Title:	Overhead Mid-Size Variable Message Sign (VMS) Support Structure - Structural Implementation
Division:	Transportation Infrastructure Management (TIM)
Branch:	Standards and Contracts Branch (SCB)
Office:	Structures Office
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Implementation

This Policy with its attachments shall be effective upon the issuance of this memorandum and will be incorporated in the next revision of the Sign Support Manual.

Background

New standard drawings for VMS overhead sign support structures have been developed for mid-sized VMS units. The mid-size units are smaller than the full-size units and have a different aspect ratio. The size and details of supporting legs and the foundations are the same as the current full-size VMS standards. This interchangeability between different VMS sizes offers enhanced flexibility, efficiency, and cost benefits for the deployment of sign structures. It also simplifies maintenance and repairs, as the same design and installation procedure can be applied across both VMS sign sizes.

The limit state design of the new structure is performed in accordance with CSA S6-19 (CHBDC) and the fatigue design is based on AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals. The support truss structure has been designed for VMS components that meet the following criteria:

1. Spans from 17592 to 34000 mm.

2. Maximum sign area of 21 square metres and a reference wind pressure of 600 Pa at a return period of 50 years.

3. Overall depth and width of the sign component of 2695 and 7700 mm respectively.

4. Maximum sign weight of 3000 kg including the internal aluminum truss.

Policy

Sign Support Manual Section (8): VARIABLE MESSAGE SIGN SUPPORTS (VMS) has been revised to include the above design changes and is attached to this memo. All related standard structural drawings (SSD 118-120, 118-121, 118-122, and 118-123) have been created to reflect the above design changes and will be available in the Contract Preparation System (CPS).

All new designs, designs underway, and stockpiled designs shall follow the requirements of this memorandum. Structures in contracts that are out for tender or contracts underway may be changed at the discretion of the Heads of the Regional Structural Sections.

Consultants working on ministry designs should be notified of these requirements by the project manager responsible for the assignment.

Approved By

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List of Appendices

Sign Support Manual Section 8: Variable Message Sign Supports (VMS)

8 VARIABLE MESSAGE SIGN (VMS) SUPPORT

8.1 GENERAL

8.1.1 STANDARD SIGN SUPPORTS

8.1.1.1 FULL SIZE VMS OVERHEAD TRUSS

Full size VMS overhead truss sign supports are used to support VMS systems. The overhead truss is fabricated in aluminum, and the vertical support legs in galvanized structural steel. They are designed to the requirements of the CSA S6-14 (CHBDC).

The sign supports contained in this Section are designed for VMS components and site conditions that meet the following criteria:

(a) Spans from 17592 to 34000 mm.

(b) Maximum total sign area of 40 square metres for a reference wind pressure of 600 Pa at a return period of 50 years. The effect of wind funnelling due to special topographical features such as deep valleys is not considered (CHBDC 3.10.1.2).

(c) Overall depth of sign component of 3075 mm.

(d) Overall width of sign component of 13220 mm.

(e) Maximum weight of sign component is 5000 kg.

(f) Location of supports and vertical clearances according to the requirements of the CHBDC and MTO Design Supplement for TAC Geometric Design Guide for Canadian Roads - 2017.

(g) Competent soil conditions (as described in Section 8.5.4) excluding rock fill.

8.1.1.1 MID-SIZE VMS OVERHEAD TRUSS

Mid-size VMS overhead truss sign supports are used to support VMS systems. The overhead truss is fabricated in aluminum, and the vertical support legs in galvanized structural steel. They are designed to the requirements of the CSA S6-19 (CHBDC).

The sign supports contained in this Section are designed for VMS components and site conditions that meet the following criteria:

(h) Spans from 17592 to 34000 mm.

(i) Maximum total sign area of 21 square metres for a reference wind pressure of 600 Pa at a return period of 50 years. The effect of wind funnelling due to special topographical features such as deep valleys is not considered (CHBDC 3.10.1.2).

(j) Overall depth of sign component of 2695 mm.

(k) Overall width of sign component of 7700 mm.

(l) Maximum weight of sign component is 3000 kg.

(m) Location of supports and vertical clearances according to the requirements of the CHBDC and MTO Design Supplement for TAC Geometric Design Guide for Canadian Roads - 2017.

(n) Competent soil conditions (as described in Section 8.5.4) excluding rock fill.

8.1.1.2 POLE MOUNTED VMS

Pole mounted VMS supports are used to support portable type VMS boards. The sign supports are fabricated in structural steel, and designed to the requirement of the CSA-S6-14 (CHBDC).

The supports are designed for VMS components and site conditions that meet the following criteria:

(a) Maximum sign board area of 15 square metres for a reference wind pressure up to 600 Pa at a return period of 50 years.

(b) Maximum depth of sign component of 3000 mm.

(c) Maximum width of sign component of 5000 mm.

(d) Maximum weight of sign component of 1000 kg.

(e) Location of supports and vertical clearances according to the requirements of the CHBDC and MTO Design Supplement for TAC Geometric Design Guide for Canadian Roads - 2017.

(f) Competent soil conditions (as described in Section 8.5.4) excluding rock fill.

