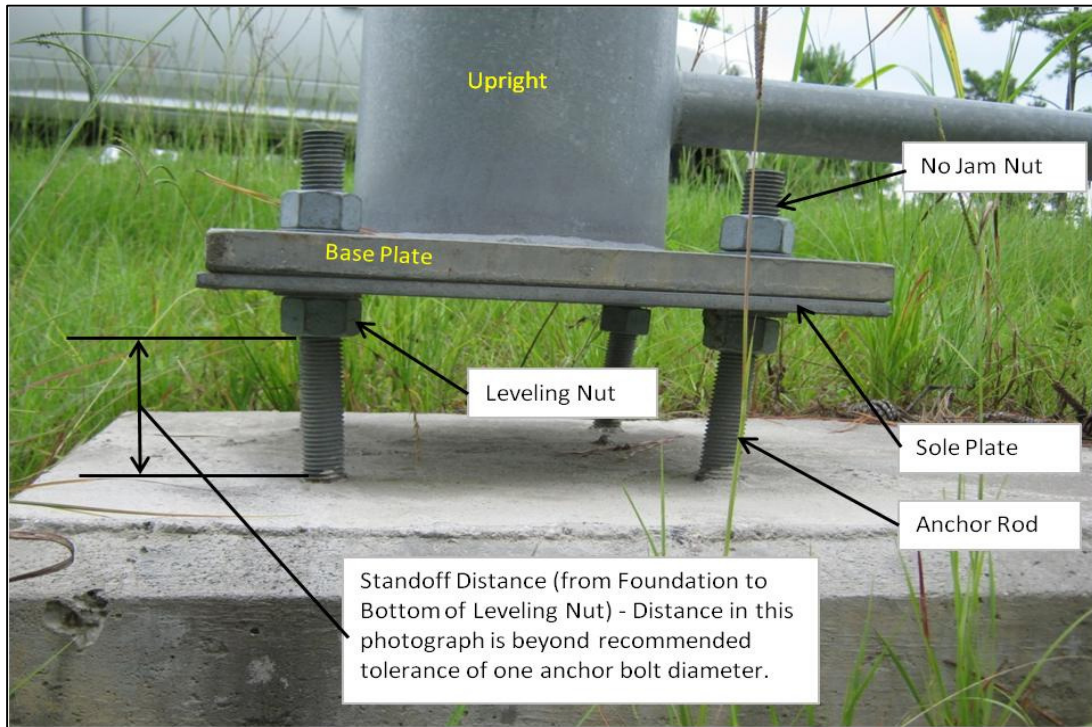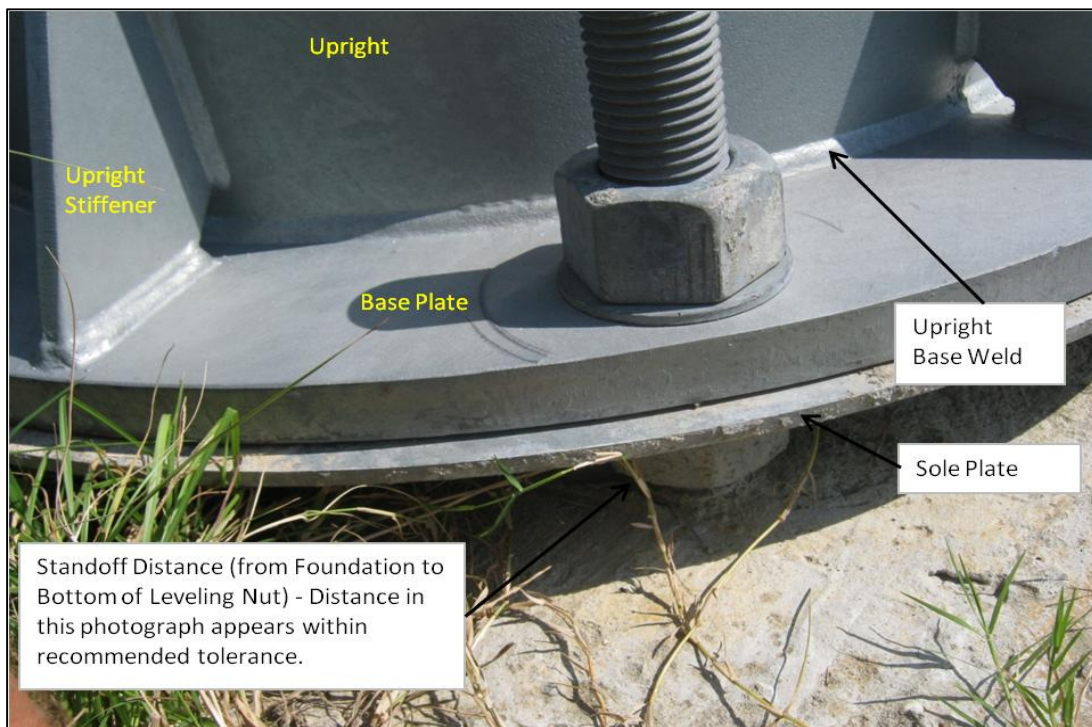

FIGURE 3.2 FOUNDATION ELEMENTS

Upright

No Jam Nut

Base Plate

Leveling Nut

Sole Plate

Anchor Rod

Standoff Distance (from Foundation to Bottom of Leveling Nut) - Distance in this photograph is beyond recommended tolerance of one anchor bolt diameter.

FIGURE 3.3 FOUNDATION ELEMENTS

Upright

Upright Stiffener

Base Plate

Upright Base Weld

Sole Plate

Standoff Distance (from Foundation to Bottom of Leveling Nut) - Distance in this photograph appears within recommended tolerance.

FIGURE 3.4 FOUNDATION AND UPRIGHT ELEMENTS

S.04   Upright (Column) – This element shall include the vertical support, column cap and associated stiffener plates and welds at the base plate connection. This element is used for uprights composed of a single support as well as multiple columns in a vertical frame. Cap plates, stiffener plates and welds connected to the uprights for span connections are included in this element. The plates welded to the span chords and the connection bolts are not included in this element. Refer to Figures 3.4 and 3.5 for components of this element.

S.05   Upright Frame Trussing – This element shall include all horizontal and diagonal secondary members in a vertical support truss. This shall include all welds for these members. Refer to Figure 3.1 for components of this element.

S.06   Upright-To-Chord Connection – This element shall include all connection plates, gusset plates, stiffener plates, saddles, u-bolts and associated welds and bolts that connect the span member(s) to the upright(s). Refer to Figure 3.5 for components of this element.

S.07   Chords – This element shall include the horizontal support member, and the chord base plate and weld if present. Secondary members, welds for secondary members (for truss spans), and bolts connecting the span to the support(s) are not included in this member. Refer to Figures 3.7 and 3.8 for components of this element.

S.08   Chord Splice – This element shall include the flange plates, bolts, welds, and stiffener plates for the chord splices. Refer to Figure 3.9 for components of this element.
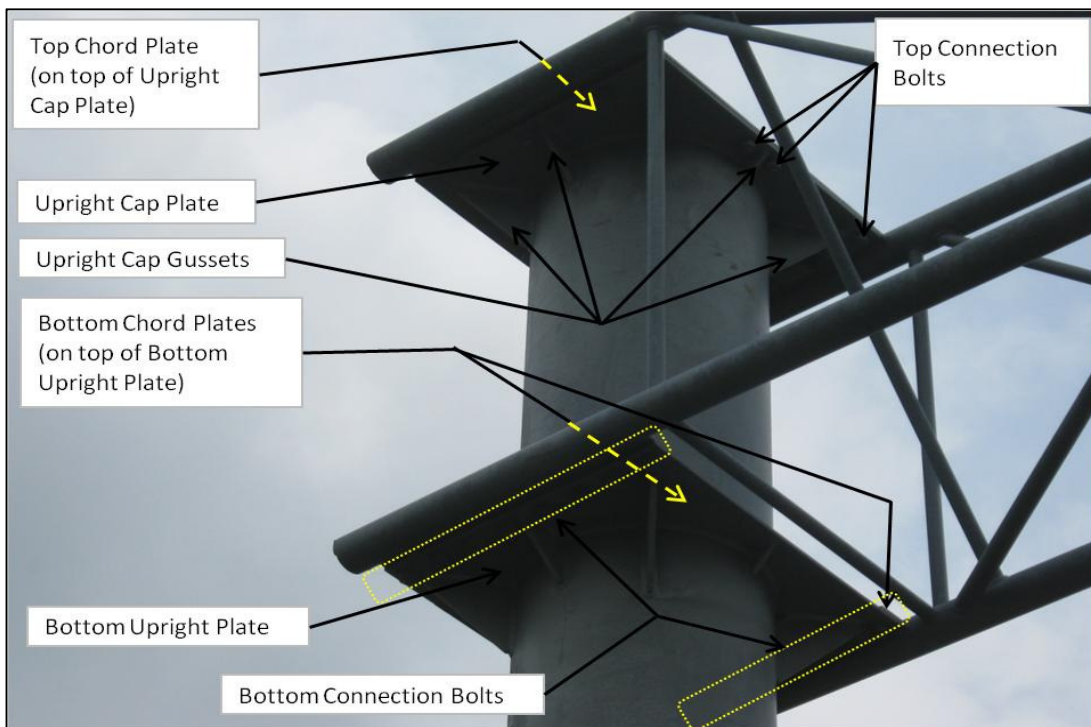
FIGURE 3.5 UPRIGHT AND SPAN ELEMENTS
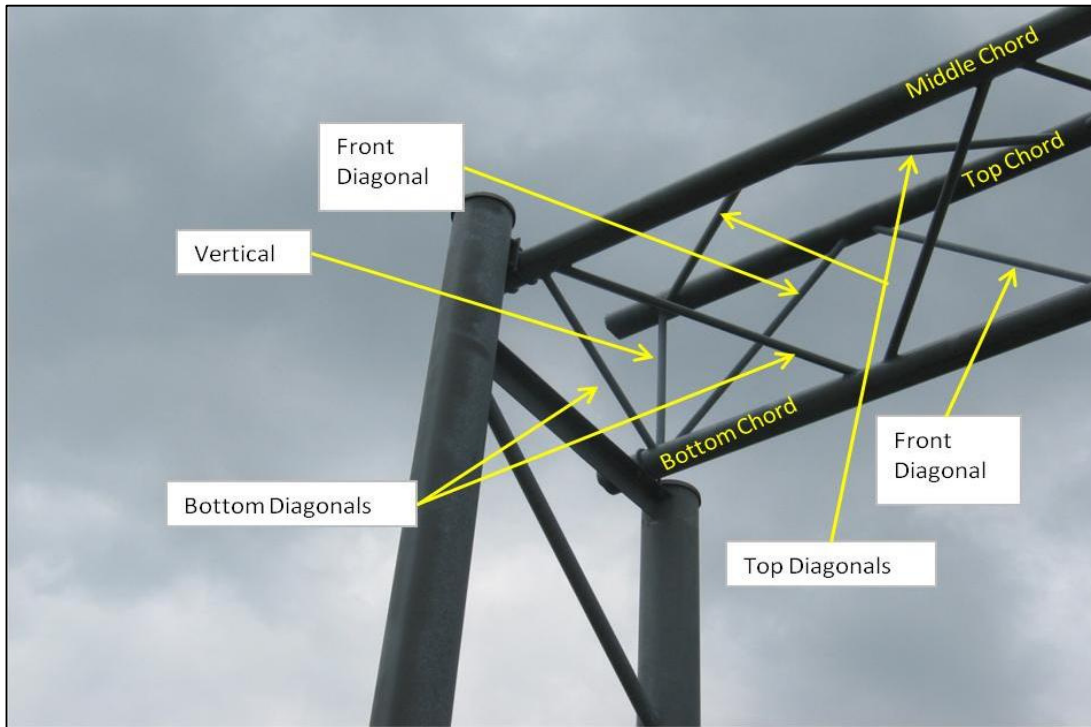

