SIGN AND PAVEMENT MARKING DESIGN

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PROJECT INITIATION

The first steps undertaken for a signing and marking design project are also the most important in determining project success. These steps include:

1. **Project Type:** Signing and marking projects generally fall into one of five categories: Areawide, Insert, Advertised, Developer, and Shop Forces. A detailed description of each project type, along with the typical contents of the final plan submission package is contained in the Project Process chapter of this manual. It is important to understand at the very beginning of the design process what the type of project is and what the final set of plans should contain.
2. **Design Request (DR) Review:** The DR will be initiated by the District Traffic office. The designer should read the DR and all supporting documentation and call the District Traffic team to verify project intention and objectives. For Developer or Design Build (DB) Projects, the Developer or DB Team may be responsible for developing the initial draft of the DR for the District's approval.
3. **Determine Available Information:** Verify if there are as-built plans, CADD files, right-of-way information, utility information, and other sources of data which can be used to improve the quality of your design.
4. **Verify Everything in the Field:** Perform your initial site visit and verify that everything in the field matches both the DR as well as the available plans and background information.

FIELD REVIEW

The initial field review is one of the most important steps in the design of any signing and marking project. This is when the designer collects and reviews the information necessary to ensure that a complete, comprehensive, and cohesive system is developed. The field review allows the designer to also determine traffic patterns including lane drops, lane reductions, lane transitions, lane continuity, turn lanes, etc. These traffic patterns will affect the signing and marking design.

The installation or modification of highway signs can often have impacts well beyond the roadway corridor being studied. Prior to the field investigation, it is important for the designer to have a clear understanding of the project objective. This means discussing the project with the team leader, reviewing the DR, and contacting the DR's author in the District Traffic office and meeting in the field if necessary. The goal of the designer should be to ensure that any changes made do not cause inconsistency or confusion in the signing system. This also presents the opportunity to identify any existing problems that can be fixed as a part of the construction project.

Prepare a Base Map

Field data collection and conceptual design are made easier if a base map is prepared. Good sources of mapping are recent TEDD or Highway Design Projects in the area or aerial mapping from MD iMAP (imap.maryland.gov/Pages/imagery.aspx). If these are not available, there are other options available. The "Grid Maps" are available in electronic format from the Geospatial Technologies Team, and they make a good base map. If more detail is required, it may be necessary to obtain a professional survey if time and budget permit, or digitize a set of old plans and then perform a thorough field check. If less information will

suffice, a schematic or "Stick Diagram" can be constructed from maps, a video log from either field videos, VISIDATA or other sources, and the field review.

The level of detail required for the plan will vary depending on the project. In fact, many Areawide and Shop Forces projects do not require scaled drawings, provided that sufficient location and construction information is given on the plans. In general, new construction plans are designed on base mapping provided by the Highway Design Division.

Information to Collect

Signing: Initial Site Visit

Once the project objective is known, the signing requirements and impacts can be estimated. For every change, impacts to signs and messages beyond the immediate project area need to be considered in addition to the actual project construction. For example, removing a supplemental sign may impact a supplemental sign on a neighboring approach roadway. Before performing the initial site visit, it is important to understand how your project fits in with existing signs and messages in the region surrounding your project. This requires verifying that sign messages, trailblazers, and sequential signs are continuous and have a consistent layout. Additionally, it is important to call Miss Utility to have all underground utilities marked within the project vicinity to verify in the field that there will be no conflicts with proposed work. This is especially important if new sign supports or structures are being proposed.

1. Collect sign size, support type and size, position, and location (i.e. station and offset) information for all signs within the corridor. Even if your project is not modifying warning, or regulatory information, these signs may influence your choice of sign location. Always take pictures and make note of any signs or supports needing replacement; bring these signs to the TEDD Project Manager's attention. Signs can be added to the project, but may require a scope change. Always check signs along all corridors approaching your project and look for signs which will be impacted by your project. Guide signs, distance/ destination signs, supplemental signs, and trailblazers are frequently impacted by signing changes.
2. Along with the elements listed above, there are several key elements of existing sign features that must be documented during the initial field visit. These features will aid the engineer in both recreating the signs for the plan sheets as well as determining if parts of the sign or the whole sign need to be replaced or overlaid. These are:

- Sign message
- Text sizes and fonts
- Sheeting type and color
- Sign condition (shadow copy, fading, damage)
- Outdated materials (button copy, engineering grade sheeting Type 3, and signs that lack fluorescent yellow/fluorescent yellow-green)

3. Always take pictures of the job site! This may eliminate a field visit later. Photographs allow the engineer to take visual evidence of existing conditions back to the office to aid in the development of the design without having to go back in the field for clarification.

   Programs such as Google Earth and VISIDATA are also good resources for verifying existing field information, however always remember that their information is dated and they do not replace the need for field reviews.

4. By this point, the designer should have a good feel for the number and location of signs to be installed on the project. For each one, identify two or three possible locations in the field. Take note of lateral clearance problems, right-of-way, utility conflicts, sign spacing, sign visibility, availability of electric service and traffic barrier types at these locations, since these will influence your choice of final location and support type. **Wherever possible, it is preferred to locate new signs behind existing traffic barrier or outside the clear zone of the roadway. When replacing an existing sign, if conditions allow, it is ideal to install the proposed sign behind the existing sign to be removed.**
5. If a potential site is behind traffic barrier, measure the entire approach length in front of the sign location, the lateral distance from the nearest edge of the sign to the back of the traffic barrier, the distance from the travel lane to the traffic barrier, and the shoulder width. The length of need must be checked to ensure adequate protection of non-breakaway supports. Refer to the MSHA *Guidelines for Traffic Barrier Placement and End Treatment Design* for guidance on length of need calculations. Also, make note of the traffic barrier end treatments and ensure that the additional sign will not impact their proper operation.
6. Look for drainage facilities and utilities that will influence the selection of proposed locations.
7. Check that the selected locations meet MdMUTCD guidelines for sign spacing.
8. Identify the location and offset of all ditches near your sign locations. Sign posts or foundations, sign lighting cabinets, meter service pedestals, and electrical handholes should never be located in the centerline (bottom) of a ditch. Instead, sign supports and foundations should straddle ditches if necessary. Ideal locations for support placement should be at an elevation along the ditch line above the line extended from the crest of the roadway to the shoulder. This will ensure that the foundations will not be eroded and the anchoring system for the TCD structures will not corrode due to flooding.
9. Check the sign messages on all approaches to the corridor. The final system should have consistent messages on all signs approaching the system as well as on the system itself.
10. Identify the locations of traffic signal and roadway lighting equipment. For projects with overhead signing, identify potential power source locations if sign lighting will be required on your project. Prior to performing fieldwork, call Miss Utility to mark all underground utilities in the vicinity so that any potential conflicts can be identified during the fieldwork.
11. Drive the entire corridor and look for opportunities to reduce the total number of signs. Check for unnecessary or unwarranted signs and look for sign messages that can be combined with others in your plan. **Remember that signs on county/city roadways must be coordinated with county/city staff.**

Signing: Subsequent Site Visits

For most projects, it will be necessary to make a second site visit. Follow-up visits will usually be necessary to finalize locations, get cross section information, check traffic barrier locations, and check roadside clearances. This is because the sign sizes are not known at the initial visit and often change throughout the course of the design. On smaller jobs, the roadside elevations can be taken at the initial site visit, however this is not always practical on large jobs.