8.1.2 LIMITATIONS

For economic and practical reasons, these supports should be placed as close as possible to the edge of the travelled portion of the highway. Therefore, the supports will probably be in the clear recovery zone and should be protected as discussed in Section 2.6. They could also be located on median barriers.

For ground mounted footings, the top of footing elevation shall be a minimum of 300 mm above the finished grade. This could be increased up to 1000 mm in order to limit the leg height. The dimensions from the top of the footing to the centreline of the full and mid-size VMS overhead truss shall not exceed 7500 mm, and to the bottom of portable VMS board shall not exceed 6500 mm.

8.1.3 DESCRIPTION OF SIGN SUPPORTS

8.1.3.1 VMS OVERHEAD TRUSS

The full size and mid-size VMS sign support structures are comprised of two vertical support legs and a rectangular overhead space truss. The vertical support legs are fabricated from structural steel, and the overhead truss from aluminum. The overhead truss is comprised of two end components (left and right) and one sign component. The system is fabricated based on specific site requirements. These supports are designed for ground mounting or supported on concrete median barriers. The typical layout plan and elevation are shown in Figures 8.1.3(a) and (b), respectively for full size and Figures 8.1.3 (c) and (d) respectively for mid-size.

The vertical support legs are made of rectangular HSS sections (column shafts) and from square HSS sections (bracing and struts). All components are interconnected by moment and shear welded connections. The column shafts are connected at the base to concrete footings by a bolted anchorage. The column lengths of the supports are not standard. At a particular location the legs may be of different heights to ensure the truss is installed horizontal.

The overhead truss in the span is made of aluminum square tubes. All components are interconnected by moment and shear welded connections. The VMS structure (sign component) is built-in to the overhead truss (walk-in VMS). The aluminum overhead truss ends are connected to the structural steel legs by a hinge type connection with a neoprene pad and stainless steel bolts.

All structural steel components, other than stainless steel bolts, nuts, and

washers, are hot-dip galvanized after fabrication. The support legs and base plates are subsequently coated with an approved paint system.