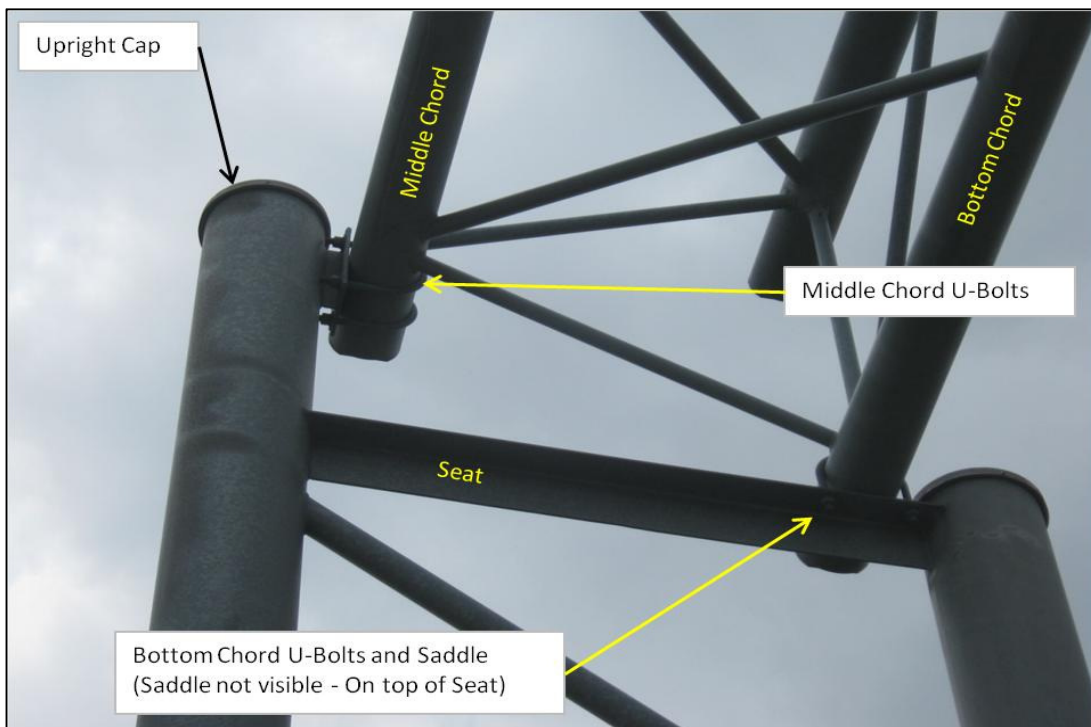**FIGURE 3.6 UPRIGHT-TO-SPAN CONNECTION**

FIGURE 3.7 SPAN MEMBERS
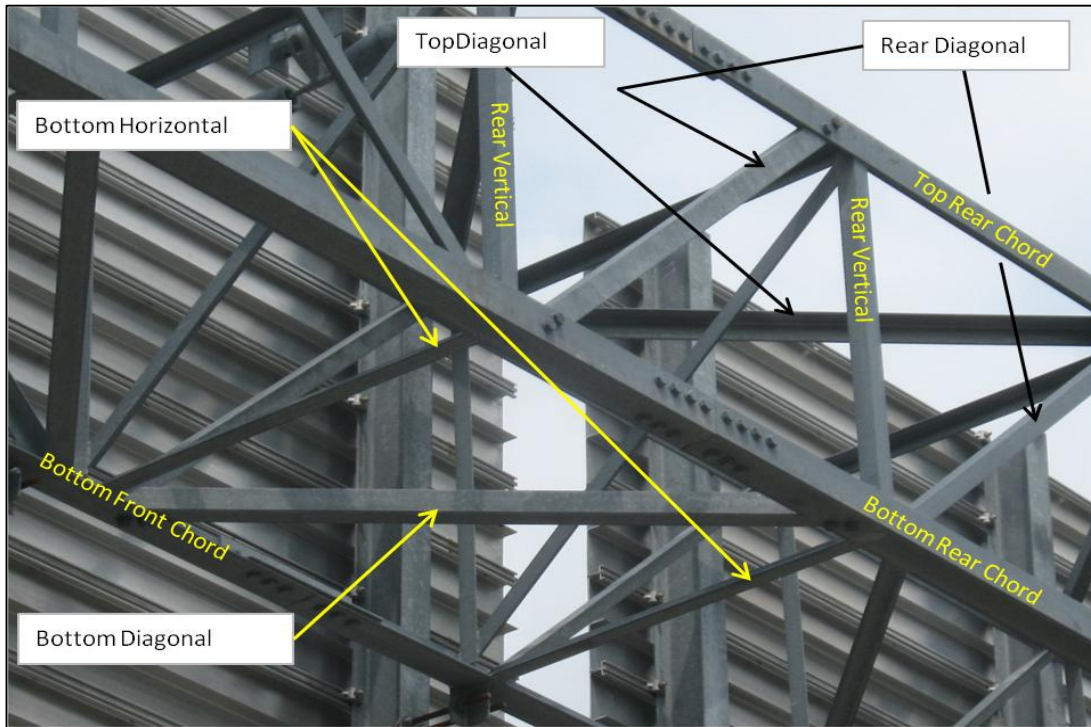

FIGURE 3.8 SPAN MEMBERS

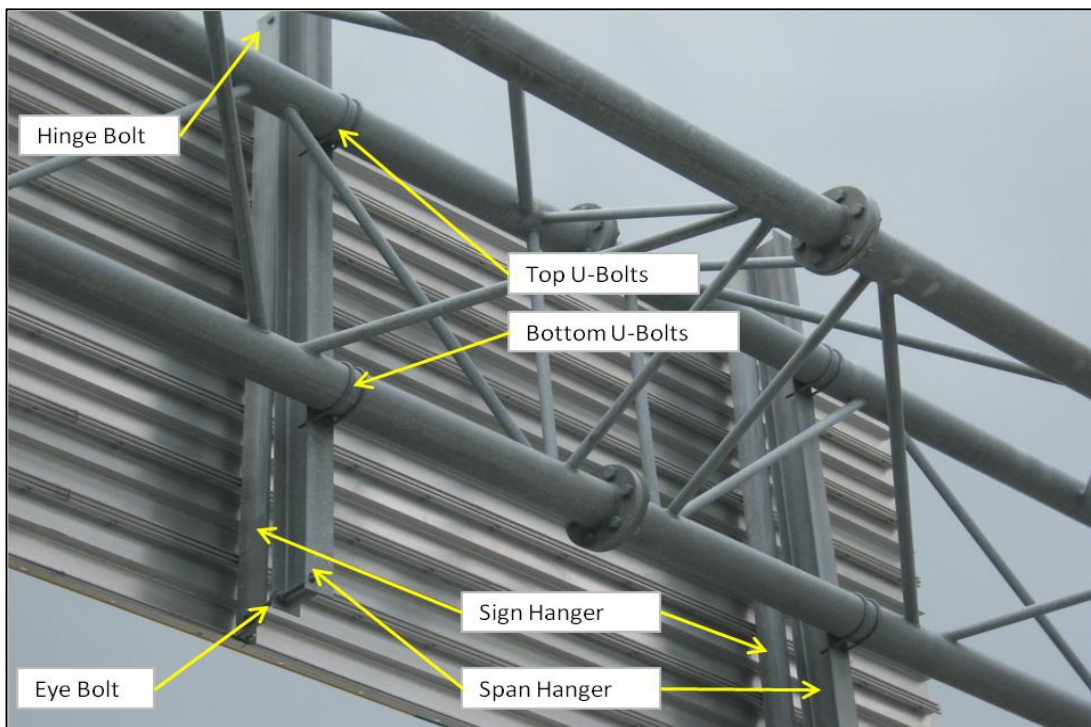**FIGURE 3.9 SPAN MEMBERS**

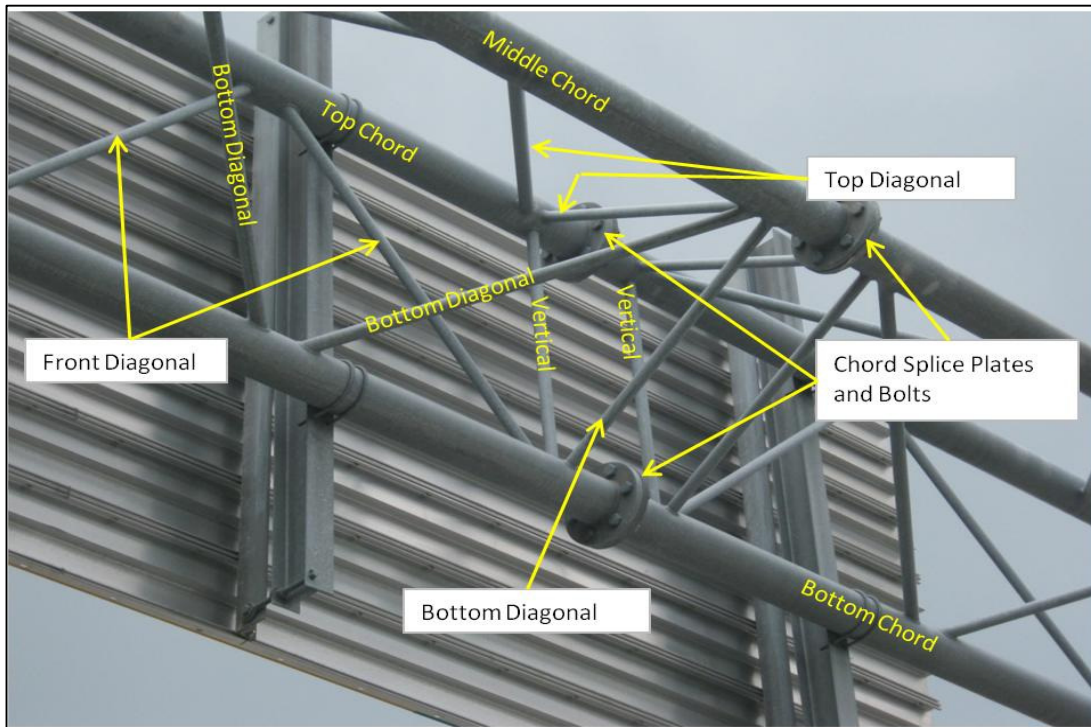**FIGURE 3.10 SPAN FRAME MEMBERS**
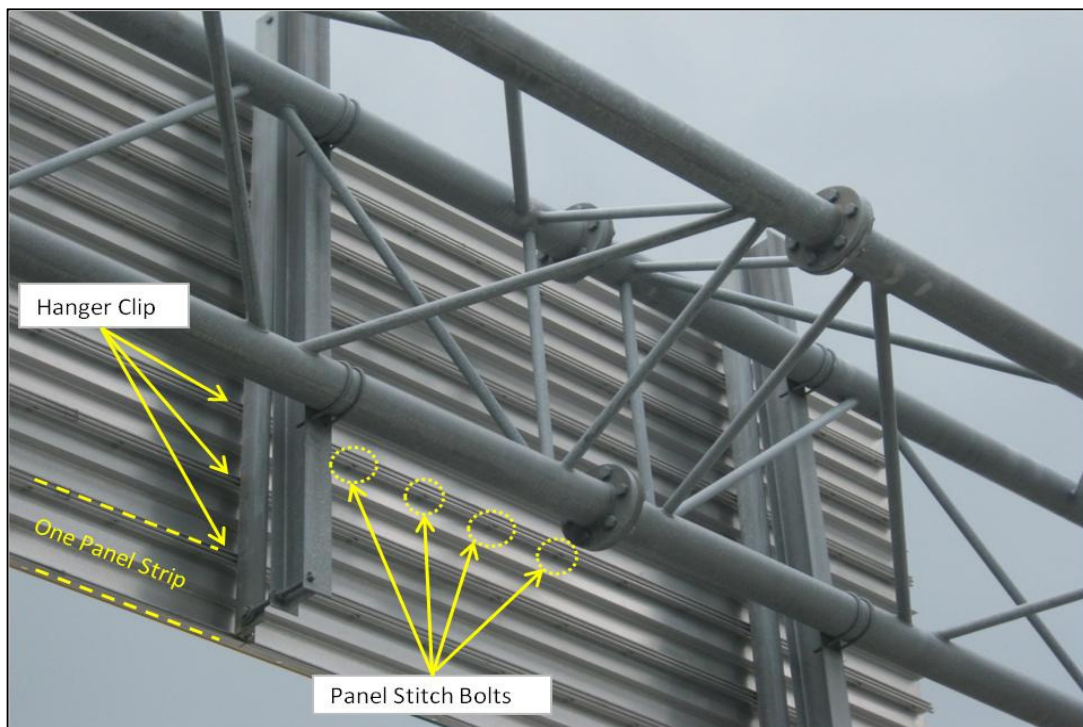
FIGURE 3.11 SPAN MEMBERS
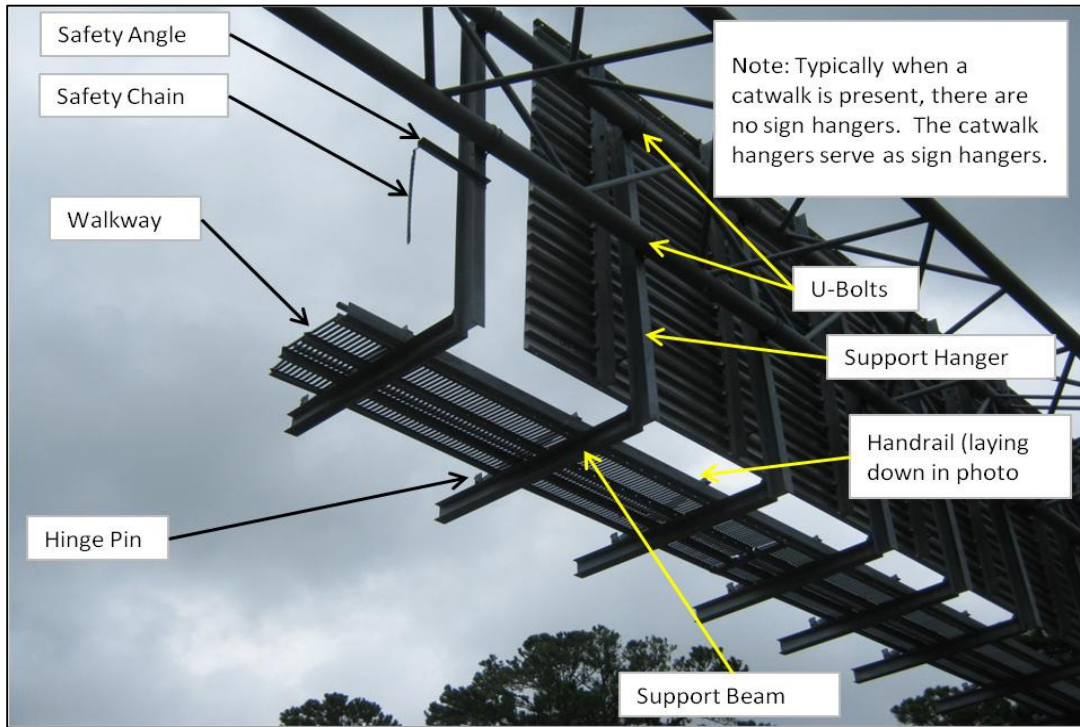