Pavement Markings

The primary purpose of taking a pavement marking inventory is to identify changes in the traffic pattern so that the appropriate changes may be made on the design plans. The field review should collect information regarding existing pavement markings and lane usage. The markings should be noted for turn lanes, auxiliary lanes, lane reductions, and lane drops. This should include the presence of lane lines, center lines, edge lines, dotted lines, transverse lines, channelizing lines, stop lines, arrows, words, and symbols. This information will be important in verifying that the overall treatment is consistent with current standards for both signing and marking. It is also important to note marked crosswalks, two way left turn lanes, raised pavement markers (RPM's), shoulder rumble strips, and raised rumble strips used for warning conditions.

Data Collection Methods

Sign Sizes

Sheet aluminum signs generally have to be measured to determine size. Extruded aluminum signs, however, can be "counted" based on the panels they are constructed from. Each panel is either 6" or 12" tall, with 6" panels generally located at the top when they are used. Note, 6" panels should be used only for special purposes where utility conflicts, right-of-way conflicts, or installing a proposed sign on existing sign support(s) impose design constraints. Each panel also has bolt holes along the top and bottom edges, and these are also 12" apart. When signs are even foot widths (i.e. 12'-0"), the holes are offset 6" from each edge. Where signs are half-foot widths (i.e. 12'-6"), the holes are offset 3" from each edge. Once again, half-foot widths should be used only for special purposes.

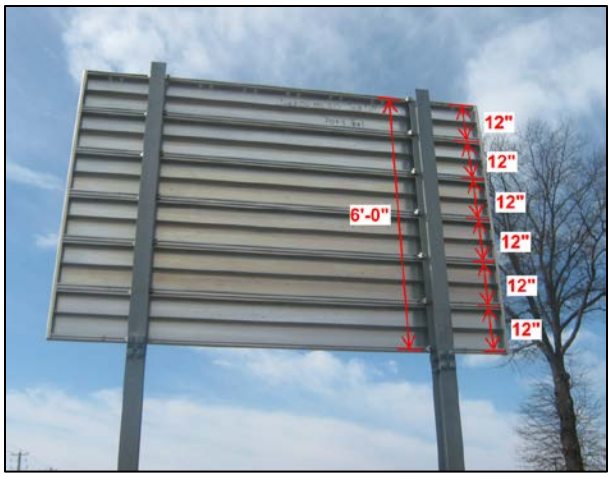


Figure SN.1 - Extruded Aluminum Sign Height

Figure SN.2 - Extruded Aluminum Sign Width

Elevations

Elevations are required to determine ground mounted support sizes and lengths as well as overhead and cantilever sign structure clearances and support sizes. They also help determine lateral placement of signs to avoid ditches, utilities, and other site features. Measuring and recording elevations is usually a two-person process involving a survey rod and a lock-level; however, for new construction, this information is available from the profiles, cross sections, and typical sections. The person holding the lock-level usually stands on the edge of shoulder on the side of the roadway on which the sign will be installed and takes measurements at the edge of shoulder, edge of travel lane, hinge

points, and the top and bottom of roadside slopes and ditches. The first measurement, taken at the edge of shoulder, is used to calculate the "eye height" of the observer, and will be used to calculate elevations and slopes. A measurement should be taken at the edge of travel lane for the purposes of estimating the elevation of the high point on the roadway. Curved sections of roadway may be super-elevated and elevations should be taken at both shoulders where practical. Measurements should be taken on both sides of the roadway for overhead structures as foundations will need to be installed on both sides. In cases where there is a median, the overhead sign structure may only span from one side of the roadway to the median. In this situation, elevations must be taken in the median too. Other methods of measuring elevations are available that utilize more common field equipment items.

Consider the following example, where the elevation of a ditch is being calculated. The observer has already taken readings for eye height at 5.2 Feet, top of slope at 7.2 Feet, and bottom of slope at 9.2 Feet.

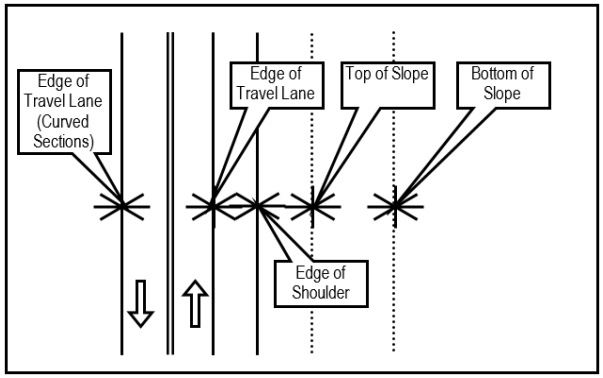


Figure SN.3 - Typical Elevation Requirements

Taking horizontal measurements from the distance between the top of slope and bottom of slope allows the rise and run to be determined and the cross section to be drawn. For example, if the horizontal distance is 5 Feet and the vertical distance is 9.2 – 7.2 = 2 Feet, the slope (Rise/Run) would be 2/5 and the cross section could be drawn accordingly.

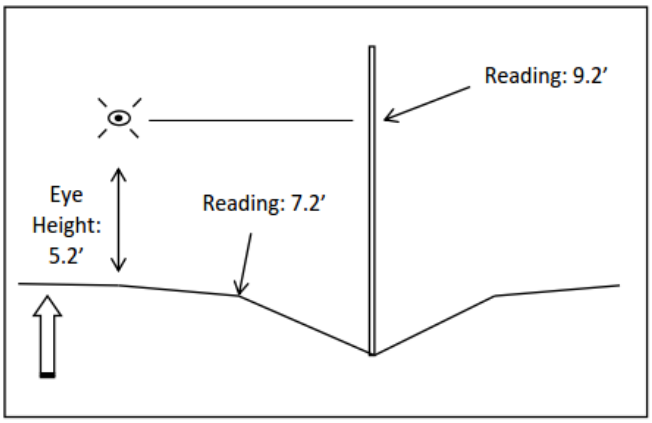


Figure SN.4 - Roadside Elevation Readings

TYPES OF SIGNS

Signing along Maryland roadways falls into eleven (11) categories:

1. **Regulatory** signs have either a black legend on a white background, a red legend on a white background or are white legend on a red background in the case of stop and yield signs. They provide motorists notice of traffic laws and regulations.