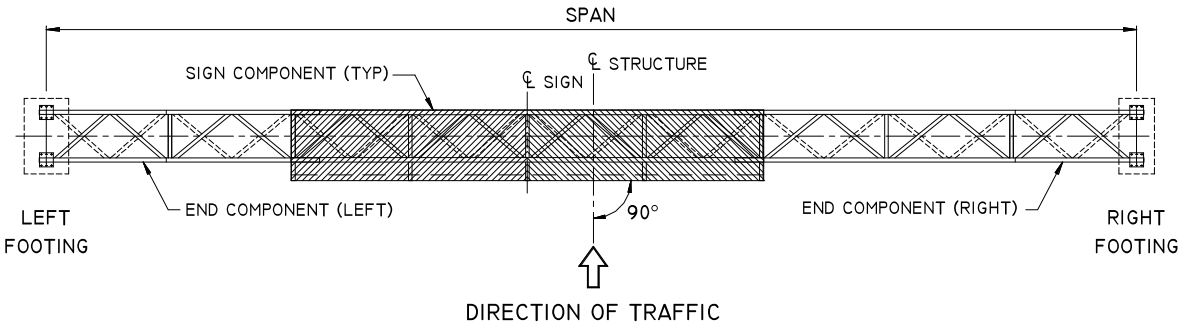

FIGURE 8.1.3(a) TYPICAL FULL SIZE VMS OVERHEAD TRUSS LAYOUT PLAN

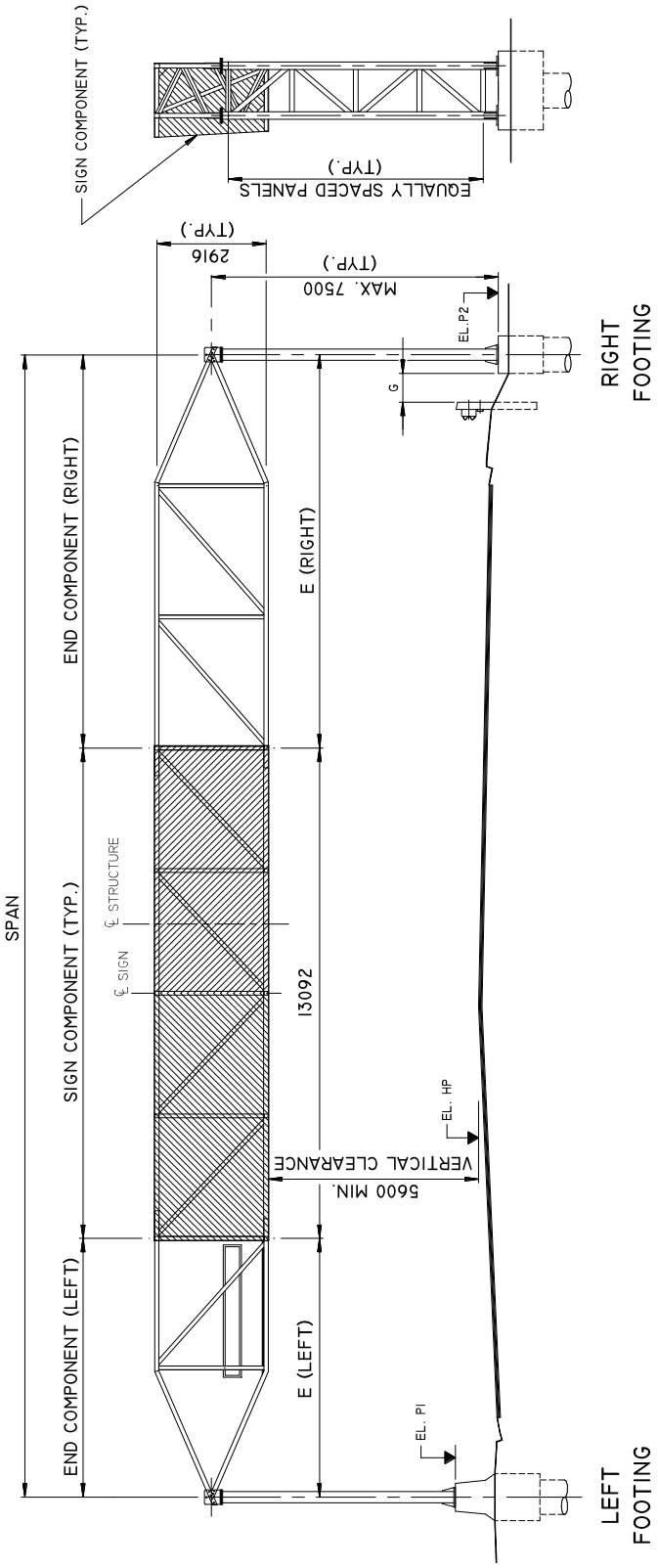

FIGURE 8.1.3(b) TYPICAL FULL SIZE VMS OVERHEAD TRUSS SUPPORT ELEVATION

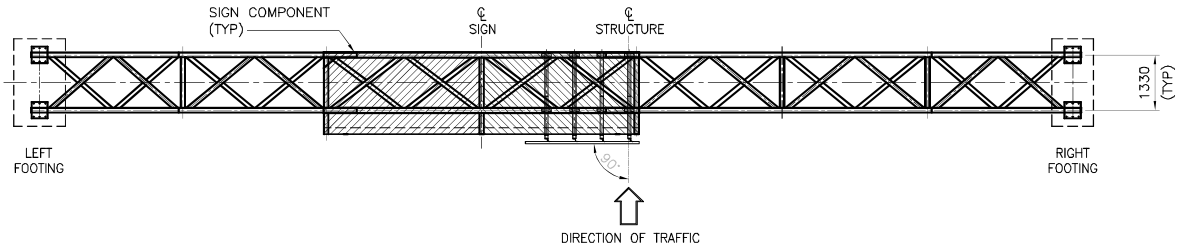

FIGURE 8.1.3(c) TYPICAL MID-SIZE VMS OVERHEAD TRUSS LAYOUT PLAN

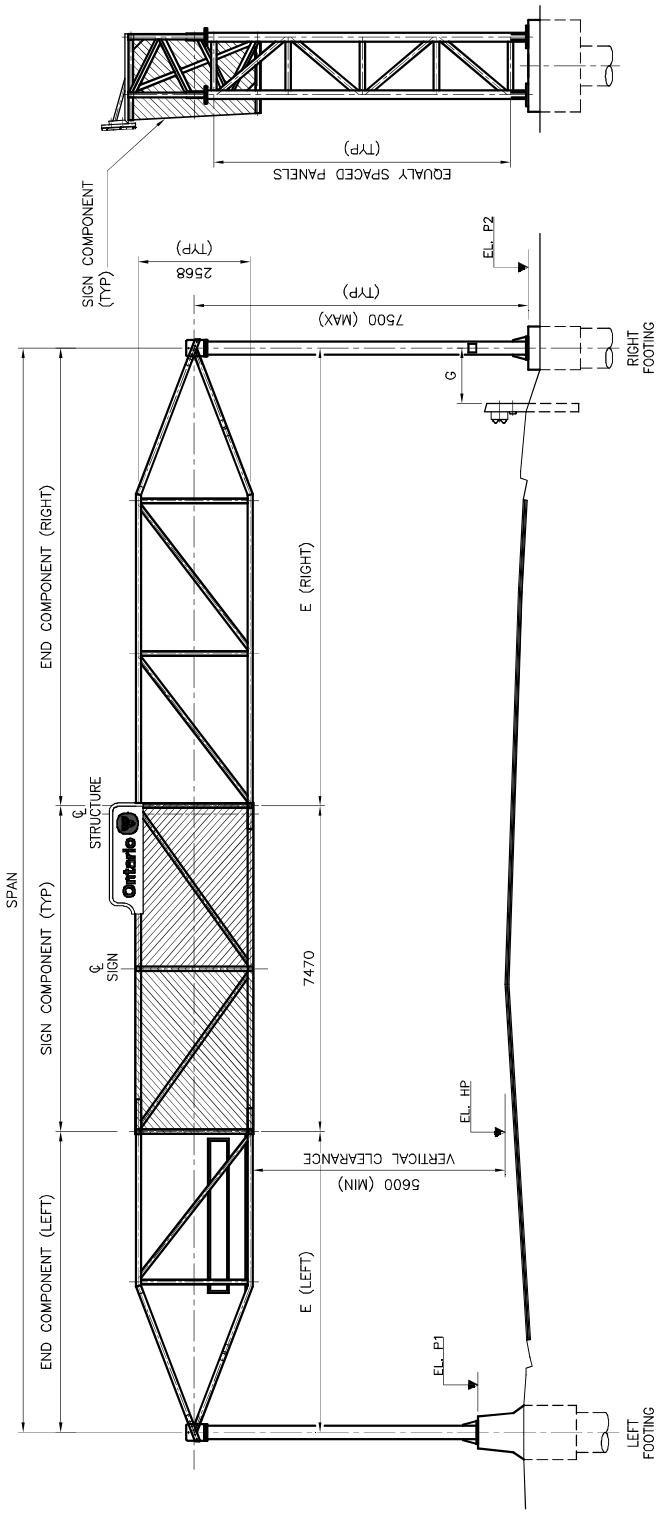

FIGURE 8.1.3(d) TYPICAL MID-SIZE VMS OVERHEAD TRUSS SUPPORT ELEVATION

8.1.3.2 POLE MOUNTED VMS

This sign support is fabricated from structural steel and comprise a single vertical pole. It is designed for ground mounting or supported on concrete median barriers. The typical layout plan and sign support elevation are shown in Figures 8.1.3(c) and (d) respectively.

The vertical support member is straight and made from round HSS or octagonal shape sections. Fabricators may choose to fabricate the octagonal shape from steel plate. Octagonal sections have to meet the requirements shown on Standard Drawings SS118-11 and SS118-13. The maximum allowable length of the vertical support, assumed in design, is 8750 mm. It is connected at the base to a concrete footing by a bolted anchorage system.

The VMS board is mounted to the pole by means of hot-dip galvanized steel brackets attached to the pole. The location and connection details are required to be designed by Fabricator to suit the type of VMS selected.

All structural steel components, other than stainless steel bolts, nuts, and washers, are hot-dip galvanized after fabrication. The pole and base plate are subsequently coated with an approved paint system.