FIGURE 3.12 SIGN PANEL MEMBERS
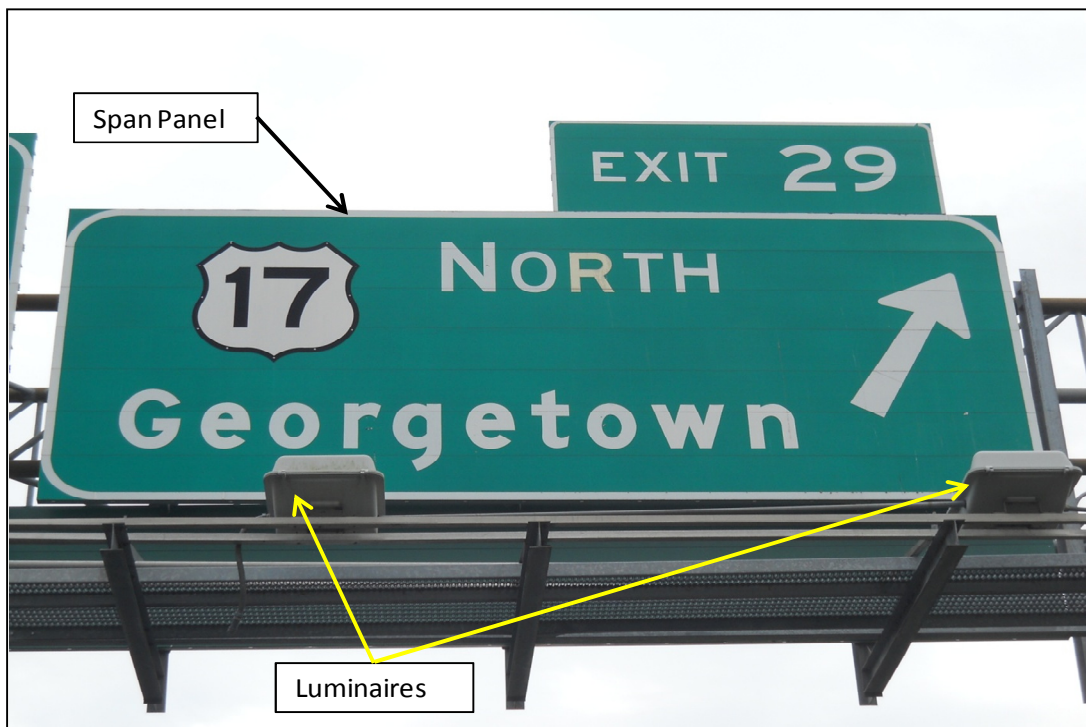
FIGURE 3.13 CATWALK ELEMENTS

FIGURE 3.14 LUMINAIRE ELEMENT

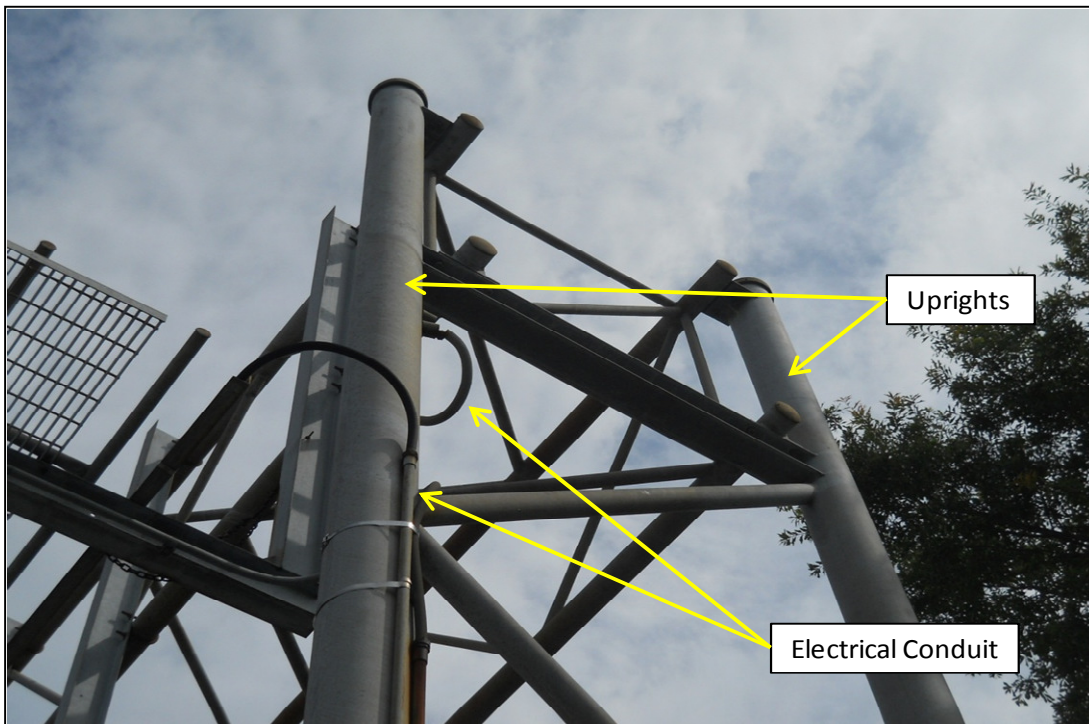**FIGURE 3.15 SIGN ATTACHMENT ELEMENT**

FIGURE 3.16 ELECTRICAL ELEMENT

S.09   Span Truss – This element shall include all truss members (diagonals, verticals and horizontals) and associated gusset plates, welds and connection bolts for the members. Refer to Figure 3.10 for components of this element.

S.10 Sign Frame – This element shall include the members that form the connections of the sign to the panel hangers and to the span. The elements include span hangers (if no catwalk is present), threaded rods, eyebolts, connection bolts and u-bolts.   Refer to Figure 3.11 for components of this element.

S.11 Sign Panel – This element shall include the sign panel members and the sign panel hangers, and all associated hardware. The elements include flat panels, extruded panel strips, stitch bolts, panel hangers, panel bolts and clips. The bolts connecting the panel hangers to the span hangers are part of Element S.10 Sign Frame. Refer to Figure 3.12 for components of this element.

S.12 Catwalk – This element shall include all components of the catwalk system, including the walkway grating, handrail, support beam, support hanger, luminaire support unistrut beams and all associated bolts and small hardware. Refer to Figure 3.13 for components of this element.

S.13 Luminaire – This element shall include the luminaire (housing, bulb, lens) and shall be used to rate structural deficiencies. Use Element S.16 Electrical to note operational deficiencies. Refer to Figure 3.14 for components of this element.

S.14 Sign Attachment – This element shall include the sign panel and connection hardware for all signs that are mounted to the upright. Refer to Figure 3.15 for components of this element.

S.15   Standoff Distance – This element shall be used for rating the standoff distance of the anchorage. Refer to Figure 3.3 for components of this element.

S.16 Electrical – This element shall be used for all exposed components of the electrical system up to the luminaires or VMS sign panels. The components shall include the conduit, flex conduit,

wiring and connection straps or clips. This is generally used for rating corrosion, open connections, open junction boxes and exposed wiring. Notes can be made for luminaires not on during night, or on during day. Refer to Figure 3.16 for components of this element.

3.3   BRIDGE MOUNT SIGN STRUCTURES

The support elements for bridge mount structures are quite different than those of a typical sign frame. The following must be used to match bridge mount structure elements to those of the typical sign frame. There will be no rating for Elements S.01 through S.05. Element S.06 Upright-to-Span Connection shall be used to rate the components connecting the structural frame to the bridge beams or deck. Element S.07 Chords shall be used to rate the strut members of the supporting frame. Element S.08 Chord splice shall apply if present (strut splice). Element S.09 Span Truss shall be used to rate any horizontals, diagonals or verticals, and associated connection hardware or welds, located between the struts. Elements S.10 though S.14, and S.16 shall be as previously defined above. Element S.15 shall not apply. Refer to Figure 3.17 for components of this type of structure.
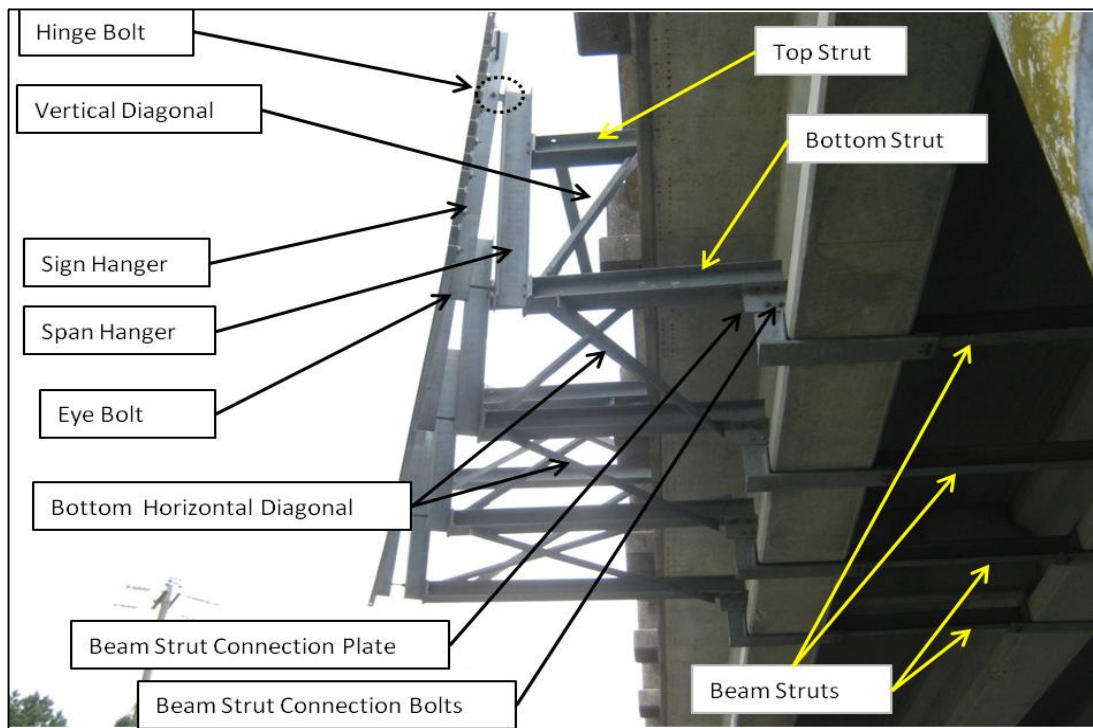
FIGURE 3.17 BRIDGE MOUNT COMPONENTS