2. **Warning** signs have a black legend on a fluorescent yellow background and they alert drivers of roadways conditions that may not be readily apparent.

3. **Guide** signs generally have a white legend on a green background and show route designations, destinations, directions, and distances. Guide signs also include route marker assemblies, generic service signs, and general information signs.

4. **Specific service signs** are white legend on a blue background guide signs located along freeways and other eligible roadways to direct motorists to services

(gas, food, lodging and camping). The Specific Services Signing Program (LOGOs) is administered by the Traffic Development and Support Division (TDSD) and TEDD is responsible for the design/installation of LOGO signing.

5. **Recreational and cultural interest signs** are guide signs that direct motorists to areas of attraction or traffic generators that are open to the general public including museums, parks, art galleries, and historical sites.

6. **School Signing:** School signs generally have a black legend on a fluorescent yellow-green background; however regulatory signing in school zones has a black legend on a white background. School signs are used to notify motorists when they enter a designated school zone, warn motorists of school crosswalks inside the designated school zone, and provide notice of the posted speeds inside the school zone.

7. **Emergency Management Signs** are used to guide and control traffic during an emergency. This includes evacuation signing and directional signing to temporary shelters.

8. **Maintenance of Traffic (MOT)** signs generally have a black legend on a fluorescent orange background. These signs are temporary; however, some have long term uses. An example of longer term MOT signing is for a large roadway construction project in which traffic is rerouted and guide signs and exit panels need to be modified to include fluorescent orange panels.

9. **Tourist Area Corridor (TAC) signs** are a system of guide signs and trailblazers meant to more efficiently direct tourists to groupings of attractions within an area. This program will eventually replace the Attraction Signing Program currently under the Specific Service Sign. This program is run by the TEDD.

10. **Other Signing Programs** are also implemented as supplemental signing throughout Maryland. These include, but are not limited to:

    - Ag-Tourism – This program is run by the Maryland Department of Agriculture (MDA) and TEDD.
    - Farmer's Market – This program is run by the MSHA District offices.
    - Maryland History – This program is a combined effort of MSHA Architectural Historians and the Maryland Historical Trust (MHT).
    - Jurisdictional Gateway – This program is a combined effort of the MSHA's Office of Traffic and Safety, Office of Environmental Design, and the District Offices.
    - Maryland Scenic Byways – This program is run by the MSHA Office of Planning and Preliminary Engineering.
    - Community Based Guide Signs – This program is run by TEDD.
    - Dedication Signing – This program is run by MDOT Headquarters and TEDD.
    - Adopt-a-Highway – This program is run by each MSHA District Office.
    - Sponsor a Highway – This program is run by the MSHA Highway Operations Team.

11. **Other Non-standard signing:** In addition to the categories above, MSHA has several programs for implementing non-

standard signing. These programs cover a wide variety of subjects and include signs such as “State Law – No Texting – No Hand Held Cell Phone”, “Move Over – Slow Down – For Emergency Vehicles on Shoulder” and “Buckle Up – It’s our law” signs. A process involving submitting an application to TDSD for director approval must be followed in order to implement non-standard signing.

SIGN CHARACTERISTICS

The four main characteristics of signs are their size, shape, color, and text size, all of which are determined based on human factors. Sign sizes, colors, shapes, and text sizes have been tested in order to ensure optimum driver comprehension and reaction times. More information about text sizes can be found in the “Sign Size and Design” section of this manual and the “Size of Lettering” section of the most recent edition of the MdMUTCD. Utilizing standard sign characteristics also reinforces the uniformity of application which was discussed in the Principles of Design chapter.

The size of all signs should be designed to fit the location and situation and not just the roadway type. The MdMUTCD offers guidance on sign size, but the designer should also consider human factors and the criteria specific to the situation.

Important MdMUTCD Points

The MdMUTCD provides the engineer with guidance for the application and design of guide signs, regulatory signs and warning signs. The Typical Applications in the MdMUTCD are not provided for all situations and it is up to the designer to apply the concepts and use engineering judgment to determine what is best for their specific situation. The following are a list of important points provided by the MdMUTCD:

1. Yield signs shall be installed on entrance ramps only when the acceleration lane does not provide for an adequate merge area.

2. Keep Right signs shall be installed on supports at an angle of 15 degrees (except where a divided highway begins) towards traffic turning left around the nose of the median. The Keep Right sign should be installed 6’ to 10’ from the nose of the median and may have an Object Marker installed in front and lower than the Keep Right sign.

3. Freeway ramp terminal signing includes options for Do Not Enter, Wrong Way, No Left Turn, and One-Way signing. Refer to typicals in the MdMUTCD and use judgment in determining the proper layout for each situation.

4. The placement of warning signs shall be based on the minimum Perception-Response Time (PRT). PRT is the time needed for:

- Detection
- Recognition
- Decision
- Reaction

5. When electronically controlled RED signal ahead warning signs are used, Signal Ahead signs are installed as a backup.

6. W3-3 (NEW) assemblies with corresponding Street Name Signs are Fluorescent Yellow and are installed along major roadways in advance of new signal installations for a period of 90 to 120 days.

7. A “Form Single Lane” treatment should be considered wherever a two lane ramp reduces to one lane before merging with

the mainline roadway, where two through lanes reduce to one lane on a multi-lane highway, or for dual-left turns onto a single lane roadway. Both travel lanes must also be designed to taper at the same rate into each other without favoring either lane. Refer to the latest MSHA "Form Single Lane Application Guidelines" for additional details.

CONCEPTUAL PLANS

Developing a Concept

The conceptual plan is developed before the actual design of any signs has begun. Prior to the concept stage, the base mapping should have been obtained and a roll map produced. Information from the field review should be drawn on the plan, including existing signs, existing traffic barrier, existing markings, existing utilities, and existing lane usage. Where possible, information that may influence the selection of final locations should also be included.

The concept plan should lay down on paper what the designer feels is the desired and preferred system of signs and proposed traffic patterns. The focus should be on the location, order, presentation, and coordination of sign messages, both within and outside the project limits. The concept does not need to address exact details of what sign sizes will fit in the field, however obvious problems should be noted and addressed. At this stage, the designer should choose between overhead and ground mounting of the signs, as this may influence other signs in the system. It should also be indicated if there are changes in the traffic pattern, as this will influence the signing, such as number of lanes feeding from an existing system into the proposed system and vice versa.