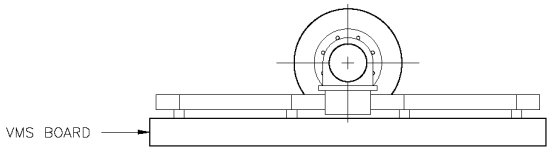

FIGURE 8.1.3(c)
TYPICAL POLE MOUNTED VMS LAYOUT PLAN

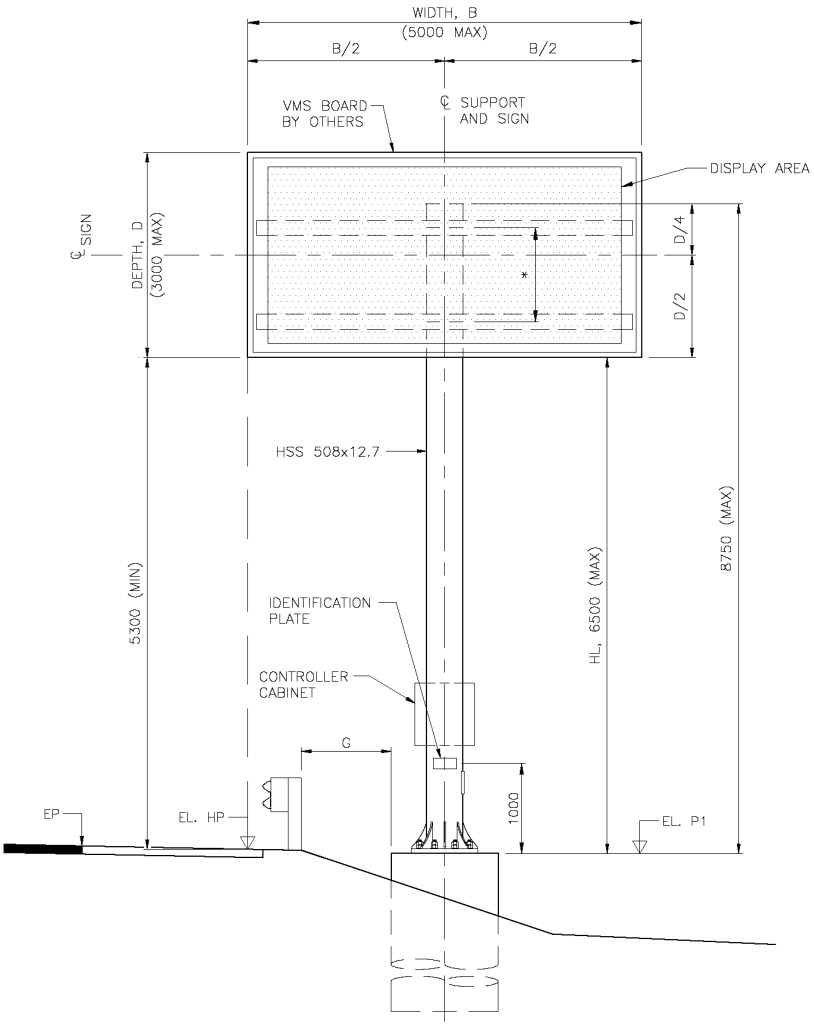

FIGURE 8.1.3 (d)
TYPICAL POLE MOUNTED VMS SUPPORT ELEVATION

8.1.4 FOOTINGS

Each sign support footing consists of a single reinforced concrete caisson. Details differ according to their location, and generally are of two types, as shown on the standard drawings: ground mounted and median mounted. (see Standard Drawings SS118-3, SS118-4, and SS118-5 for pole mounted VMS supports; SS118-6, SS118-7, and SS118-8 for VMS overhead truss supports).

The indicated footing depths are the minimum required for each support. Footing proportions apply to competent soil conditions of uniform composition. Parameters upon which the design is based are given in Section 8.5.4.

Encountered soil conditions such as rock fill, land fill, and soft material are not covered here and require the footing to be designed by an Engineer.

8.1.5 CLEARANCE

For ground mounted footings, the minimum horizontal clearance ‘G’ from the back of traffic protection barrier to the nearest face of sign support footing shall not be less than the values specified in Figure A3.2 (see Appendix to Section 3).

The minimum vertical clearance from the bottom of the sign component to the highest point on the highway, including shoulders, curbs, and medians, shall not be less than 5600 mm for VMS overhead truss, and 5300 mm for pole mounted VMS under dead load deflection.

8.1.6 SUPPLY AND ERECTION

For a temporary installation, a Tri-Chord overhead truss (Section 4) with the same span as a prospective VMS truss structure could be mounted on the VMS support legs. A connection detail for this assemblage is shown on Standard Drawing SS118-36.

Construction shall meet the requirements of OPSS 915, Construction Specification for Sign Support Structures, and associated Special Provisions.

Each sign support structure shall have a corrosion-protected identification plate showing the site number (formerly structure ID number), the manufacturer’s name or the trademark, and the date of manufacture.

8.2 PROCEDURES

8.2.1 GENERAL

The sign support structures are fabricated from shop drawings based on the standard drawings on a site-specific basis.

The design of the VMS overhead sign support structure is based on a reference wind pressure of 600 Pa. The geometric layout of the overhead truss shall depend on the location of the sign component along the span of the structure, in relation to the travelled portion of the highway (see Standard Drawing SS118-36). Multiple combinations of end components (left/right) and sign components can be obtained, as shown in Figure 8.2.1. The length of panel for the end components will vary, within certain limits, in every structure. The length of panel for the sign component is fixed. Design dimensions (structural sections) for end and sign components are fixed, and are given on the Standard Drawings SS118-37 and SS118-38.

The design of the pole mounted VMS support is based on a reference wind pressure of 600 Pa. Design dimensions are given on the Standard Drawings SS118-11 and SS118-13.

8.2.2 DATA REQUIRED

For each VMS sign support, the following data is required:

(1) The span (for overhead truss).

(2) The site location of the structure. For a proposed highway or a highway under reconstruction, the location should be specified as a station.

(3) The location of the sign component along the longitudinal centreline of the structure (for overhead truss).

(4) The elevation of the highest point on the highway under the sign component, and the final ground elevations under the sign structure.