3.4   HIGH MAST LIGHT POLE STRUCTURES

The support elements for high mast light pole structures use the same nomenclature as typical sign structures. The following must be used to match high mast light pole elements to those of the typical sign frame. There will be no rating for Elements S.05 through S.12. Element S.13 Luminaires shall be used to rate the components of the light assembly. Element S.14 Sign Attachment shall be used if present. Element S.16 Electrical shall used for the electrical components inside the access hatch. Refer to Figure 3.18 and 3.19 for components of this type of structure.
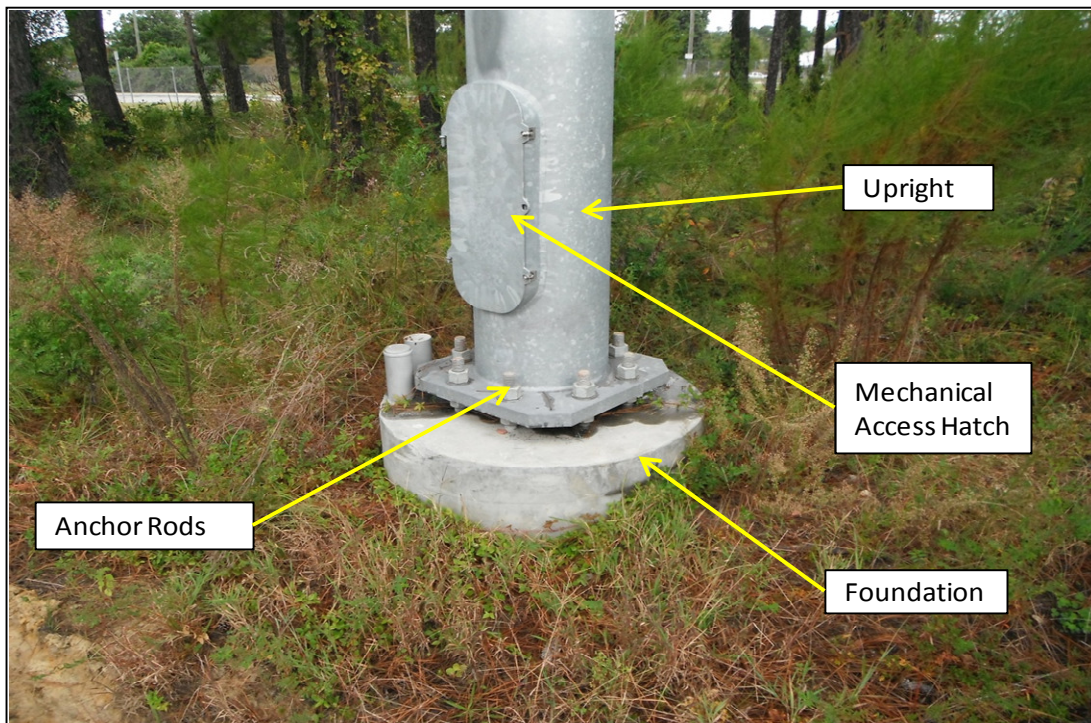
FIGURE 3.18 HIGH MAST LIGHT POLE COMPONENTS

FIGURE 3.19 HIGH MAST LIGHT POLE COMPONENTS

4.0 RECORDING

This chapter will cover the ratings for structural elements and repair recommendations and priorities. It will also cover the procedures for using the Trimble.

4.1 RATINGS

In order to provide consistency among inspectors and ratings, the following was developed. These are not hard rules, but shall serve as a guide. The inspector shall use his or her expertise in evaluating and rating observed defects. The type of affected component or location of the defect may have a significant impact on the severity of the defect.

GENERAL DEFINITIONS

0 – Not Applicable

1 – Element performs intended function high degree of reliability (good)

2 – Element performs intended function with small reduction in reliability (fair)

3 – Element performs intended function with significant reduction in reliability (poor)

4 – Element does not perform intended function with any degree of reliability (critical)

Following are more detailed rules to be applied per element or type of material:

1 – Element Performs Intended Function With High Degree In Reliability (Good)

- No noticeable deficiencies
- Corrosion – Light (no pitting) or none
- Metal Cracks – Very minor or none
- Concrete Cracks – Hairline (temperature or shrinkage) or none
- Concrete Spalls – Insignificant spalls (typically mechanical corner or edge chips, rather than internal corrosion-caused spall)
- Bolts – Connections are tight, or a few loose minor connections

2 – Element Performs Intended Function With Small Reduction In Reliability (Fair)

- Corrosion – Minor (Light to Moderate) corrosion – can have some pitting, but no section loss of metal
- Metal Cracks – Cracks in secondary members
- Concrete Cracks – Minor cracks (approximately 3/16 in. or less, with no corrosion bleed out)
- Concrete Spalls – Minor spalls. (May have one exposed reinforcement, but the exposed length is less than 2 in. and the location is not impacting strength or serviceability)
- Bolts – Less than 20 percent of connections have loose or missing nuts and bolts

3 – Element Performs Intended Function With Significant Reduction In Reliability (Poor)

- Corrosion – Moderate to heavy corrosion – loss of section could be up to 30 percent

- Metal Cracks – Cracks in 20 percent of secondary members, or <20 percent if concentrated in same area. Cracks in primary members or connections to primary members
- Concrete Cracks – Large cracks (approximately equal to greater than ¼ in.) that reduces strength or serviceability
- Concrete Spalls – Large or deep spalls with exposed, corroded reinforcing
- Bolts – Between 20 percent and 50 percent of connections have loose, missing or heavily corroded nuts and bolts.

4 – Element Does Not Perform Intended Function With Any Degree Of Reliability (Critical)

- Corrosion – Major loss of section in metal (more than 30 percent)
- Metal Cracks – Cracking in critical stress areas. Minor cracks in fracture critical members.
- Concrete Cracks – Flexural or shear cracks
- Bolts – More than 50 percent of connections have loose, missing or heavily corroded nuts and bolts.

4.2 REPAIR RECOMMENDATIONS

General repair recommendations consist of the following:

- Corrosion – Corrosion on bolts and nuts and other small parts is generally best repaired by replacing the part, rather than cleaning and recoating it. It is rare that a corroded bolt can be completely cleaned of corrosion such that corrosion will not reoccur within several years. Areas of corrosion on main and secondary members and plates can be properly cleaned and coated with a liquid applied cold galvanizing compound.
- Metal Cracks - Cracks in metal components can be repaired through arresting techniques, repairing welds, installing splices or wraps, or replacing the cracked member or component.
- Concrete cracks – Generally concrete cracks in sign structure foundations rarely get significant enough to warrant repair. Typically an entire area may have signs of concrete deterioration rather than a significant crack. Epoxy crack repair can be used or for significant deterioration, deleterious concrete can be removed and replaced with a concrete patch.
- Concrete Spalls – As with concrete cracks, concrete spalls are rare in overhead sign structure foundations. Spalls can be repaired with a concrete patch.
- Bolts – As discussed above, corrosion in bolts is typically best addressed by replacing the bolt. If bolts are loose, they should be tightened or replaced. Verify that washers (if needed) are present prior to repair. High strength bolts (such as in chord splice connections) should be

replaced, not tightened. If the bolts originally were not tightened properly, then they may be able to be tightened, but in most structures, the bolts should be replaced. When anchor rods are tightened, all the anchor rod nuts should be tightened per the recommended procedure in the Guidelines. Lock washers should be removed to allow for anchor rod connections.

5.0   SIGN STRUCTURES DATABASE APPLICATION

5.1   APPLICATION   DEVELOPMENT   ENVIRONMENT   AND   SOFTWARE REQUIREMENTS

- The SCDOT Sign Structures inspection and viewer intranet site was developed using Microsoft's ASP.net API. It utilizes the .Net 4.0 framework and will support Internet Explore Versions 7 or later.
- The server that the web site will be installed on must have windows IIS 6 or greater
- Optimal screen resolution should be set at 1100 pixels by 800 pixels or greater
- The Microsoft SQL Server 2008 database will be used to house the sign structure inspection data and photos.

5.2   APPLICATION CONFIGURATION PARAMETERS

The SCDOT Sign Structures intranet site will utilize a web.config file to configure site parameters including:

- Report Path location where summary structure listing reports and inspection detail reports will be stored
- A list of windows user login names that will have admin user access on the SCDOT Sign Structures site.
- SCDOT Sign Structures inspection database location and connection parameters

5.3   USER INTERFACE

The user interface for the sign structures application is shown in Figure 5.1. All of the application features are accessed from this form. The form contains two tabs: Structures and Administration.

Structures Tab

The Structures tab is divided into three main areas – a location/general information pane, an inspections pane, and a search pane.

FIGURE 5.1 MAIN APPLICATION FORM

Search Pane

The left side of the Structures form contains the search pane which allows the user to select a sign structure by ID number, barcode number or by selecting from a list. The "Create Summary Report" button is used to generate a summary listing of the sign structures and basic information in PDF format.

Location/General Information Pane
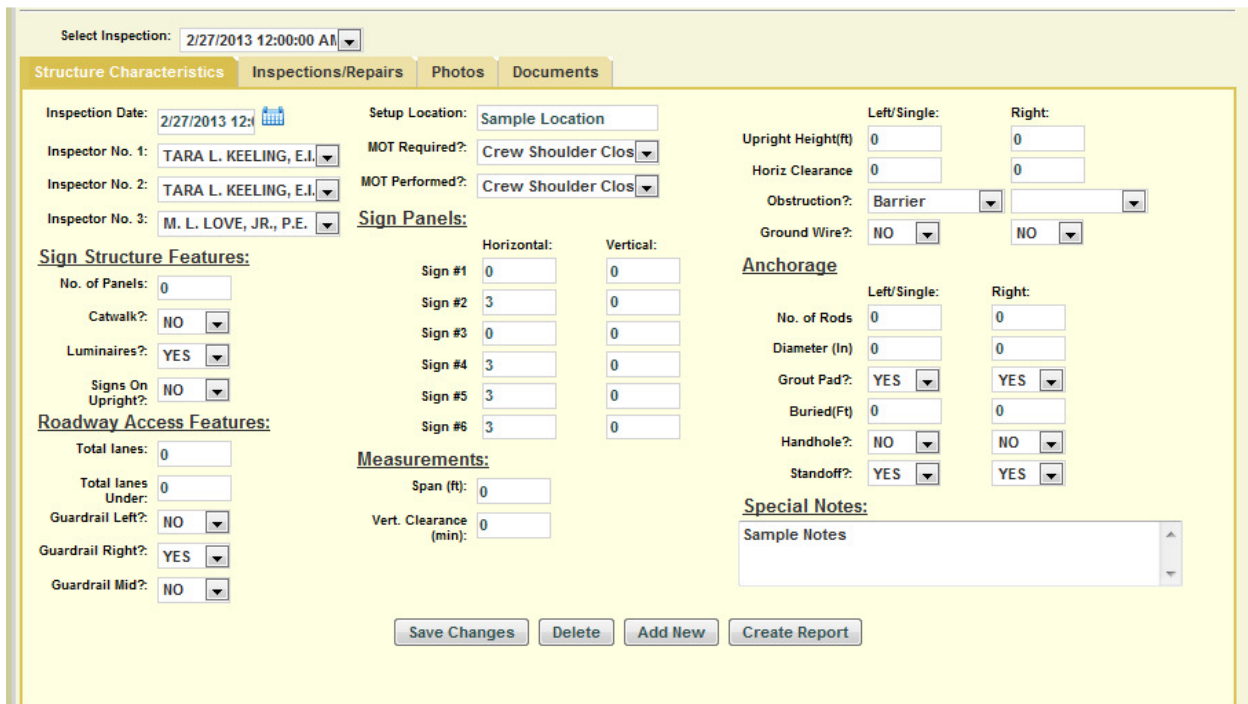
This pane displays basic information about the currently selected sign structure, including the location of the structure and information about the structure itself. Note that if the current structure contains any critical defects, a notification will be displayed at the top of this pane. Users may edit, add and delete structures by using the appropriate buttons at the bottom of the form.