The Signing "System"

Signs are designed to operate as part of a system that makes use of driver memory and learning to reinforce messages and improve understanding and reaction. The conceptual plan should address the design on a system, or a "Big Picture", level to ensure continuity with existing messages and treatments. The development of a concept plan usually involves the following steps.

Guide Signs

1. *Note the Area Type*: Urban, suburban, and rural characteristics often influence the type, size, frequency and support structures for signs along a roadway. Also, note roadway geometrics, travel speeds and traffic volumes.

2. *Determine Functional Classification:* Use the latest approved version of the Highway Location Reference (HLR) to determine if the highway is a freeway, expressway, urban interstate, rural interstate, conventional roadway, or a low volume roadway.

3. *Identify Routes and Destinations:* Identify the primary routes, road names, primary destinations, supplemental destinations, and services that need to be signed. This information will be available from the field review, maps, neighboring roadways, and the district traffic office. A list of Maryland's Control Cities by route number can be provided by TEDD. The control cities along interstates may also be found in List of Control Cities for Use in Guide Signs on Interstate Highways from AASHTO.

4. *Identify Problem Areas:* Check the roadway for unusual circumstances that may cause driver confusion or difficulty. These include lane drops, lane reductions, splits, and confusing geometry. The design must address these situations.

5. *Identify Signs Which Cannot Be Moved*: A number of signs are either tied to a specific location or are part of programs which are run by other divisions. As a result, these signs either should not be moved or the

relocation should be coordinated with other divisions. This includes Maryland Historical Markers which designate a specific historical site and the Adopt/Sponsor a Highway signs which typically can be moved to a nearby location, but it requires coordination with the Office of Maintenance. These types of signs should only be moved if there is no other alternative and the design should be closely coordinated with the lead Division.

6. *Choose a Scheme or System*: The selection of a scheme or system type will depend on roadway classification and configuration. Typical configurations include the conventional full complement of the 1 Mile, ½ Mile, exit direction trio, or may include sequential signs, arrow-per-lane and diagrammatic signs. Lower classification roadways, such as two lane and local roadways, will usually be adequately covered by route markers, distance/destination signs and advance street name signs.

7. *Sketch and Locate Proposed Signs*: Using the scheme chosen above and the messages identified in Step 2 as a guide, make hand sketches of the proposed signs and locate them approximately on the plan. Most often this is done with a roll map and "Post-It Notes", particularly for large projects.

8. *Check Opportunities to Reduce Clutter:* When the initial layout is complete, re-evaluate the concept looking for logical ways to eliminate signs, combine signs, and reduce costs. This process should always keep the needs of the driver as a primary objective.

Warning and Regulatory Signs

1. *Place Warning Signs*: Identify where warning signs are needed and sketch them on the plan. While it is not necessary to address every warning sign at the concept level, it is important to consider unusual situations such as lane reductions, lane drops, sharp curves, low design speed ramps, etc. Refer to the MdMUTCD for application of these signs.

2. *Place Regulatory Signs*: Similar to warning signs, it is not necessary to address all regulatory signs at the concept level. It is sufficient to identify what types will be used and what criteria will be used for most cases. It is usually important to identify one-way and wrong way treatments, lane use control signs, stop/yield signs, and the post interchange sequence (speed limit and confirmatory route marker assembly).

3. *Place Route Markers, Service Signs, and Others*: If they have not already been addressed, review the application of route marker and service signs. This is also the time to review the need for any other signs, such as historic signs.

Reducing Clutter

There are many demands competing for the installation of highway signing. In addition to the standard complement of regulatory, warning, and guide signs, there are programs for service signs, logo signs, supplemental generator signs, historical markers, historic signs, and tourism signs. A designer should be concerned with preventing signs from being lost in a background of visual clutter.

The latest edition of the MdMUTCD states "Regulatory and warning signs should be used conservatively because these signs, if used to excess, tend to lose their effectiveness." On the other hand, a frequent display of route signs and directional guide signs will keep the driver informed of the vehicle's location and will not lessen the sign's value.

One of the purposes of the conceptual plan is to check that new projects not only recognize

this problem, but also attempt to reduce it. In this type of environment, it is important to prioritize information into what the driver needs to know and what is supplemental and not required for the driver. Reasonable accommodations should be made to install signs that are not necessary to the driver's safety, however this should not be done at the expense of the basic principles of human abilities and time-distance relationships. In order to prioritize signs and resolve any conflicts that arise as part of the design process, the following sign hierarchy should be followed when developing a signing plan:

1. Signing for motorist right of way (stop/yield)

2. Regulatory Signs

3. Warning signs to alert drivers of the unexpected

4. Guide Signs

5. Supplementary destination guide signs and additional program related signing (Tourism, Historic, Adopt a Highway, etc.)

Concept Review

The designer will develop what he or she feels is the desired sign message layout prior to the conceptual plan review, when these recommendations will be reviewed. A concept plan is beneficial for smaller projects, whereas a detailed "Post-It-Note" roll map is useful as a concept for large scale projects as a method to adjust messages and concept layouts of signs.

The concept review is an important step in the design process, because it sets the foundation for the messages and sign types to be used and then gathers comments and input from all interested parties early in the design process. The designer, the designer's team leader, director's staff, and the district traffic office at a minimum usually attend the Concept Review meeting. Depending on the complexity and level of input desired, it is also helpful to have the Division Chief, Assistant Division Chief, representatives from another design team, and where applicable the design consultant and the Highway Design Division Lead present.

The exact type of review necessary will depend on the project size and scope. Obviously, if the project is replacing a single sign knock-down, a formal meeting is not necessary. This type of review can take place by fax, mail or e-mail. For larger projects involving new construction or signing replacements through a corridor, a concept review meeting can take several hours.

Review Items

A reviewer should consider the following items when participating in the review of a concept plan:

1. Verify that all signs outside the project limits are consistent with the proposed signing and that all sign messages and layouts are consistent.

2. Check that the level of signing is appropriate for the facility in question. Keep in mind that the level of signing for a Freeway differs significantly from a two-lane highway.

3. Check route numbers, cardinal directions, route names, and destinations. They should be accurate and consistent with other signing in the area and with the latest approved version of the HLR.

4. Check that supplemental destinations are addressed where needed.

5. Check service signs for applicability and consistency. Make sure that logo and generic signs do not address the same service at an interchange.

6. Check unexpected or unusual circumstances and see that they are adequately signed. This should include lane drops, lane reductions, turn restrictions, confusing geometry, etc.

SIGN SIZE AND DESIGN

The MdMUTCD describes standard signs and outline criteria for their application. The MdMUTCD also gives general criteria governing the design of guide signs. The Maryland Standard Sign Book should be used for all standard signs. The purpose of this section is to give guidance on the design of signs and application of the rules from the MdMUTCD as well as Maryland SHA practice.