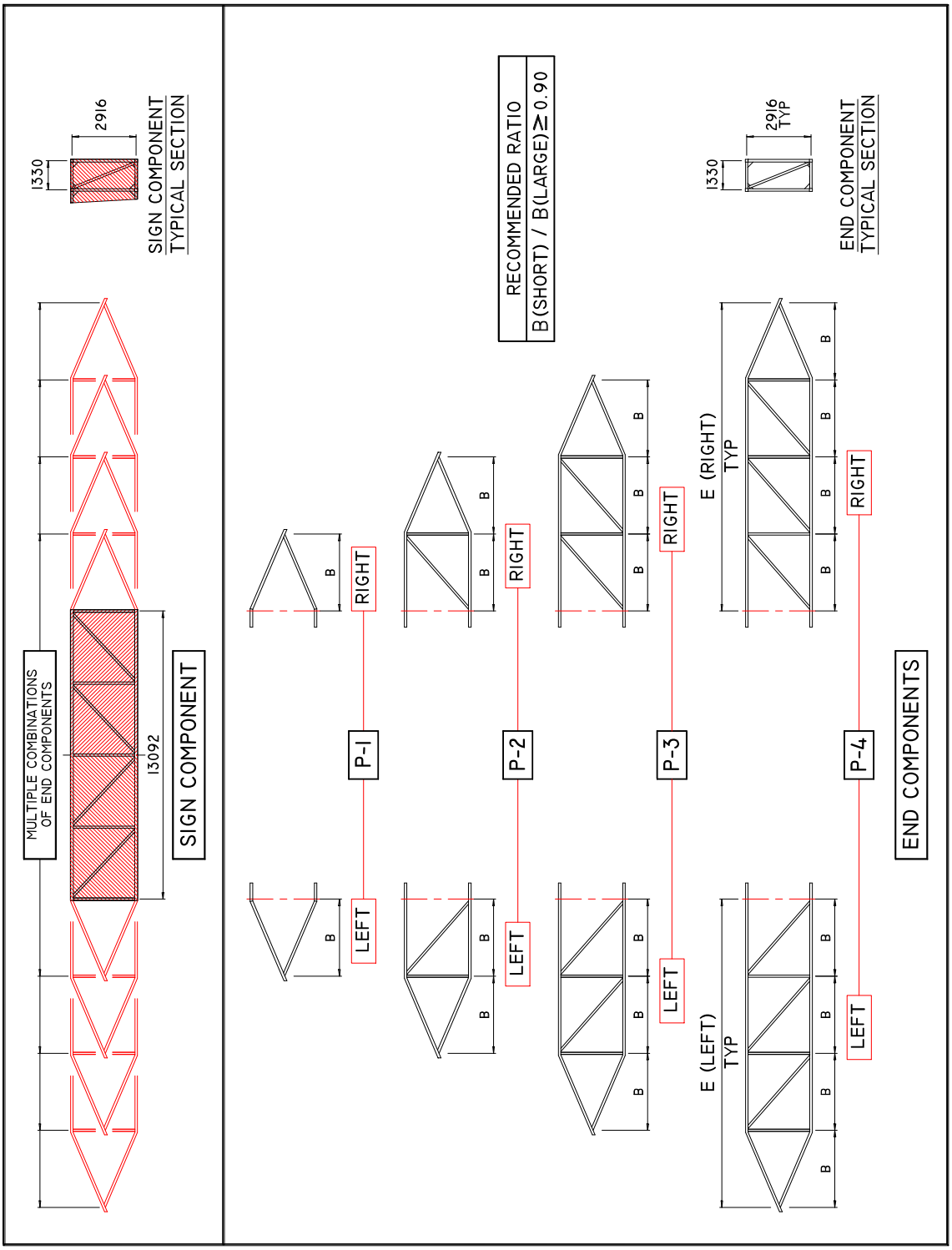

FIGURE 8.2.1 VARIABLE MESSAGE SIGN SUPPORT LAYOUT COMBINATIONS

8.2.3 PROCEDURE FOR DESIGN OF VMS SIGN SUPPORT STRUCTURES

CASE 1 – FULL SIZE VMS OVERHEAD TRUSS (MID-SIZE VMS OVERHEAD TRUSS SIMILAR)

GIVEN: SPAN AND LOCATION OF SIGN COMPONENT
Example: a span of 27990 mm, and a distance of 12138 mm from the centreline of the left leg to the centreline of the sign component.

STEP 1: OBTAIN THE LENGTH OF THE END COMPONENTS.
E.g., The distance between centreline of end verticals of the sign component is 13092 mm. The sign component is centered at 12138 mm from the left leg. Therefore, the dimension from the centreline of the left leg to the left end vertical of the sign component, E_{left}, is equal to 12138-13092/2 = 5592 mm. Based on the given span, E_{right} is equal to 27990 – 13092 – 5592 = 9306 mm.

STEP 2: OBTAIN THE LENGTH OF PANELS
The number of panels for each end component should be kept to a minimum. The length of the panel, b, for a given end component shall be a constant value, and within the following limits: $2250 \leq b \leq 3600$ mm.
E.g., B (LEFT) = 5592/2 = 2796 mm, and B (RIGHT) = 9306/3 = 3102 mm.

STEP 3: CHECK BOUNDARY CONDITIONS

(a) The maximum length of the vertical support leg from the top of the footing to the centreline of the overhead truss shall be 7500 mm.

(b) The dimension measured from the highest point on the highway, EL.HP, to the bottom of the sign component shall be equal to or greater than 5600 mm.

(c) For static and aesthetic reasons, the ratio between the length of panel in both end components should be kept as close to 1 as possible. The minimum recommended value is 0.9. A minor relocation of the sign component may be required.
E.g., 2796/3102 = 0.9

STEP 4: COMPLETE THE STANDARD DRAWINGS

Refer to 8.3 for Preparation of Drawings.

CASE 2 – POLE MOUNTED VMS

GIVEN: VMS SIZE AND LOCATION OF SIGN COMPONENT
Example: 4000 mm x 2200 mm VMS board.

STEP 1: CHECK BOUNDARY CONDITIONS

(a) The maximum length of the vertical support leg from the top of the footing to the bottom of VMS board shall not exceed 6500 mm.

(b) The dimension measured from the highest point on the highway, EL.HP, to the bottom of the sign component shall be equal to or greater than 5300 mm.

If any of the above conditions are not satisfied, the initial design parameters must be revised.

STEP 2: COMPLETE THE STANDARD DRAWINGS

Refer to Section 8.3 for Preparation of Drawings.