Inspections Pane

The inspections pane displays information collected during field inspections, and is divided into four tabs: structure characteristics, inspections/repairs, photos and documents. The application is designed to manage multiple inspections for each structure. When the desired inspection date is selected from the drop-down box at the top of the pane, the tabs will display the information for that date.

Structure Characteristics Tab

The Structure Characteristics tab contains data from field inspections that describe the structure, as well as inspection information. Changes and edits can be made by using the buttons at the bottom of the pane.

FIGURE 5.2 STRUCTURES CHARACTERISTICS TAB

In addition, a report may be generated for the selected data by clicking the "Create Report" button.

SCDOT

Inspection Detail Report

Identification

Structure Num: 22

Type: BR_1P-2C

Date Inspected: 2/27/2013

Location

County: ABBEVILLE

City: test city 6

Route Num: 55

Route Name: Route 5

Direction: NB

Location: test 6

Roadway Access Features

Number of Lanes: 0

Number of Lanes Under Construction: 0

Guardrail Left:

Guardrail Middle:

Guardrail Right:

Structure Features

Number of Panels: 0

Catwalk: N

Luminaries: Y

Signs On Upright:

6/5/2013   1

FIGURE 5.3 INSPECTION DETAIL REPORT

Inspections/Repairs Tab

FIGURE 5.4 INSPECTIONS/REPAIR TAB

The Inspections/Repairs tab contains inspection information for each of the sixteen inspection elements. Selecting an element from the "Inspection Elements" list on the left side of the pane will display the ratings, issues and comments in the "Inspection Results/Comments" on the right side of the pane.

Photos Tab

The Photos tab allows the user to view and upload photographs associated with the current structure and the currently selected inspection date. Note that any number of photographs may be uploaded for a given structure and inspection date.

FIGURE 5.5 PHOTOS TAB

Documents Tab

The Documents tab allows the user to attach and view documents associated with the current structure and the currently selected inspection date. These documents may contain ancillary information that is not captured elsewhere in the application. Any number of documents may be uploaded for a given structure and inspection date.
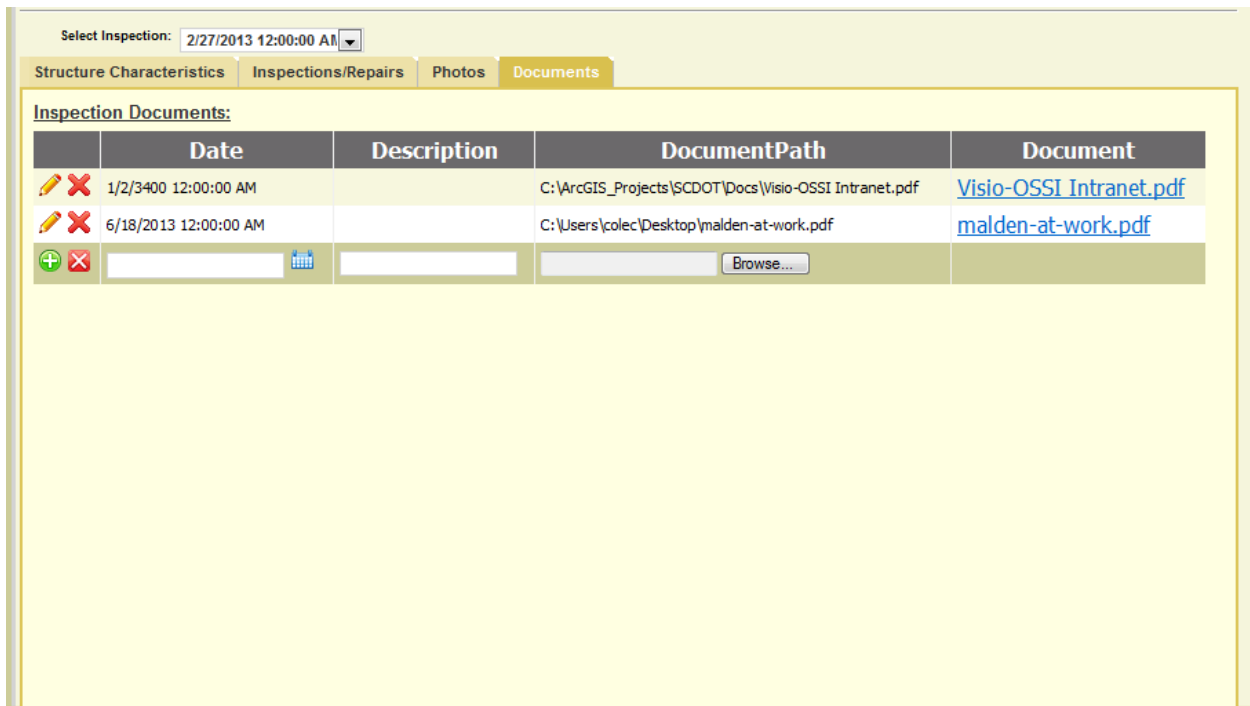
FIGURE 5.6 DOCUMENTS TAB

Administration Tab

The Administration tab allows the user to modify the domain tables in the sign structures database. These tables contain the codes used by the database and the corresponding descriptions.
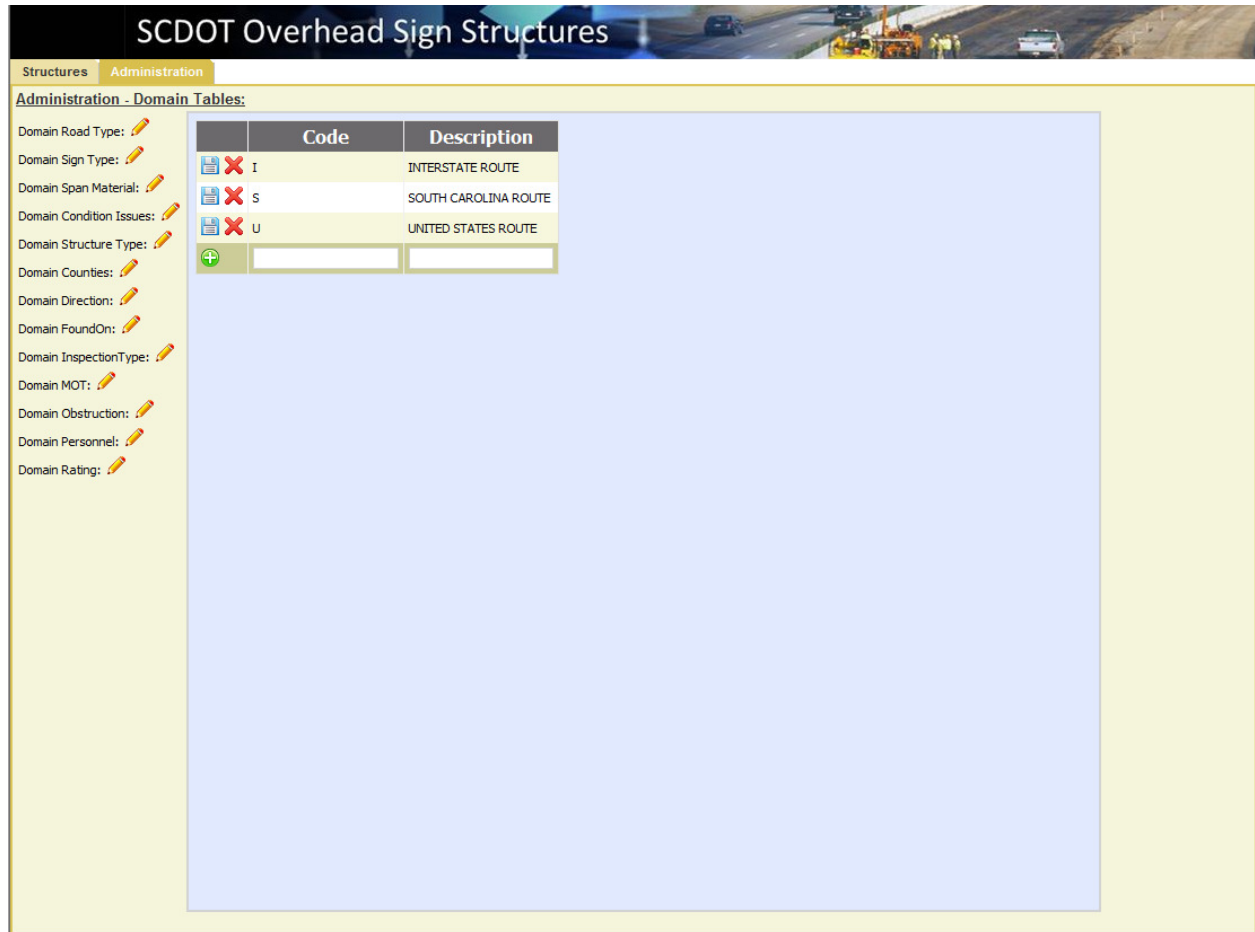
FIGURE 5.7 ADMINISTRATION TAB

APPENDIX A INSPECTION FORM

SCDOT Overhead Sign Inspection

SIGN NO. _____

FIELD INSPECTION RECORD

OLD SIGN NO. _____

INSPECTORS: _____ **DATE:** _____ **TIME LEFT SITE:** _____

STRUCTURE LOCATION

COUNTY _____ CITY _____ LATITUDE N _____

ROAD TYPE ☐ I ☐ US ☐ SC ☐ CR ☐ LOCAL LONGITUDE W _____

ROAD DESIG. ☐ (1)MAINLINE ☐ (2)RAMP ☐ (3)AUXILIARY ☐ (4)OTHER

NUMBER _____ DIR _____ ROAD NAME _____

LOCATION DESC. _____

SIGN HAS CRITICAL DEFECTS: Y N   **DOT NOTIFIED:** Y N

SIGN STRUCTURE FEATURES

STR. TYPE ☐ BR ☐ CA ☐ BM ☐ MA ☐ HM ☐ BF

UPRIGHT					SPAN				
TYPE ☐ 1P	☐ 2F	☐ 4F	☐ NA		TYPE ☐ 2C	☐ 3C	☐ 4C	☐ MA	☐ NA
MAT ☐ GS	☐ AL	☐ WS	☐ PS		MAT ☐ GS	☐ AL	☐ WS	☐ PS	

NO. PANELS _____ CATWALK? Y N   LUMIN.? Y N   SIGNS ON UPRIGHT? Y N

(ONLY INCLUDE MAJOR PANELS)

ROADWAY/ACCESS FEATURES

TOTAL LANES _____ TOTAL LANES UNDER _____

GUARDRAIL: LEFT - Y N NA   RIGHT - Y N NA   MID - Y N NA

SET UP: +15' BEHIND G/RAIL BEYOND CURB ON SHLD IN LANE OFF-RAMP LANE

MOT REQUIRED: NONE CREW SHLD CLOSURE MOT SHLD CLOSURE LANE CLOSURE

MOT PERFORMED NONE CREW SHLD CLOSURE MOT SHLD CLOSURE LANE CLOSURE

PHOTOGRAPHS

O/A FRONT _____ FND LEFT (OR SINGLE) _____

O/A REAR _____ FND RIGHT _____

UPRIGHT-TO-SPAN _____ TRUSS REAR _____

SIGN PANELS: #1 _____ #2 _____ #3 _____ #4 _____ #5 _____

MEASUREMENTS

UPRIGHT HEIGHT: LEFT (SINGLE) _____ FT   RIGHT _____ FT

SPAN _____ FT

HORIZ CLEARANCE (EDGE OF LANE TO NEAREST OBSTRUCTION - NOT A CURB)