Sign Legibility

Sign legibility will play a key role in designing the sign layout. It helps to determine the required text size for different driving scenarios. The MdMUTCD states that 30 feet of legibility distance per 1 inch of letter height should be used. Thus, a sign with 8" letters would be legible to drivers at 240 feet distance under the guidelines. Table SN.1 summarizes legibility distances for common letter heights. The MdMUTCD also contains charts that state the minimum legend size per roadway type.

Table SN.1 - Sign Legibility Distance

Letter Height (Inches)	Legibility Distance (Feet) based on 30 ft/in
4	120
6	180
8	240
10	300
10.67	320
12	360
13.33	400
15	450
16	480
20	600

An important concept related to how long a driver needs to see a sign is Decision Sight Distance. The AASHTO "A Policy on Geometric Design of Highway and Streets" defines this as "the distance required for a driver to detect an unexpected or otherwise difficult-to-perceive information source or hazard in a roadway environment that may be visually cluttered, recognize the hazard or its threat potential, select an appropriate speed and path, and initiate and complete the required safety maneuver safely and efficiently". Decision Sight Distances are inherently longer than other sight distance criteria because they allow time for a driver to comprehend the information presented by the roadway environment (i.e. the sign or hazard) and make a judgment regarding course of action.

Sign Layout

The first step in sign layout is determining the class of facility the sign will be used along. This will be used to select letter heights from the charts in the Guide Signs chapters of the MdMUTCD. For warning and regulatory signs, letter heights range from 1¼ in. on parking signs to 8 in. on some warning signs depending on visibility needs. Once a letter height has been selected, the MdMUTCD offers the following guidelines for legend design:

- The minimum height of legend for ground mounted expressway signs is 8 inches.
- Capital letter heights shall be 6 inches and lower case letters shall be 4.5 inches minimum on conventional roads.
- Capital letter heights shall be inches and lower case letters shall be 3 inches minimum for all low volume or urban roads (25 mph).
- The spacing between lines of copy should be approximately three-fourths of the average upper case letter height for adjacent lines of copy or the height of the

corresponding lower case letter. Examples of spacing can be found in Table SN.2.

- Spacing between lines of copy and the top and bottom borders should be approximately equal to the average letter height of the adjacent line of copy.
- Spacing between legend and vertical borders should be approximately equal to the largest letter.

Table SN.2 - Sample Sign Layout Spacing

Legend height (inches)	Interline Spacing (inches)	Spacing between legend and top/bottom border (inches)	Spacing between legend and vertical border (inches)
8/6	5.25	7	8
10.67/8	7	9.335	10.67
13.33/10	8.75	11.665	13.33
16/12	10.5	14	16
20/15	13.125	17.5	20

Sign layout is an iterative process that can be broken down into 6 steps. Given that signs are generally fabricated in heights and widths of even 12" multiples, strict application of the above spacing recommendations does not usually produce a design that can be used for fabrication. It is usually necessary to adjust the interline and edge spacing to obtain a workable design; the MdMUTCD should be referenced for guidance on interline spacing and layout during the design. This process is usually performed using MSHA's SIGNTOOL program or other sign design program. These programs make alternative layouts easy to develop and modify. A typical design process would involve the following steps:

1. Select appropriate letter heights for the legend and symbols based on the facility class.
2. Using TEDD's CADD Standards manual, place all of the legend and symbols. Designers are referred to the SIGNTOOL Users Manual, the sign program users guide and the CADD Standards Manual for information regarding the proper use of Microstation, signing programs and SIGNTOOL software.
3. Space the various lines of legend according to the spacing guidelines provided in Table SN.2.
4. Place a border following the spacing guidelines between legend and border provided in Table SN.2.
5. Check the computed height and width against manufacturing capabilities. Generally, the sign shop fabricates extruded signs in even foot multiples (both height and width). Using the spacing recommendations as a guideline, additional space can be added or possibly deleted to develop the required height and/or width.
6. When selecting the corner radius and border thickness, use Table SN.23 and Table SN.34 as a guide. Border thickness and corner radius are selected based on text size and the smallest sign dimension, either height or width. Note that the top corner borders of exit panels should have a radius of 6" and are an exception to Table SN.3. Additionally, the bottom border corners of exit panels shall be square, not rounded. See Figure SN.5 as an example.

Figure SN.5 - Sign Border Example

Table SN.3 - Sign Border Radii

Smallest Side Dimension (Feet)	Corner Radius (Inches)
2	3
3	3
4	6
5	6
6	9
7	9
8 +	12

Table SN.4 - Sign Border Thickness

Text Height	Text Series	Border Thickness
8"	EM or E	*See note
8"	D	1.25"
8"	C or B	1"
6"	EM, E or D	1"
6"	C or B	0.75"
4"	All	0.75"
*Smallest Dimension ≤ 4: 1.25" Smallest Dimension > 4: 2"		

General Principles

There are many general principals, or possibly rules of thumb, which are applied to sign design on a daily basis. Some important ones to always keep in mind are:

- When designing for a cloverleaf interchange, the top destination should be for the closer exit ramp and the bottom destination for the further or second ramp.
- For diamond interchanges, the top destination should be the one requiring a left turn and the bottom destination for a right turn at the end of the exit ramp.
- Cardinal directions on guide signs should be top-aligned with the route marker shield to which it applies.
- JCT, ALT, USE, TO, and FOLLOW messages on guide signs should be center-aligned with the route marker shield to which the message applies.
- Where EXIT ONLY panels will be constructed on extruded panels, maintain 12” multiples for the height. Refer to the “Advanced Guide Signs” Section of the MdMUTCD for design of exit panels for advance guide signs for left exits.
- For multilane exits at Major interchanges with either option and/or split lanes, an Overhead Arrow-per-Lane or Diagrammatic sign should be used based on MdMUTCD guidance.
- When designing guide signs for left exits in lieu of diagrammatic signs, the action messages starting with the furthest sign should be “LEFT X MILE”, “LEFT EXIT”, “NEXT LEFT”, followed by the exit direction sign. The action message shall have black legend and border on a fluorescent yellow background.
- The exit panels for left exit guide signs are white legend and border on a green background with a fluorescent yellow overlay on the panel with “LEFT” in black legend. The panel should be left justified above the guide sign.
- Don’t center all lines of a multi-line message. Where the road name, destination, or other message is more than one line, the second line is indented, not centered. The vertical space between two lines of a split message is reduced in relation to other vertical spacing. Never split a single destination or roadway into more than two lines.
- Spacing between legend and symbols is (for example a shield and a cardinal direction) should be equal to the capital letter height.
- Road names should not be hyphenated and placed on two lines.