8.3 PREPARATION OF DRAWINGS

8.3.1 DATA REQUIRED

Prior to design, a “Key Plan and Frame Dimension” drawing(s) must be prepared to enable the working drawings to be detailed. This drawing(s) will form part of the contract document and must show, for one or more structures, the following information:

(1) A key plan, indicating the approximate location of each support.

(2) The Site Number.

(3) The support span measured from centreline to centreline of leg (for overhead truss)

(4) The control line or the centreline of the roadway, and the offset of the left leg from the control line.

(5) The elevation of the highest point on the roadway surface under the support structure.

(6) The dimension measured from the highest point (EL.HP) on the roadway surface to the bottom of the sign component. This height shall not be less than 5600 mm for overhead truss and 5300 mm for pole mounted VMS.

(7) The dimensions from the top of the footing (EL.P1 or EL.P2) to the centreline of the VMS overhead truss shall not exceed 7500 mm, and to the bottom of portable VMS board shall not exceed 6500 mm

(8) The top of footing elevation. This elevation can differ for each leg, if required. The elevation shall be a minimum of 300 mm above the ground line. This could be increased up to 1000 mm in order to limit the column leg height as stated in (7).

(9) The elevation of the ground line at each footing.

(10) The offset of the centreline of each footing from the control line, either as a note or as a dimension.

(11) The station of the support structure on a designated highway centreline or control line.

(12) A designation for each footing as a “Left Footing” or “Right Footing”. Left and Right for this purpose are defined as if looking in the direction of the traffic, as shown in Figure 8.1.3(a).

(13) The footing type for each sign support footing (see Section 8.1.4). For ground mounted footings, the dimension ‘G’ from the front face of the traffic protection barrier to the leg or the footing, whichever is closer (see Section 8.1.5).

(14) For the sign component, the following additional information is required:
- An outline in dashed line showing the sign component,
- The requested location of the sign component with respect to the centreline of the left column.

8.3.2 SIGN SUPPORT DRAWINGS

If the supports are to be supplied and erected as part of a contract, the following Standard Drawings must be used: SS118-11, SS118-13, SS118-36, SS118-37, SS118-38, SS118-120, SS118-121, SS118-122, or SS118-123 for the structure; SS118-3, SS118-4, SS118-5, SS118-6, SS118-7 or SS118-8 for the footings. Up to 10 sign supports can be detailed on one sheet.

The Appendix contains reduced prints of these drawings, showing what information needs to be added. The Contract and W.P. numbers should be added to the title block. The sheet number is added when the drawings for the entire contract are assembled.

On Standard Drawings SS118-11, SS118-13, SS118-36, and SS118-120 there is a table to be completed on the drawing. In the table, one vertical column of data is used for each sign.

The Standard Drawings shall be sealed, dated and signed according to 2.4.1.

The data required to complete Table 1 on Standard Drawing SS118-36, and SS118-120 consists of the following:

(i) Station
(ii) Site Number
(iii) The support span measured from centrelines of support legs
(iv) Truss Diagram. The electronic file of the Standard Drawing SS118-36 contains schematic sign and end components drawn on the left border that shall be used to fill this box.

(v) End Component (Left):
Type of Panel (P-1, P-2, P-3 or P-4)
E (Left): dimension from centreline of left column to left end vertical of sign component.
B (Left): length of panel
End Component (Right):
Type of Panel (P-1, P-2, P-3 or P-4)
E (Right): dimension from centreline of right column to right end vertical of sign component.
B (Right): length of panel

(vi) Elevation of the highest point on the highway under the sign, including shoulders, curbs and median, EL.HP

(vii) Elevation at top of the left support footing, EL.P_1

(viii) Elevation at top of the right support footing, EL.P_2

(ix) Door Side (Left/Right).

(x) Left Footing Type (see Section 8.1.4)

(xi) Right Footing Type (see Section 8.1.4)

The data required to complete Table 1 on Standard Drawings SS118-11 and SS118-13 consist of the following:

(i) Frost Depth; may be obtained from Appendix to Section 2 in this manual if the recommendations of a geotechnical engineer are not available

(ii) Station

(iii) Site Number

(iv) Sign Size (DxB)

(v) Footing Type (see Section 8.1.4)

(vi) Dimension between top of footing and bottom of sign board, H_L

(vii) Barrier to support clearance, G (see Section 8.1.5)

(viii) Elevation at top of the support footing, EL.P1

(ix) Elevation of the highest point on the highway under the sign, including shoulders, curbs, and median, EL.HP

8.4 MAINTENANCE AND INSPECTION

All components must be properly inspected and maintained according to the requirements described in the Sign Support Inspection Guidelines, 2002.

Long term durability of sign supports is dependent on routine maintenance and inspection. In order to prevent corrosion damage and fatigue problems to the base plate and the anchorage assembly, and to allow for proper inspection of the assembly, the following shall be ensured:

(i) The base of the vertical support leg shall be kept free from dirt and debris.
(ii) The top of the footing shall be a minimum of 300 mm above the ground surrounding it.
(iii) The connection welds shall be inspected regularly for fatigue cracking. Check tightening of connection and anchor bolts periodically.