LEFT _____ FT OBSTRUCTION: _____

RIGHT _____ FT OBSTRUCTION: _____

VERTICAL CLEARANCE (MIN) _____ FT

SIGN DIMS (HxV) #1 _____ #2 _____ #3 _____ #4 _____ #5 _____

ANCHORAGE

LEFT (OR SINGLE)		RIGHT		GROUND WIRE?	
NO. OF RODS	_____	NO. OF RODS	_____	LEFT: Y N	
DIAMETER	_____ IN.	DIAMETER	_____ IN.	RIGHT: Y N	
GROUT PAD?	Y N	GROUT PAD?	Y N	HANDHOLE?	
BURIED?	_____ FT	BURIED?	_____ FT	LEFT: Y N	
STANDOFF	_____ IN	STANDOFF	_____ IN	RIGHT: Y N	

BARCODE STICKER PLACED ON STRUCTURE: Y N   **UT COMPLETED:** Y N

ALL ITEMS ON COVER _____

ALL RATINGS NOTED _____   PROJECT NO. _____

SCDOT Overhead Sign Inspection   SIGN NO. _____
FIELD INSPECTION RECORD

S.01 FOUNDATION COMMENTS	
RATING =	
	PRIM: SECD:

S.02 ANCHOR ROD COMMENTS	
RATING =	
	PRIM: SECD:

S.03 BASE PLATE COMMENTS	
RATING =	
	PRIM: SECD:

S.04 UPRIGHT (COLUMN) COMMENTS	
RATING =	
	PRIM: SECD:

S.05 UPRIGHT FRAME TRUSS COMMENTS	
RATING =	PRIM: SECD:

ADDITIONAL NOTES _____
_____
_____
_____

PROJECT NO. _____

SCDOT Overhead Sign Inspection

FIELD INSPECTION RECORD

SIGN NO. _____

S.06 UPRIGHT-TO-CHORD CONNECTION COMMENTS RATING =	 PRIM: SECD:
S.07 CHORDS COMMENTS RATING =	 PRIM: SECD:
S.08 CHORD SPLICE COMMENTS RATING =	 PRIM: SECD:
S.09 SPAN TRUSS MEMBERS COMMENTS RATING =	 PRIM: SECD:

ADDITIONAL NOTES _____

_____

_____

_____

PROJECT NO. _____

SCDOT Overhead Sign Inspection

FIELD INSPECTION RECORD

SIGN NO. _____

S.10 SIGN FRAME COMMENTS	
RATING =	
	PRIM: SECD:

S.11 SIGN PANEL COMMENTS	
RATING =	
	PRIM: SECD:

S.12 CATWALK COMMENTS	
RATING =	
	PRIM: SECD:

S.13 LUMINAIRE COMMENTS	
RATING =	PRIM: SECD:

ADDITIONAL NOTES _____

_____
_____
_____

PROJECT NO. _____

SCDOT Overhead Sign Inspection

FIELD INSPECTION RECORD

SIGN NO. _____

S.14 SIGN ATTACHMENT COMMENTS	
RATING =	PRIM: SECD:

S.15 STANDOFF DISTANCE COMMENTS	
RATING =	PRIM: SECD:

S.16 ELECTRICAL COMMENTS	
RATING =	PRIM: SECD:

ADDITIONAL NOTES _____

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PROJECT NO. _____

SCDOT Overhead Sign Inspection
FIELD INSPECTION RECORD

SIGN NO. _____

S.01 FOUNDATION REPAIRS	
S.02 ANCHOR ROD & STANDOFF REPAIRS	
S.03 BASE PLATE REPAIRS	
S.04 UPRIGHT REPAIRS	
S.05 UPRIGHT TRUSS REPAIRS	
S.06 UPRIGHT-TO-CHORD CONN. REPAIRS	
S.07 CHORD REPAIRS	
S.08 CHORD SPLICE REPAIRS	
S.09 SPAN TRUSS REPAIRS	
S.10 SIGN FRAME REPAIRS	
S.11 SIGN PANEL REPAIRS	
S.12 CATWALK REPAIRS	
S.13 LUMINAIRE REPAIRS	
S.14 SIGN ATTACH. REPAIRS	
S.16 ELECTRICAL REPAIRS	

PRIORITY CODES: PC1-HIGH (1 MONTH);   PC2-MIDDLE (3 MONTHS);   PC3-MIDDLE (1 YEAR);   PC4-LOW (2 YRS)

PROJECT NO. _____

APPENDIX B DATABASE STRUCTURE

The tables and field structures for the sign structures database are shown below.

Table: Structures

Columns

Name	Type
PK	**StructureNum**	**bigint**

Name	Type
ID	**bigint identity**
Date_Inspdate	
County	varchar(50)
City	varchar(50)
StructureType	varchar(50)
RoadType	varchar(50)
RouteType	varchar(50)
RouteNum	varchar(50)
Direction	varchar(50)
Milepost	numeric(18,0)
Location	varchar(50)
InspectionType	varchar(30)
InspectionLeader	varchar(50)
QualEngineer	varchar(50)
InstallYear	int
Lat	numeric(18,0)
Lon	numeric(18,0)
NumberSplice	int
LeftEOPToSupport	numeric(18,0)
RightEOPToSupport	numeric(18,0)
FoundedOn	varchar(20)
BridgeNumber	varchar(20)
TotalSignArea	numeric(18,0)
SignComments	varchar(300)
Barcode	varchar(50)
RouteName	varchar(50)
HasBarcode	varchar(3)
Publish	varchar(3)
SupportClimb	varchar(3)
SpanMaterial	varchar(20)
SupportMaterial	varchar(20)
SpanClimb	varchar(3)
RouteAux	varchar(3)
CriticalDefects	varchar(3)
SCDOTNotified	varchar(3)

Table: Inspections

<u>Columns</u>

	Name	Type
PK	**ID**	**bigint identity**
FK1	**StructureNum**	**bigint**
	Date_Insp	date
	Inspector1	varchar(4)
	Inspector2	varchar(4)
	Inspector3	varchar(4)
	NumberSignPanels	int
	CatwalkPresent	varchar(4)
	LuminairesPresent	varchar(4)
	SignsOnUpright	varchar(4)
	NumberLanes	int
	NumberLanesUnder	int
	GuardRailLeft	varchar(4)
	GuardRailRight	varchar(4)
	GuardRailMid	varchar(4)
	Location	varchar(50)
	MOTRequired	varchar(10)
	MOTPerformed	varchar(10)
	Sign1HorPanel	int
	Sign1VerPanel	int
	Sign2HorPanel	int
	Sign2VerPanel	int
	Sign3HorPanel	int
	Sign3VerPanel	int
	Sign4HorPanel	int
	Sign5VerPanel	int
	Sign6HorPanel	int
	Sign6VerPanel	int
	Sign7HorPanel	int
	Sign7VerPanel	int
	SpanWidth	numeric(18,0)
	MinVerticalClearance	numeric(18,0)
	UprightHeight_LS	numeric(18,0)
	UprightHeight_R	numeric(18,0)
	HorizClearance_LS	numeric(18,0)
	HorizClearance_R	numeric(18,0)
	Obstruction_LS	varchar(10)
	Obstruction_R	varchar(10)
	GroundWire_LS	varchar(4)
	GroundWire_R	varchar(4)
	NumRods_LS	int
	NumRods_R	int
	Diameter_LS	numeric(18,0)
	Diameter_R	numeric(18,0)
	Pad_LS	varchar(4)
	Pad_R	varchar(4)
	Buried_LS	numeric(18,0)
	Buried_R	numeric(18,0)
	Handhole_LS	varchar(4)
	Handhole_R	varchar(4)
	Standoff_LS	varchar(4)
	Standoff_R	varchar(4)
	Comments	varchar(300)
	S01_Rating	int
	S01_PrimaryIssues	varchar(200)
	S01_PrimaryCorrosion	int
	S01_SecondaryIssues	varchar(200)

Columns

Name	Type
S01_SecondaryCorrosion	int
S01_Comments	varchar(300)
S02_Rating	int
S02_PrimaryIssues	varchar(200)
S02_PrimaryCorrosion	int
S02_SecondaryIssues	varchar(200)
S02_SecondaryCorrosion	int
S02_Comments	varchar(300)
S03_Rating	int
S03_PrimaryIssues	varchar(200)
S03_PrimaryCorrosion	int
S03_SecondaryIssues	varchar(200)
S03_SecondaryCorrosion	int
S03_Comments	varchar(300)
S04_Rating	int
S04_PrimaryIssues	varchar(200)
S04_PrimaryCorrosion	int
S04_SecondaryIssues	varchar(200)
S04_SecondaryCorrosion	int
S04_Comments	varchar(300)
S05_Rating	int
S05_PrimaryIssues	varchar(200)
S05_PrimaryCorrosion	int
S05_SecondaryIssues	varchar(200)
S05_SecondaryCorrosion	int
S05_Comments	varchar(300)
S06_Rating	int
S06_PrimaryIssues	varchar(200)
S06_PrimaryCorrosion	int
S06_SecondaryIssues	varchar(200)
S06_SecondaryCorrosion	int
S06_Comments	varchar(300)
S07_Rating	int
S07_PrimaryIssues	varchar(200)
S07_PrimaryCorrosion	int
S07_SecondaryIssues	varchar(200)
S07_SecondaryCorrosion	int
S07_Comments	varchar(300)
S08_Rating	int
S08_PrimaryIssues	varchar(200)
S08_PrimaryCorrosion	int
S08_SecondaryIssues	varchar(200)
S08_SecondaryCorrosion	int
S08_Comments	varchar(300)
S09_Rating	int
S09_PrimaryIssues	varchar(200)
S09_PrimaryCorrosion	int
S09_SecondaryIssues	varchar(200)
S09_SecondaryCorrosion	int
S09_Comments	varchar(300)
S10_Rating	int
S10_PrimaryIssues	varchar(200)
S10_PrimaryCorrosion	int
S10_SecondaryIssues	varchar(200)
S10_SecondaryCorrosion	int
S10_Comments	varchar(300)
S11_Rating	int
S11_PrimaryIssues	varchar(200)
S11_PrimaryCorrosion	int
S11_SecondaryIssues	varchar(200)

Columns

Name	Type
S11_SecondaryCorrosion	int
S11_Comments	varchar(300)
S12_Rating	int
S12_PrimaryIssues	varchar(200)
S12_PrimaryCorrosion	int
S12_SecondaryIssues	varchar(200)
S12_SecondaryCorrosion	int
S12_Comments	varchar(300)
S13_Rating	int
S13_PrimaryIssues	varchar(200)
S13_PrimaryCorrosion	int
S13_SecondaryIssues	varchar(200)
S13_SecondaryCorrosion	int
S13_Comments	varchar(300)
S14_Rating	int
S14_PrimaryIssues	varchar(200)
S14_PrimaryCorrosion	int
S14_SecondaryIssues	varchar(200)
S14_SecondaryCorrosion	int
S14_Comments	varchar(300)
S15_Rating	int
S15_PrimaryIssues	varchar(200)
S15_PrimaryCorrosion	int
S15_SecondaryIssues	varchar(200)
S15_SecondaryCorrosion	int
S15_Comments	varchar(300)
S16_Rating	int
S16_PrimaryIssues	varchar(200)
S16_PrimaryCorrosion	int
S16_SecondaryIssues	varchar(200)
S16_SecondaryCorrosion	int
S16_Comments	varchar(300)

Table: REPAIRS

Columns

	Name	Type
PK	ID	bigint identity
	InspectionID	bigint
	ElementID	varchar(10)
	Priority	varchar(10)
	RepairRecommended	varchar(100)
	RepairCompleted	date

Table: InspectionPhotos

Columns

	Name	Type
PK	ID	bigint identity
	InspectionID	bigint
	PhotoDate	date
	PhotoDescription	varchar(200)
	PhotoUploadPath	varchar(200)
	ImagePhoto	image

Table: InspectionDocuments

Columns

	Name	Type
PK	ID	bigint identity
	InspectionID	bigint
	DocumentDate	date
	DocumentDescription	varchar(200)
	DocumentUploadPath	varchar(200)
	DocumentFileName	varchar(50)
	Document	image

Table: sysdiagrams

Columns

	Name	Type
PK	diagram_id	int identity
U1	name	sysname
U1	principal_id	int
	Version	int
	Definition	image

APPENDIX C DATABASE DOMAINS

The following diagrams show the domain tables for the sign structures database.