Text Heights

The tables in the “Guide Signs – Freeways and Expressways” chapter of the MdMUTCD provide guidance for text heights for different

sign messages and roadway types. The tables provide minimum text heights for different categories of freeway and expressway signs: Major (Category A and B), Intermediate, Minor, and Overhead. To avoid confusion about which category should be used for particular locations, it is beneficial for the designer to initiate a discussion with the MSHA Project Manager at the beginning of the project design. Further guidance to clarify and supplement the information provided in the MdMUTCD is included below.

When using the MdMUTCD tables, if a sign fits into one of the "Type of Interchange" categories and is also an overhead, the larger minimum text height of the two applicable columns should typically be used.

Generally, for overhead signs, exit direction signs should be one text size larger than the advance guide signs. For example, if the advance guide signs have a 16" capital letter text height, the exit direction should have 20" capital letter text heights. This applies to signs on conventional roads as well as freeways and expressways.

The sizes shown in Table SN.5 should be used for overhead signs on conventional roadways. Table SN.6 includes the minimum sizes that should be used for ground mounted guide signs on conventional roadways.

Table SN.5 - Conventional Overhead Sign Minimum Text Heights

Legend	Size
Exit Panel (word/number)	10"/15"
Shield	36"
Cardinal Direction	15"/12"
(1st Letter, Rest of word)	
Auxiliary and Alternative Routes (i.e. JCT, TO, ALT, etc.)	12"
Destination (Upper/Lower)	16"/12"
Distance (number/word)	15"/10"
Fractions (Numeral/Overall)	10"/15"
Action Message	10"

Table SN.6 - Conventional Ground Mounted Sign Minimum Text Heights

Legend	Size
Shield	24"
Cardinal Direction	10"/8"
(1st Letter, Rest of word)	
Auxiliary and Alternative Routes (i.e. JCT, TO, ALT, etc.)	6"
Destination (Upper/Lower)	10.67"/8"
Distance (number/word)	10"/8"
Fractions (Numeral/Overall)	8"/12"
Action Message	6"

Table SN.7 - Standard Capital Letter Heights (Series B, C, D, and E)

Standard Letter Heights (Inches)	
3*	8
4*	10
5*	12
6	16

***3, 4, and 5 Inch letter heights are not used on guide signs**

The following table includes the uppercase and lower case configuration for standard E-mod letter heights. In signs where the words are both uppercase and lower case this should be used. The lower case heights shown are the minimum because text heights will vary by letter.

Table SN.8 - Standard E-mod Letter Heights (inches)

Initial Upper Case	Lower Case
6	4.5
8	6
10.67	8
13.33	10
16	12
20	15

Sign Layout Example

As an example sign layout, consider an Advance Guide Sign for an intermediate interchange located along I-81 in Washington County. The MdMUTCD recommends the following letter sizes for Freeway guide signs:

Table SN.9 - Letter Heights for Design Example

Legend	Size
Exit Panel (word/number)	10”/15”
Shield	36”
Destination (Upper/Lower)	16”/12”
Distance (number/word)	15”/10”
Fractions (Numeral/Overall)	10”/15”

Referring to the sign layout guidelines mentioned earlier, an initial layout might produce the following spacing shown in Figure SN.6.

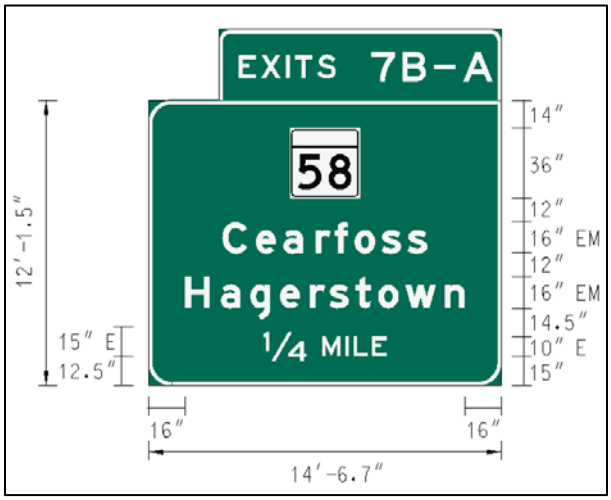


Figure SN.6 - Initial Layout for Design Example

A quick application of the above rules led us to choose 12” for the interline spacing, 14” for the spacing to the top of the sign, and 16” for lateral spacing from the edge (vertical border) of the sign. The total height calculated, 145.5” should be modified to an overall total of 12’-0” (or 144”). Because the width of the sign is only about 5” less than 15’-0”, the edge spacing should be increased evenly to reach 15’-0” since it is preferred to have the sign width rounded to a whole number.

Refining your Design

A refining technique for improving sign legibility is to reduce spacing between associated messages and increase spacing between route – destination – information messages.

In this example, a logical location to subtract the required inch and a half from the overall total height would be between “1/4 MILE” and the bottom of the sign because while the spacing is slightly compromised for the “1/4” fraction, the spacing is still adequate for the “MILE.”

Figure SN.7 - Final Layout for Design Example

Combining Messages

The goal of sign designers should be to install the fewest signs necessary to provide motorists with required informational needs. Combining messages is one way to reduce the required number of signs while grouping messages having a common theme. Cloverleaf interchanges are frequently designed with an overhead structure

containing both the Exit Direction sign for one interchange ramp and a second "¼ MILE" sign for the subsequent ramp. Since these ramps often serve a common route number or route name, these messages can be combined to produce a single sign. This may allow the structure size to be reduced, reduces the total number of signs along the highway, or creates room for a different sign to be installed. In either case, care should be taken not to overload the driver with information. The MdMUTCD's rules regarding legend and number of destinations per interchange still apply. Two of the primary objectives of combining messages are:

1. Group messages to provide motorists with a more effective and concise presentation.
2. Reduce the total number of highway signs and minimize driver information overload.

Message Dividers

Message dividers are most commonly used to separate road names, points of interest, destinations, and services on distance and destination signs. They also are used on combined guide signs, where road names are used on the primary guide signs or to separate action messages for different ramps. Figure SN.8 and Figure SN.9 show example message divider applications.

These signs are governed by the following rules:

- The divider color and dimensions are the same as the sign border. See Table SN.3 and Table SN.4 for border dimensions.
- Where a partial divider is used, it is 2/3 of the sign height for vertical dividers or sign width for horizontal dividers. This is also referred to as a 2/3-bar.
- Where distance/destination panels are stacked for different classifications of guide signs (ie. services and recreational), a single divider (usually white) is used between the different colored backgrounds.
- Message dividers should imply the degree of association between various items. For example, if services are associated with a particular point of interest, no divider is used. If the services are separate but available at the same exit, then a divider is used.
- For EXIT ONLY panels, both a black and white border is used to separate the fluorescent yellow panels from the green panels.

