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39.1 General

WisDOT policy item:

The design for sign structures shall be in accordance with the *AASHTO Standard Specifications, 17th Edition*.

Signing is an integral part of the highway plan and as such is developed with the roadway and bridge design. Aesthetic as well as functional considerations are essential to sign structure design. Supporting sign structures should exhibit clean, light, simple lines which do not distract the motorist or obstruct his view of the highway. In special situations sign panels may be supported on existing or proposed grade separation structures in lieu of an overhead sign structure. Aesthetically this is not objectionable if the sign does not extend below the girders or above the top of the parapet railing. Some of the more common sign support structures are shown in the following figure.

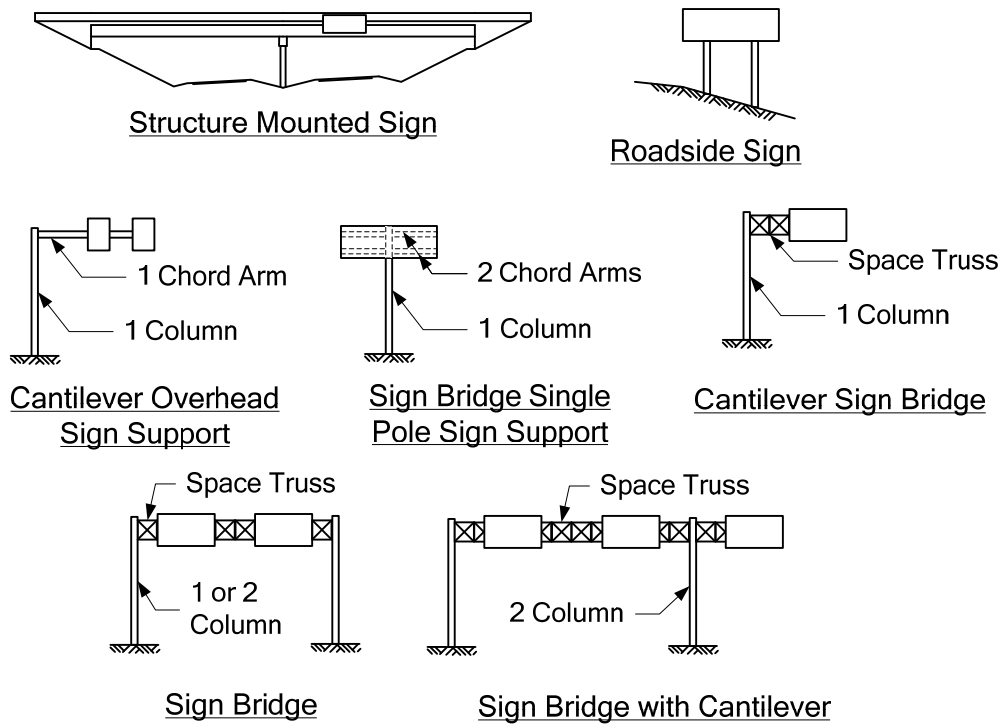


Figure 39.1-1
Sign Support Structures

39.1.1 Signs on Roadway

Roadside sign supports are located behind existing or planned guardrail as far as practical from the roadway out of the likely path of an errant vehicle. If roadside signs are located within the 30 foot corridor, break-away sign supports are detailed. Wisconsin has experienced that the upper hinge on ground mounted signs with break-away supports does



not work and it is not used. Since FHWA has not approved this removal, the hinge is used on all federal projects. All overhead sign-column type supports are located at the edge of shoulder adjacent to traveled roadway or placed behind barrier type guardrail.

Overhead sign structures, for new and replacement structures only, are to have a minimum vertical clearance of 18'-3" above the roadway. See the *Facilities Development Manual (FDM)*, Procedure 11-35-1 Attachment 9, for clearances relating to existing sign structures. The minimum vertical clearance is set slightly above the clearance line of the overpass structure for signs attached to existing structures.

39.1.2 Signs on Bridges

Span deflections of the superstructure due to vehicle traffic are felt in sign bridge structures mounted on those bridges. The amount and duration of sign bridge deflections is dependent on the stiffness of the girder and deck superstructure, the location of the sign on the bridge, and the ability of the sign structure to dampen those vibrations out to name a few. These vibrations are not easily accounted for in design and are quite variable in nature. For these reasons, the practice of locating sign bridges on to bridge structures should be avoided when ever possible.

The following general guidance is given for those instances where locating a sign structure onto a bridge structure is unavoidable due to the length of the bridge or a safety need to guide the traveling public to upcoming ramp exits or into specific lanes on the bridge.