Domain_Personnel		
PK	**ID**	**int identity**
	Name	**varchar(50)**
	Number	varchar(10)
	LastName	varchar(30)
	Initials	varchar(10)

Domain_Obstruction		
PK	**ID**	**int identity**
	Code	**varchar(10)**
	Description	varchar(50)

Domain_RouteAux		
PK	**ID**	**int identity**
	Code	**varchar(10)**
	Description	varchar(50)

Domain_RepairPriorityCode		
PK	**ID**	**int identity**
	Code	varchar(10)
	Description	varchar(50)

Domain_ConditionIssues		
PK	**ID**	**int identity**
	Code	**varchar(20)**
	Description	varchar(50)

Domain_RoadType		
PK	**ID**	**int identity**
	Code	**varchar(10)**
	Description	varchar(50)

Domain_StructureType

PK	ID	int identity
	Code Description	varchar(20) varchar(50)

Domain_SupportMaterial

PK	ID	int identity
	Code Description	**varchar(10)** varchar(50)

Domain_Rating

PK	ID	int identity
	Code Description	smallint nvarchar(255)

Domain_MOT

PK	ID	int identity
	Code Description	**varchar(10)** varchar(50)

Domain_SpanMaterial

PK	ID	int identity
	Code Description	**varchar(10)** varchar(50)

Domain_InspectionType

PK	ID	int identity
	Code Description	**varchar(50)** varchar(50)

Domain_Direction

PK	ID	int identity
	Code Description	**varchar(10)** varchar(50)

Domain_Counties		
PK	<u>ID</u>	**int**
	County Name County # District	varchar(50) varchar(2) varchar(2)

Domain_SignType		
PK	<u>ID</u>	**int**
	Code Description	varchar(20) varchar(50)

Domain_YesNo		
PK	<u>ID</u>	**int identity**
	Code Description	**varchar(10)** varchar(20)

Domain_FoundOn		
PK	<u>ID</u>	**int identity**
	Code Description	**varchar(10)** varchar(50)

APPENDIX D ARC PAD INSTRUCTIONS

ArcPad Instructions

Data Entry

1) Turn on the Trimble Nomad by pressing the green button on the lower left of the unit.
2) Use the stylus to click on the ArcPad symbol:

3) ArcPad will automatically open to the map file for this project. It will look something like this:
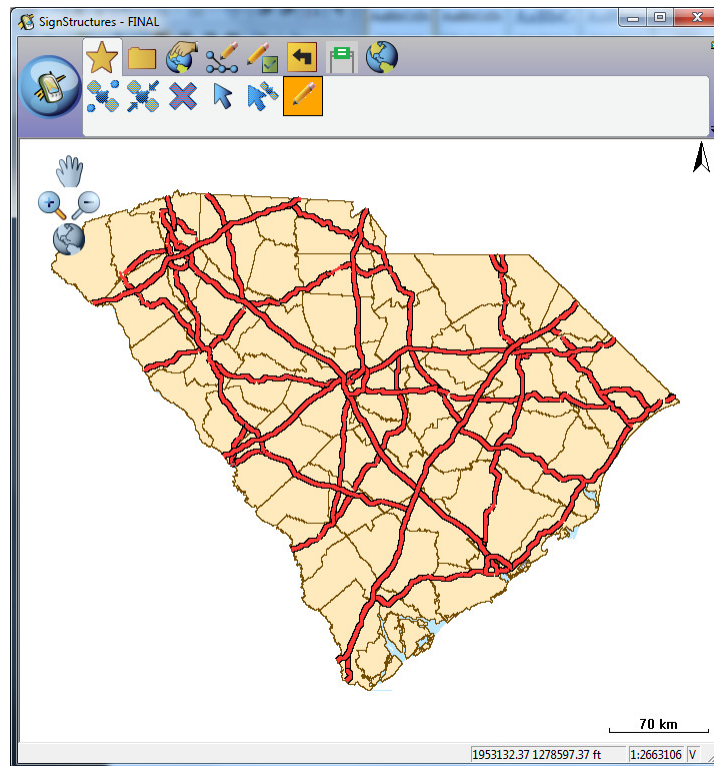
4) The map file will automatically attempt to establish a GPS connection when it opens. This may initially take up to a few minutes. Note that you must be outside and have a relatively open view of the sky.

ArcPad will display a "No Fix" message in a red box while waiting to obtain a GPS signal. When a signal is obtained, the red box will disappear and coordinates will appear on the screen.

5) Most of the ArcPad toolbars are displayed, but most of the time only 2 toolbars will be needed. These are circled in the image below:
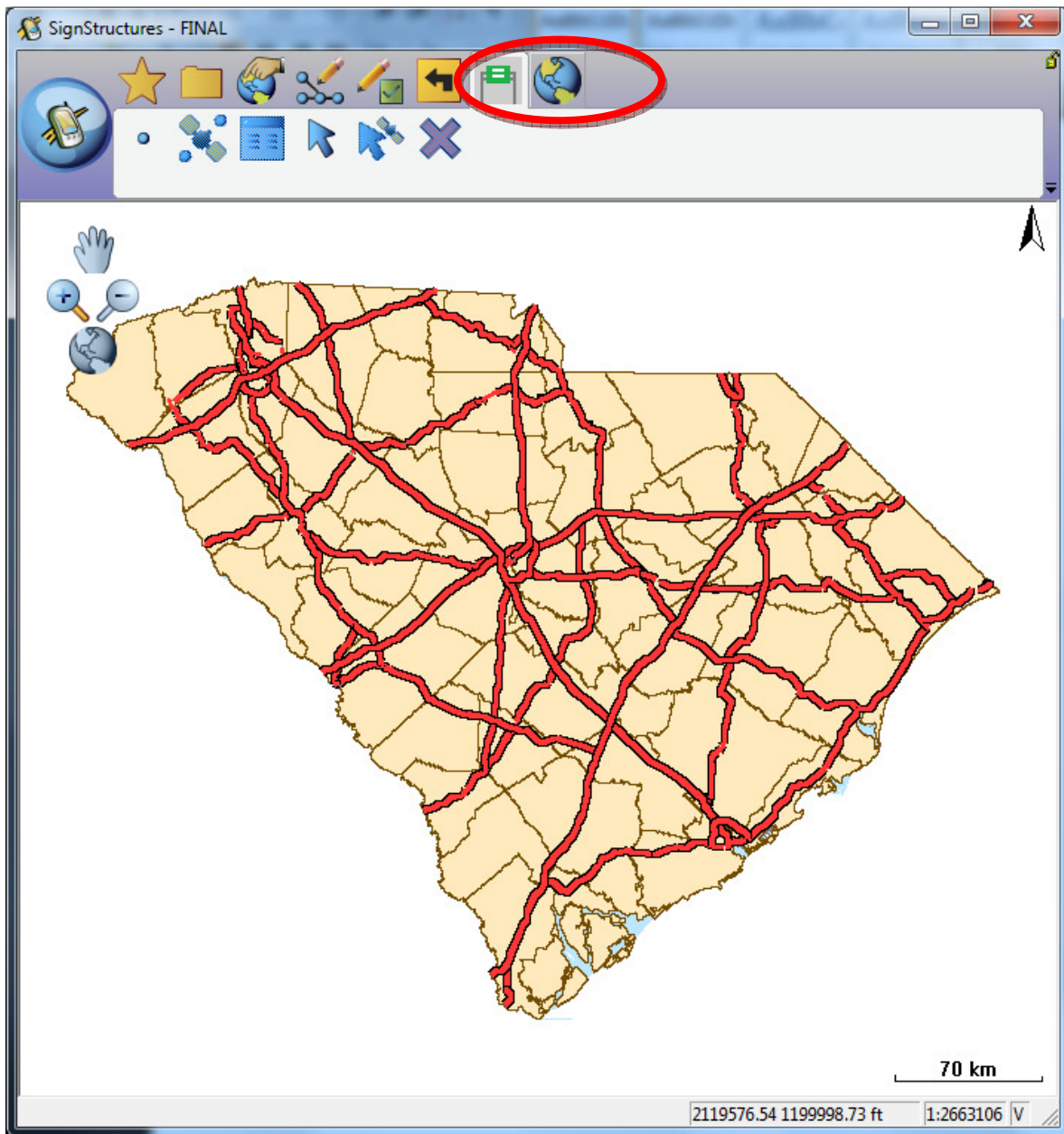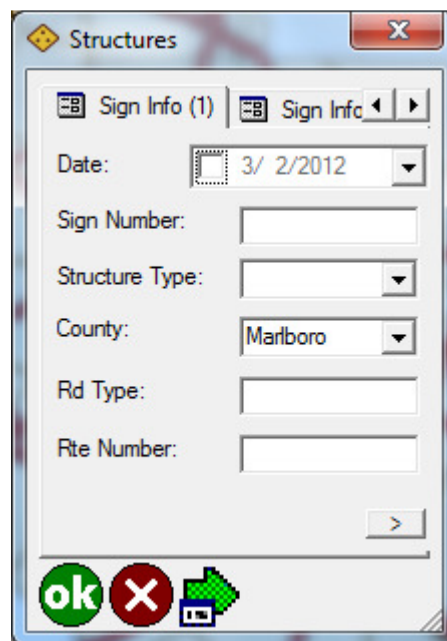
6) The Structures toolbar contains tools for capturing a location and data. Clicking on the icon will display the tools.

Structures Toolbar

Capture Point Feature - Add a point by clicking on the map with the stylus.

Capture Point Feature Using GPS - Add a point by using the current GPS location.

Delete Feature - Delete the selected point.

Edit Attributes - Edit the attributes of a selected point.

Select Point Using GPS - Select a point by using the current GPS location.

Select Point - Select a point by clicking on with the stylus, or by drawing a box around it.

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ENGINEERS INC.

7) To add a feature, select either the **Capture Point Feature** or **Capture Point Feature Using GPS** tool.

> **Capture Point Feature** – Select the tool, then click the point on the map. For the sake of accuracy, it is important to be zoomed in enough to capture a good location. It may take a few seconds for the point to be captured. Once the point has been captured, a form will appear on the screen to allow for attribute input.

> **Capture Point Feature Using GPS** – Upon selecting the tool, a point will be captured at the current GPS location (location of the GPS unit). It may take a few seconds for the point to be captured. Once the point has been captures, a form will appear on the screen to allow for attribute input:

> Note that on the Trimble units the tabs appear at the bottom of the page.

8) To enter data, use the stylus to select an item from a drop-down menu, or use the virtual keyboard (tap lower right of screen) to enter text.

9) To move to another form, either click the arrow buttons and the desired tab, or click the previous/next page buttons:

Tab

Arrow buttons

Previous Page

Next Page
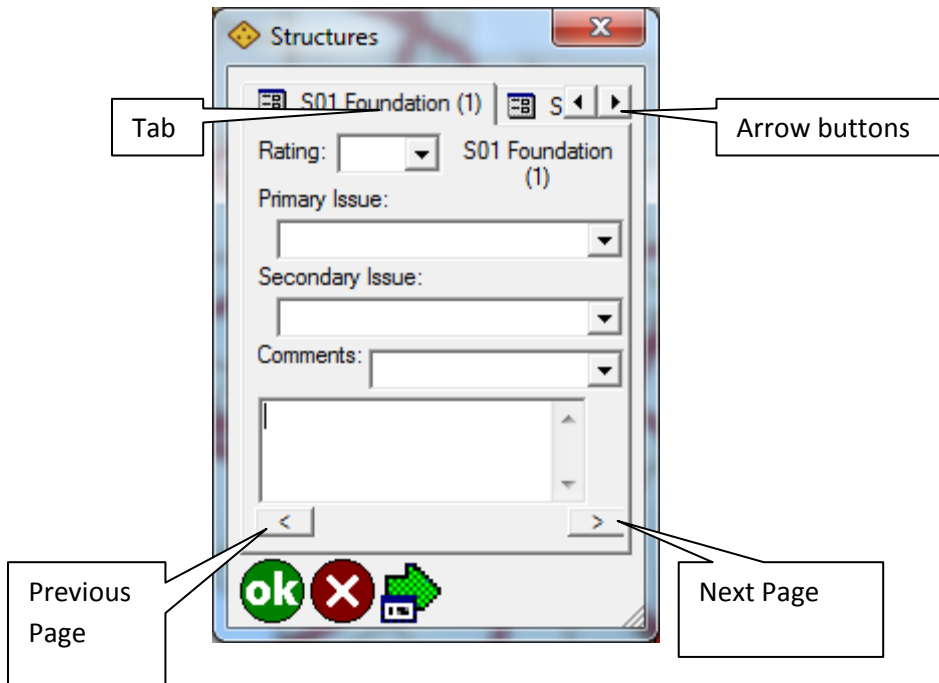
10) There are 4 photo forms:

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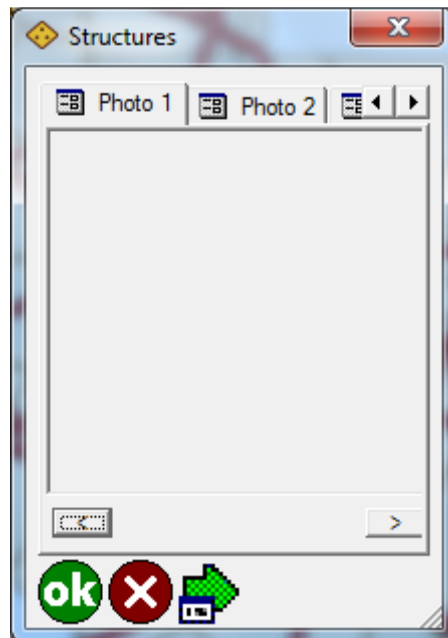
To take a photograph, click on the form to activate the built-in camera, point the front (top) of the unit at the subject, then click the form again to take the picture. The form may need to be refreshed in order to display the photo. To do this, move to the next/previous page and then come back.