Figure SN.8 - Typical Message Dividers

Figure SN.9 - Typical Message Dividers

Negative Contrast

Negative contrast signs are those with a light background and a dark legend (such as an 'EXIT ONLY' panel). They are intended to stand out from the rest of the sign in order to

alert drivers of what is ahead. These types of supplemental signs are used for interchange entrances and exits. Figure SN.10 shows an example of a guide sign with negative contrast in the "ONLY" panels.

Figure SN.10 - Negative Contrast "ONLY" Panels

Positive Contrast

Positive contrast signs are those with a dark background and a white legend (such as a standard guide sign as shown in Figure SN.9). They are intended to provide the user with clear messages of what is ahead.

Clearview Fonts

Clearview fonts should no longer be used. Refer to the February 25th, 2016 MSHA memorandum with the subject "Guidance – Federal Highway Administration Termination of Interim Approval of Clearview Font" for information regarding Clearview Font usage.

Arrows

The MdMUTCD and the FHWA Standard Highway Signs book define six standard arrows, the "UP" and "Down" arrows, intended for use on interstate guide signs, and the "Standard Arrows" which can be used on all signs. In addition, Maryland SHA also uses several curve and turn arrows which have been developed for unique situations. The MSHA Standard Sign Book gives dimensions and details for all arrows used in Maryland.

"UP" arrows are used to designate exiting or turning movements on exit direction signs. The Type A Arrow (as defined in the Standard Signs Book and the MdMUTCD) are used along interstate highway as well as other freeways and expressways. The Type A up or Interstate Arrow should not be used along conventional roadways. The Interstate "Down" or "lane designation" arrows tell motorists what lanes to use to reach a particular destination or follow a specific route. They are commonly used for "EXIT ONLY" signs. These arrows are intended to point at the center of the lane to which they refer. The latest approved version of the MdMUTCD requires that Down Arrows must be vertical and point at the approximate center of the lane to which it applies. Down arrows can NOT be rotated as previously allowed. This frequently happened at a choice lane, where the MdMUTCD now recommends considering Overhead Arrow-per-Lane or Diagrammatic signs instead.

The Type D or "Standard Arrow" is only used for guide signs which are post mounted along conventional roadways and ramps. This includes distance/destination, warning, and regulatory applications. Dimensions for standard letter heights are given in the Appendix of the Standard Sign Book, however non-standard sizes can be scaled for application to warning and regulatory signs. The MdMUTCD recommends that the arrowhead width be equal to the capital letter height.

Diagrammatic Signs

Diagrammatic signs are a special category of signs in the MdMUTCD that are intended to graphically depict roadway conditions ahead. They are installed at the advance guide sign locations (i.e. 1-MILE and ½-MILE) and are commonly used to indicate freeway splits, left exits, choice lanes, route discontinuity, and lane drops. The MdMUTCD states that "Diagrammatic guide signs have been shown to be less effective than conventional or Overhead Arrow per Lane guide signs at conveying the destination or direction(s) that each approach lane serves, regardless of

whether dedicated or option lanes are present." Diagrammatic signs shall not be installed at the Exit Direction sign location.

In addition to visualizing the roadway geometry, diagrammatic signs can be combined with LEFT EXIT panels to clearly identify left exits. These signs tend to be extremely large (the one along southbound I-270 is one of the largest signs in Maryland), and as such are found mainly along Interstates and Freeways. The MdMUTCD section on freeway signing gives criteria governing the design of diagrammatic signs and specifies dimensions for lane widths, lane line widths, and arrowhead sizes. It is important to note that the manual specifically states that these signs SHALL NOT be used at cloverleaf interchanges except for the following cases as detailed in section 2E.22 of the MdMUTCD:

- "Where the outer (non-loop) exit ramp of the cloverleaf is a multi-lane exit having an optional exit lane that also carries the through route"
- "At cloverleaf interchanges that include collector-distributor roadways… that are accessed from the mainline by a multi-lane exit having an optional exit lane that also carries the through route"

Figure SN.11 - Typical Diagrammatic Sign

Sign Lighting

Existing sign lighting shall remain in-place until the sign and/or structure gets replaced. When high-performance Type XI sheeting has been installed on overhead guide signs, refer to the Maryland SHA Lighting Guidelines, 2017. Sign lighting is not required unless specific conditions, such as tight curves or complex geometry restrict vehicles from illuminating the signs with their headlights. Other conditions that may require sign lighting include the presence of fluorescent panels or background visual clutter which may include lighting behind the sign.

MSHA uses individual luminaire supports (traditional lighting) where sign lighting is required. Sign Lighting Maintenance Systems are still installed in many locations throughout the state, but is not used on new projects. With the use of LED luminaires, maintenance is less frequent because LED luminaires have a greater service life than High Pressure Sodium (HPS) luminaires. On all new projects, sign lighting, if needed, will only be installed along interstate highways and controlled access freeways and in accordance with the Maryland SHA Lighting Guidelines, 2017.

For traditional lighting, the luminaires are mounted on steel beam supports that are attached to the overhead truss (see Figure SN.12 and Figure SN.13 examples). Also, see the lighting design section of this manual.

The basic elements of sign lighting design are:

1. Selecting the number and wattage of light sources and LED drivers.
2. Identifying a power source.
3. Determine circuitry.
4. Maintenance considerations.

Figure SN.12 - Sign Lighting Individual Supports

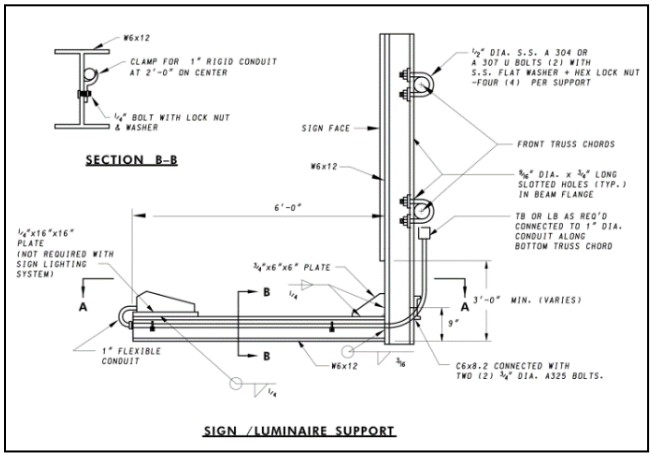


Figure SN.13 - Sign Lighting Supports

Light Source Selection

All new sign lights installed in Maryland are LED, and the number of light sources is based on the sign height and width. TEDD has a standard Sign Lighting Schedule, which is included in the Appendix of this manual. Since design of the LED fixtures varies considerably, the approval of the sign lighting installation is based on the photometrics submitted by supplier.