1. Locate the structure support bases at pier locations.
2. Build the sign bridge base off the top of the pier cap.
3. Provide set back of the upright support of the sign bridge behind the back face of parapet to preclude snagging of any vehicle brushing with that parapet.
4. Use single pole sign supports (equal balanced butterfly's) in lieu of cantilevered (with an arm on only one side of the vertical support) sign supports.
5. Consider the use of a Stockbridge type damper in the horizontal truss of these structures.
6. Do not straddle the pier leaving one support on the pier and one support off the pier in the case of skewed substructure units for full span sign bridges.



39.2 Specifications and Standards

Reference specifications for sign structures are as follows:

- AASHTO "*Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals*"
- AASHTO "*Standard Specifications for Highway Bridges*"
- State of Wisconsin "*Standard Specifications for Highway and Structure Construction*"
- ASTM "*Standards of the American Society for Testing and Materials*"

Standard design data and details for break-away sign supports and sign bridges are given on the Chapter 39 Standard Details.



39.3 Design Considerations

Supports for roadside signs are of two types depending upon the size of the sign to be supported. For small signs, the column supports are treated timber embedded in the ground. For large signs, the columns are galvanized or weathered steel supported on cylindrical concrete footings. Currently, all steel column supports for roadside signs are designed to break-away upon impact.

The following design data is employed for designing ground mount or roadside sign supports as given on the "Break Away Sign Support Detail" Standard Detail:

Wind Velocity	75 mph Based on the fastest mile wind speed map and its corresponding methods to find wind pressure.
Wind Components	Normal = 1.0
	Transverse = 0.0
Ice Load	3 psf (144 Pa)
Group Loads	% of Allowable Stress
I Dead	100
II Dead + Wind	140
III Dead + Ice + (1/2 Wind)*	140
Allowable Soil Pressure	3 ksf

* Minimum Wind Load = 25 psf

Wind loading is applied to the area of sign and supporting members.

Ice loading is applied to one face of the sign and around the surface of supporting members.

Sign structures for support of overhead signs are to be either a single column cantilever or butterfly or a space truss sign bridge supported by one or two columns at each end. For cantilever sign bridge structures, the footing is a single cylindrical shaft with 'vanes' to prevent the overturning and twisting of the structure. For space trusses having one or two columns on an end, the footing is composed of two cylindrical caissons connected by a concrete cross-girder. The top surface of concrete foundations for all sign bridges is to be 3' above ground line.

The following design data is employed for designing steel sign bridges as given in the Chapter 39 Standard Details.

Wind Velocity = 90 mph Based on the 3-second gust wind speed map and its corresponding methods to find wind pressure.



Wind Components	Normal	Transverse
Combination 1	1.0	0.2
Combination 2	0.6	0.3

Table 39.3-1
Wind Components

Dead Load = Wt. of Sign, supporting structure and lights.

Ice Load = 3 psf to one face of sign and around surface of members.

Group Loads	% of Allowable Stress
I Dead	100.0
II Dead + Wind	133
III Dead + Ice + (1/2 Wind)	133
IV Fatigue	**

Table 39.3-2
Allowable Overstresses

* Minimum Wind Load = 25 psf

** See Fatigue section of AASHTO for fatigue loads and stress range limits.

Steel cantilevered sign bridge structures (four chord structures carrying Type I signage) are classified, for purposes of fatigue design, as Category 1 structures. These cantilevered support structures are designed to resist Natural Wind Gust and Truck-Induced Gust wind effects. Four chord cantilevered sign supports carrying Type 1 signage are not designed for Galloping wind effects due to the substantial stiffness and satisfactory performance history in this state.

Aluminum sign bridges are currently not being designed for new structures. Rehabilitation and repair type work may require use of aluminum members and shall be allowed in these limited instances. The following guidelines apply to aluminum structures in the event of repair and rehabilitation type work.

Aluminum sign bridge trusses are designed and fabricated from tubular shapes shop welded together in sections. The minimum thickness of truss chords is 1/4 inch and the minimum outside diameter is 4 inches. The recommended minimum ratios of “d/D” between the outside diameters “d” of the web members and “D” of chord members is 0.4. A cast aluminum base plate is required to connect the aluminum columns to the anchor bolts. AASHTO Specifications require damping or energy absorbing devices on aluminum overhead sign support structures to prevent vibrations from causing fatigue failures. Damping devices are required before and after the sign panels are erected on all aluminum sign bridges. Stock-bridge type dampers are recommended.