11) There is one barcode form:

To capture a barcode, press the right softkey on the unit to activate the scanner, then scan the beam over the barcode. Once captured, the code will appear in the textbox on the form.

Right Softkey – Activates barcode scanner

12) Once the data have been entered into the forms, save and exit by clicking the green OK button on the lower left of the form.
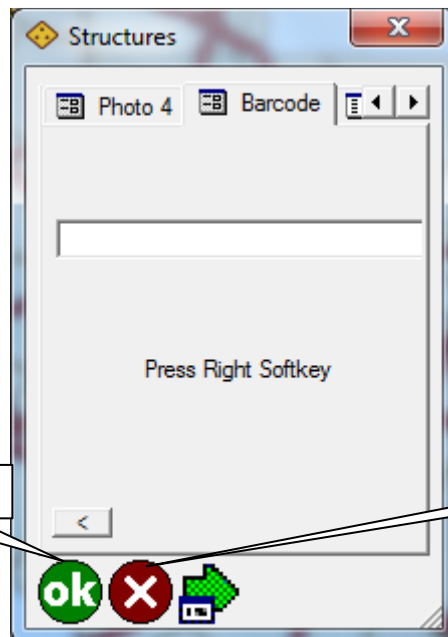
Save and Close.

Exit without saving.

To exit the form without saving, press the red "X" button.

13) Existing points may be selected by using the selection tools. Once a feature is selected, its attributes may be edited by using the **Edit Attributes** tool. This may be necessary if the attribute entry forms were accidentally closed when adding a point.

14) Existing points may be deleted by selecting them and then clicking the **Delete Feature** tool.

Navigation Tools

Navigation Toolbar

Center Map Using GPS – Click tool to center map.

Zoom In – Draw box on map.

Pan – Click and drag on map.

Fixed Zoom Out – Click tool.

Zoom Out – Draw box on map.

Fixed Zoom In – Click tool.
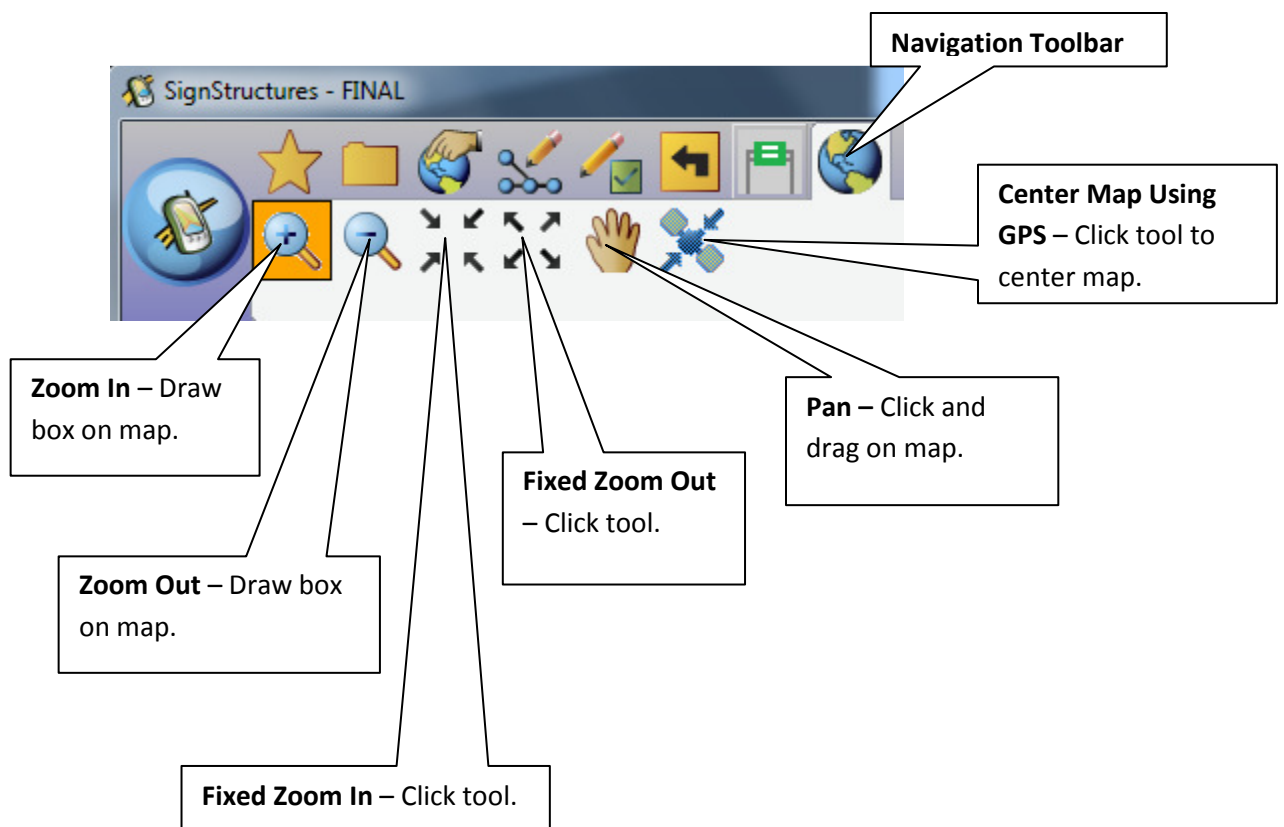
Note that other ArcPad navigation tools are available in the navigation toolbar:

APPENDIX E STAND-OFF GUIDELINES

STANDOFF GUIDELINES					
Cantilever or Butterfly					
DIA	Min (in.)	Max (in.)	Rating	PC	Repair
1"	0"	1.25"	1	NA	NO REPAIR
1"	1.375"	1.5"	2	3	Analysis
1"	1.625"	2.5"	3	2	Analysis
1"	2.625"		4	1	Analysis
1.25"	0"	1.5"	1	NA	NO REPAIR
1.25"	1.625"	1.875"	2	3	Analysis
1.25"	2"	3.125"	3	2	Analysis
1.25"	3.25"		4	1	Analysis
1.5"	0"	1.875"	1	NA	NO REPAIR
1.5"	2"	2.25"	2	3	Analysis
1.5"	2.375"	3.75"	3	2	Analysis
1.5"	3.875"		4	1	Analysis
1.75"	0"	2.187"	1	NA	NO REPAIR
1.75"	2.25"	2.625"	2	3	Analysis
1.75"	2.75"	4.375"	3	2	Analysis
1.75"	4.5"		4	1	Analysis
2"	0"	2.25"	1	NA	NO REPAIR
2"	2.375"	2.5"	2	3	Analysis
2"	2.625"	3.5"	3	2	Analysis
2"	3.625"		4	1	Analysis
2.25"	0"	2.812"	1	NA	NO REPAIR
2.25"	3"	3.375"	2	3	Analysis
2.25"	3.5"	5.625"	3	2	Analysis
2.25"	5.75"		4	1	Analysis
2.5"	0"	3.125"	1	NA	NO REPAIR
2.5"	3.25"	3.75"	2	3	Analysis
2.5"	3.875	6.25"	3	2	Analysis
2.5"	6.375"		4	1	Analysis

STANDOFF GUIDELINES					
Bridge					
DIA	Min (in.)	Max (in.)	Rating	PC	Repair
1"	0"	1.5"	1	NA	NO REPAIR
1"	1.625"	2.5"	2	3	Analysis
1"	2.625"	3.5"	3	2	Analysis
1"	3.625"		4	1	Analysis
1.25"	0"	1.875"	1	NA	NO REPAIR
1.25"	2"	3.125"	2	3	Analysis
1.25"	3.25"	4.375"	3	2	Analysis
1.25"	4.5"		4	1	Analysis
1.5"	0"	2.25"	1	NA	NO REPAIR
1.5"	2.375"	3.75"	2	3	Analysis
1.5"	3.875"	5.25"	3	2	Analysis
1.5"	5.375"		4	1	Analysis
1.75"	0"	2.625"	1	NA	NO REPAIR
1.75"	2.75"	4.375"	2	3	Analysis
1.75"	4.5"	6.125"	3	2	Analysis
1.75"	6.25"		4	1	Analysis
2"	0"	3"	1	NA	NO REPAIR
2"	3.125"	5"	2	3	Analysis
2"	5.125"	7"	3	2	Analysis
2"	7.125"		4	1	Analysis
2.25"	0"	3.375"	1	NA	NO REPAIR
2.25"	3.5"	5.625"	2	3	Analysis
2.25"	5.75"	7.875"	3	2	Analysis
2.25"	8"		4	1	Analysis
2.5"	0"	3.75"	1	NA	NO REPAIR
2.5"	3.875	6.25"	2	3	Analysis
2.5"	6.375"	8.75"	3	2	Analysis
2.5"	9"		4	1	Analysis

Repair for all standoff issues: "Perform anchorage analysis to include effects of standoff."

APPENDIX F LOOSE ANCHOR NUTS GUIDELINES

LOOSE ANCHORAGE NUTS GUIDELINES

Cantilever or Butterfly

# Loose	Total #	Rating	PC
1	4	3	2
2	4	4	2
3 or 4	4	4 – Call	1
1	6	2	3
2	6	3	2
3	6	4	2
4, 5 or 6	6	4 – Call	1
1	8	2	3
2, 3	8	3	2
4, 5	8	4	2
6 to 8	8	4 – Call	1
1, 2	10	2	3
3, 4	10	3	2
5, 6	10	4	2
7 to 10	10	4 – Call	1
1, 2	12	2	3
3, 4, 5	12	3	2
6 to 8	12	4	2
9 to 12	12	4 – Call	1

Bridge - 1P

One Side

# Loose	Total #	Rating	PC
1	4	3	2
2	4	4	2
3 or 4	4	4 – Call	1
1, 2	6	2	3
3	6	3	2
4	6	4	2
5 or 6	6	4 – Call	1
1, 2	8	2	3
3, 4	8	3	2
5, 6	8	4	2
7, 8	8	4 – Call	1
1 to 3	10	2	3
4, 5	10	3	2
6, 7	10	4	2
8 to 10	10	4 – Call	1
1 to 3	12	2	3
4 to 6	12	3	2
7 to 9	12	4	2
10 to 12	12	4 – Call	1

Bridge - 2F

One Side

# Loose	Total #	Rating	PC
1 to 3	8	2	3
4 to 5	8	3	2
6	8	4	2
7 or 8	8	4 – Call	1
1 to 4	12	2	3
5 to 7	12	3	2
8 to 9	12	4	2
10 to 12	12	4 – Call	1
1 to 5	16	2	3
6 to 9	16	3	2
10 to 12	16	4	2
13 to 16	16	4 – Call	1

Bridge - 2F

Single Base Plate

# Loose	Total #	Rating	PC
4	4	4 - Call	1
5, 6	6	4 - Call	1
7, 8	8	4 - Call	1

Repair for all loose nuts: "Tighten all anchor and leveling nuts."

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