8.5 DESIGN INFORMATION

8.5.1 GENERAL

Design and detailing data for the Full Size VMS Overhead Truss and the Pole Mounted VMS contained in this Section conforms to the requirements of the CSA-S6-14 (CHBDC). Design and detailing data for the Mid-Size VMS Overhead contained in this Section conforms to the requirements of the CSA-S6-19 (CHBDC)

Properties for structural materials used in calculations are based on Standard CSA-G40.20-13/G40.21-13 Grade 300W or 350W structural steel, Alloy 6061-T6 aluminum extruded tube and plates, 30 MPa concrete, and Grade 400W reinforcing steel for footings, as stipulated in the Standard Drawings.

The maximum weight of the full size overhead sign component, which includes the self-weight of the aluminum truss, shall not exceed 5000 kg. The maximum weight of the mid-size overhead sign component which includes the self-weight of the aluminum truss, shall not exceed 3000kg. The maximum weight of the portable VMS board shall not exceed 1000 kg.

In the VMS overhead truss, all bolts, nuts, and washers shall be stainless steel and conform to ASTM F593 Alloy 304, with a minimum yield of 480 MPa and a minimum tensile strength of 715 MPa. In the pole mounted VMS, all bolts, nuts, and washers shall conform to ASTM F3125/F3125M and be hot-dip galvanized in accordance with OPSS 911.

Wind loads, design, and detailing for fatigue were in accordance with AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, 2015, including the 2017 Interim Revisions, unless otherwise stated.

8.5.2 DESIGN DIMENSIONS

The design dimensions for the VMS overhead truss sign supports found in

the Standard Drawings were developed by determining the member responses under various design spans and wind loads. Member responses were checked for ultimate, serviceability, and fatigue limit states. The analysis was then confirmed with the use of a three-dimensional finite element model.

8.5.3 DEFLECTIONS

The deflections for both vertical and horizontal members of the VMS overhead truss support system are limited for clearance concerns as well as for aesthetic purposes. The vertical deflection of horizontal supports are limited to 1% (L/100), and horizontal deflection of vertical supports were restricted to 2% (L/50). Both limitations are well within the suggested limits provided in AASHTO's "LFRD Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals", 2015, which allows 2.5% lateral movement or 1º40' angular rotation from the centreline at the top of the structure in relation to the centreline at its base.

The maximum lateral deflection of the pole mounted VMS due to wind load has been limited to 1.5% of pole height. The lateral deflection of the concrete foundation has been limited to an instantaneous rotation of 0.01 radians (0º30') under wind load.

8.5.4 FOUNDATIONS

The caisson foundations were modelled in S-Frame as beam elements with spring constants representing earth pressure. Springs constants in the dead load direction (for sustained load) were assumed to be 1/3 the value of those in the live load direction (for instantaneous load). Any resisting earth pressure in the frost depth layer was discounted.

Assumed soil parameters below the frost layer are as follows:

		CASE 1 (Sand)	**CASE 2** (Soft Clay)
LENGTH OF CAISSON BELOW FROST LAYER	**Upper 2/3**	$\Phi' = 28^{o}$	$C_u = 25$ kPa
	Lower 1/3	$\Phi' = 30^{o}$	$C_u = 50$ kPa

APPENDIX TO SECTION 8

VARIABLE MESSAGE SIGN SUPPORTS

SS118-6 VARIABLE MESSAGE SIGN (VMS) SUPPORT FOOTING DETAILS - GROUND MOUNTED

SS118-7 VARIABLE MESSAGE SIGN (VMS) SUPPORT MEDIAN MOUNTED FOOTING - SYMMETRICAL

SS118-8 VARIABLE MESSAGE SIGN (VMS) SUPPORT MEDIAN MOUNTED FOOTING - ASYMMETRICAL

SS118-11 POLE MOUNTED VARIABLE MESSAGE SIGN SUPPORT GENERAL ARRANGEMENT (GROUND MOUNTED)

SS118-13 POLE MOUNTED VARIABLE MESSAGE SIGN SUPPORT GENERAL ARRANGEMENT (MEDIAN MOUNTED)

SS118-36 VARIABLE MESSAGE SIGN (VMS) SUPPORT GENERAL ARRANGEMENT

SS118-37 VARIABLE MESSAGE SIGN (VMS) SUPPORT END COMPONENT - DETAILS

SS118-38 VARIABLE MESSAGE SIGN (VMS) SUPPORT SIGN COMPONENT – DETAILS

SS118-120 MID-SIZE VAARIABLE MESSAGE SIGN (VMS) SUPPORT STRUCTURE GENERAL ARRANGEMENT

SS118-121 MID-SIZE VARIABLE MESSAGE SIGN (VMS) SUPPORT STRUCTURE END COMPONENT - DETAILS

SS118-122 MID-SIZE VARIABLE MESSAGE SIGN (VMS) SUPPORT END COMPONENT - DETAILS

SS118-123 VARIABLE MESSAGE TRILLIUM SIGN TAB

NOTE

See Appendix to Section 4 for reduced size prints of the following Standard Drawings for the Pole Mounted VMS support footing details.