Steel full span sign bridge trusses are designed and fabricated from tubular shapes for chords and angle shapes for web members. The minimum thickness of steel web members is 3/16 inch and 0.216 inches for chord members. The connections of web members to chords are designed for bolting or shop welding to allow the contractor the option to either galvanize individual members or complete truss sections after fabrication. The columns are steel pipe sections. Steel base plates are used for anchor bolt support attachment.

Steel cantilever sign bridges are designed and fabricated from tubular shapes for chords and angle shapes for web members. The minimum thickness for the members is indicated on the steel cantilever standard sheet.

When butt welding box sections, a back-up plate is required since the plates can only be welded from one side. The plate must be of adequate width for film to be used during weld inspection. The exposed weld is ground smooth for appearance as well as fatigue.

Signs are attached to sign bridge trusses at the time of erection. If the signs are not available, blanks are attached to a minimum of one-fourth the truss length near its center. The minimum depth of the blanks is equal to the truss depth plus 24 inches. The blanks are to project an equal distance beyond the top and bottom chord members.

Do not add catwalks to new structures unless they contain Dynamic Message Signs. Catwalks add additional cost to a structure and present a maintenance issue. They can be added if a decision is made to light the signs in the future. Design structures for a 20'-3" (2'-0" extra) vertical clearance when they are located in a continuous median freeway lighting area, for new and replacement structures only. The sign bridge should be structurally designed to handle a catwalk for those cases when the additional clearance is provided for possible future attachment. Additional accommodations for potential future lighting include providing handholes in the uprights and conduit in the concrete bases for future electrical.

For structures that are not located in continuous median freeway lighting areas or do not contain Dynamic Message Signs, the additional 2 feet of structure height should not be utilized. Therefore, the design vertical clearance should be 18'-3" for new and replacement structures only. No handholes or conduit shall be installed on the structure in this case.

Brackets, if required, for maintenance of light units are required to support a 2'-3" wide catwalk grating and a collapsible handrail. Brackets and handrailing are fabricated from aluminum. Catwalk grating and toe plates are fabricated from steel and galvanized.

Contract plans should note on them (under the general notes) if hand holes are required on both uprights of the sign bridge.

Design of all Sign Bridge structures should reflect some provision for the possibility of adding signs in the future (additional sign area). Consideration should include the number of lanes, possible widening of roadway into the median or shoulder areas, and use of diagrammatic signs to name a few. The truss design should reflect sizing the chords for maximum force at the center of the span. The design of the upright and truss webs should allow for signs being placed (say sometime in the future) more skewed to one side than the other. Uprights should be selected the same size (outside diameter x thickness) for each side and the design shall reflect different lengths on either side as required by site conditions.



39.4 Structure Selection Guidelines

Sign structures are composed of “sign bridges” and “overhead sign supports”. Either type of sign structure can be configured to be a cantilever sign structure (one upright to arm) or a full-span sign structure (two uprights, one on each end of the span). Roadside sign supports are an exception to the above naming convention.

“Sign Bridges” generally carry Type 1 Signs and occasionally Variable Message Signs (VMS). These are large sign structures. Sign depths have ranged from 5 feet or less to over 15 feet in the case of large diagrammatic signs. Total sign areas accommodated are up to 260 sq. ft. on cantilever sign bridges. Total sign areas accommodated on full span sign bridges range from 250 to over 1000 sq. ft. of sign area. These ranges are for approximate guide only. Most sign bridges generally have truss members consisting of four round chords and angle web members supporting the signs on the span or arm (although some three chord structures have been used for full span sign bridges). Uprights are comprised of one pole for a cantilever sign bridge. Full span sign bridge uprights usually consist of two poles joined by angle web members at each end of the span (although single pole uprights have been used on three chord full span sign bridges). “Sign Bridges” are designed by the Bureau of Structures or a consultant. Structure contract plans provide full details that a fabricator can construct the sign bridge from. Standard details for the four chord sign bridge are associated with this Chapter of the Bridge manual which requires a design for each sign bridge structure including a foundation.

“Overhead Sign Supports” carry both Type 2 (smaller) directional signs and more recently limited amounts of Type 1 sign area. Overhead sign supports are also used to carry small LED or changeable message signs. Overhead sign supports are smaller sign structures. Sign depths have ranged from 3 to 4 feet deep for traffic directional (Type 2) signs to slightly more than 10 feet for small information (Type 1) signs. Total sign areas accommodated are up to 45 sq. ft. on cantilever overhead sign supports. Total sign areas accommodated on full span overhead sign supports range up to 300 sq. ft. These ranges are again an approximate guide and can be more or less depending on variables such as span length, location of the sign with respect to the upright(s), the height of the upright(s), etc. Uprights are comprised of one pole (round tapered pipe) for either the cantilever or full span overhead sign support. Arms on cantilevers or the span on a full span overhead sign support are either one chord (round tapered pipe), or two chords with angle web members (planar truss). “Overhead Sign Supports” are normally bid by the contractor and designed by a fabricator or by another party for a fabricator to construct. These structures usually have the least plan detail associated with them and are depicted in the Construction Detail portion of the state contract plans. A concrete footing base design is required to be shown in the contract plans for overhead sign supports. See the WisDOT Facilities Development Manual (FDM) Procedures 11-55-20 and 15-1-20 for more information on Overhead Sign Supports.

Sign bridges carrying variable message signs require special consideration. Special concerns include:

1. Weight of the sign panel.
2. Width and weight of catwalk.



3. Consideration of wind effects unique to these signs.
4. Modification to brackets used.

Wisconsin has allowed use of the Minnesota 4 chord configuration for sign bridges carrying variable message signs providing that the designer check the design for their particular structure.



39.5 Geotechnical Guidelines

Several potential problems concerning the required subsurface exploration for foundations of sign structures exist. These include:

- The development and location of these structures are not typically known during the preliminary design stage, when the majority of subsurface exploration occurs. This creates the potential for multiple drilling mobilizations to the project.
- Sometimes these structures are located in areas of proposed fill soils. The source and characteristics of this fill soil is unknown at the time of design.
- The unknowns associated with these structures in the scoping/early design stages complicates the consultant contracting process. How much investigation should be scoped in the consultant design contract?

Currently, all sign structure foundations are completely designed and detailed in the project plans. Sign-related design information can be found in the Facilities Development Manual (FDM) or Bridge Manual as described in the following sections.

39.5.1 Sign Bridges

WisDOT has created a standard foundation design for cantilever sign bridges carrying Type 1 signs that meet several criteria/limitations. These single shaft footings contain wings that help resist torsion. This standard foundation is presented on Standard 39.12 of the Bridge Manual Standard Details. If cantilever sign bridges carrying Type 1 signs exceed the limitations for the use of a standard foundation (as defined in the Bridge Manual Standard Details), individual foundations must be fully designed. This involves determining the subsurface conditions as described below.

Foundations supporting full-span sign bridges, which carry Type 1 and occasionally VMS signs, are individually designed. They generally have two cylindrical shafts connected by a concrete cross-girder below each vertical upright. WisDOT has no standard details for these structures.

39.5.2 Overhead Sign Supports

Overhead sign supports are described in Sections 11-55-20 and 15-1-20 of the FDM. In addition, Section 641 of the Standard Specifications outlines the design/construction aspects of these structures.

If these structures meet several criteria/limitations, the designer can use WisDOT-developed standard foundations for them. The designer can then insert the proper standard detail drawing (SDD) sheet into the plans. SDD sheets exist for cantilever overhead sign supports. These single shaft bases for cantilever overhead sign supports vary in depth and range from 24" to 42" in diameter. Another SDD sheet applies to full-span overhead sign supports and is 36" in diameter. The standard foundations in these SDD sheets were designed using slightly conservative soil design parameters. If the design criteria for these standard designs are not met, the SDD sheets cannot be used and the structure foundation must be fully designed



and the unique details supplied in the construction details portion of the contract plans. This involves determining the subsurface conditions as described in the following section.

39.5.3 Subsurface Investigation and Information

No subsurface investigation/information is necessary for any of the sign structures that meet the limitations for allowing the use of WisDOT standard foundations. Appropriate subsurface information is necessary for any of these structures that require individual designs.

There may be several methods to obtain the necessary subsurface soil properties to allow individual design of foundations, as described below:

- In areas of fill soils, the borrow material may be unknown. The designer should use their best judgment as to what the imported soils will be. Standard compaction of this material can be assumed. Conservative soil design parameters are encouraged.
- The designer may have a thorough knowledge of the general soil conditions and properties at the site and can reasonably estimate soil design parameters.
- The designer may be able to use information from nearby borings. Judgment is needed to determine if the conditions present in an adjacent boring(s) are representative of those of the site in question.
- If the designer cannot reasonably characterize the subsurface conditions by the above methods, a soil boring and Geotechnical report (Site Investigation Report) should be completed. Necessary soil design information includes soil unit weights, cohesions, phi-angles and location of water table.

Designers should also beware of the potential of high bedrock, rock fills and the possible conflict with utilities and utility trenches.

Consultants should follow similar methods and guidance in the completion of their work for the Department.



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