Power Sources

Signs are typically powered from the roadway lighting circuits where roadway lighting is present and spare capacity exists. Connections to existing circuits can be made in the base of light poles, or spare circuits can be run from an existing cabinet to the signs. In either case, the existing circuits should be reviewed to ensure sufficient spare capacity exists.

Where there is no roadway lighting, a separate cabinet and power drop will be necessary for the sign lighting. For most situations, a Pole Mounted Lighting Cabinet (see MSHA's *Standard Specifications for Construction and Materials*) will be sufficient to power the sign lighting. A remote service consists of an enclosure, a 60 amp Main breaker, 2-20 amp circuit breakers, and a photocell. This is sufficient to provide 2 circuits operating at 240V, which can power 1 or 2 signs. Where the total load is more than 32 Amps, the cost of multiple Pole Mounted Cabinets versus a Base Mounted Lighting Cabinet should be examined. The decision between a Base Mounted and Pole Mounted Cabinet is a cost trade-off between supplying individual Pole Mounted Cabinets which each may be half the cost of a Base Mounted Cabinet, plus additional trenching and cable to reach a central location. Refer to Spec. Section 807, Electrical Service Equipment, for utility connection information. However, where a Pole Mounted Cabinet is insufficient, it will be necessary to install a Base Mounted Cabinet.

Determine Circuitry

Sign lighting design is a balance between total circuit load and circuit voltage drop. The three rules governing lighting circuit design are: sign lights should be run from two different circuits, the total voltage drop in each circuit should be less than or equal to NEC guidelines (5% of the source voltage currently), and the maximum circuit load in amperes is determined by NEC guidelines (currently 80% of the circuit breaker trip size for roadway lighting). For connections to existing roadway lighting, it is important to

determine if there is sufficient capacity in both the cabinet and the circuits that will be used. Where a remote service is used, it is important to check the total load, because they are not intended to handle large lighting systems.

More information regarding sign lighting and circuit design can be obtained from the lighting section of this manual.

Maintenance Considerations

Sign lighting maintenance is a key concern given the costs that are associated with roadway work and Maintenance of Traffic (MOT). MSHA tracked the costs of changing bulbs for a sign on the Capital Beltway. That particular job required less than $1,000 in new bulbs, but over $10,000 in MOT costs for lane closures. However, LED luminaires have minimized the frequency of changing bulbs, so the costs of maintenance have also decreased.

As well, to reduce maintenance costs locating guide signs with sign lighting over a shoulder may be considered if it makes sense from an engineering point of view. Obviously, this cannot apply to all situations. While advance guide signs and exit direction signs function the same over the shoulder versus over the travel lanes, exit only and lane designation signs (i.e. those signs with down arrows) need to be pointing at the center of the appropriate lane. Another situation requiring judgment would be the inside of curves, where a sign located over the shoulder may not have sufficient sight distance for motorists.

Considering Construction and Fabrication

Fabrication

There are different processes by which signs are fabricated depending on what type of sign is being made. The process used affects not only the cost of construction, but also what can and cannot be made.

In Maryland, larger signs are constructed on an extruded aluminum background and the legend is direct applied. Direct applied copy, including letters and numbers, is generally less expensive than other fabrication methods and can either be fabricated in the MSHA Sign Shop or ordered from a vendor. Some elements of the sign legend, including route marker shields and other symbol legends, are installed using rivets under a method referred to as Demountable Copy.

Demountable Copy uses a legend that is fabricated individually on sheet aluminum and then riveted to the extruded panels. This allows minor copy changes to be made in the field using only a drill and a rivet gun. While demountable copy is allowed in Maryland, it is not used by the MSHA Sign Shop and the industry in general is no longer using it. The use of demountable copy is typically limited to a handful of legend symbols that are used on large guide signs, including:

- Route marker shields
- Generic service symbols
- TOLL plaques
- E-ZPass® plaques

Specific Service or Logo signs are unique in that they are fabricated to be completely demountable. The copy, logos, dividers, and any arrows or other symbols are all demountable. Because these signs can change frequently, fabricating all of the components to be demountable allows for easy reconfiguration and modification of the signs.

The use of extruded panels for large guide signs allows modification to part of a sign without replacing the entire sign. Since the typical green background of larger signs is directly applied to each individual extruded panel before the panels are assembled to make the sign, panels can be added or

removed simply by unbolting the extrusions in the field.

Smaller signs and signs involving artwork typically use silk screening as part of the fabrication process. This involves making a master screen or template and using it to apply ink to the reflective sheeting background. The master is made using a photographic process and a full-scale mock up, which allows one screen to be used for the production of many signs. Each color of legend must be applied in a separate process (and using a separate screen), allowing dry time between colors. Screening offers a high degree of consistency and quality while producing a large number of signs in a short time frame.

Construction

Guide sign legend can be modified when the sign has demountable copy as discussed earlier and when the sign is in relatively good condition. Instead of replacing an entire sign, it makes more sense to replace just the weathered, damaged, or inaccurate portion of a sign. Copy changes are an economical way to modify signs; however, designers should be careful when doing so because:

- Over time, the sheeting behind copy weathers at a different rate than sheeting that is exposed to sunlight and the elements. This can produce ghost images after legend is modified. When this occurs, replacement or a sheet aluminum overlay should be considered.
- Making substantial changes is time consuming. Where signs are mounted over the travel lanes, changes should be limited to a short line or a few symbols. For substantial changes to the sign message or to ensure all legends, symbol sizes, and spacing adhere to MdMUTCD requirements, consider a sheet aluminum overlay instead. Sheet aluminum overlays are less expensive to fabricate than extruded signs and can be installed quickly if they are small, minimizing lane closure time and crew expenses. However, construction means and methods should be evaluated to determine the benefits of using sheet aluminum overlays. For example, overlaying an entire overhead sign may not be the best option because it may require multiple pieces of sheet aluminum, which increases construction time and may result in a lower quality sign that has many visible joints and may not have consistent reflectivity. Further, if overlays are used on a temporary basis holes from the rivets will remain when the overlay is removed.
- While lane closures are introduced, look at the option of upgrading not only the sign, but also sign lighting, if still warranted, and other adjacent signs.
- Button copy is an older type of legend where the letter is made of plastic and round reflectors are mounted on top of the letter to provide reflectivity. Background sheeting on these signs is usually Engineering Grade, an older type with relatively low reflectivity. Button copy signs should be replaced whenever they are located within your project limits.

SIGN SUPPORTS

Mounting Hardware

The type of hardware used for sign mounting depends primarily on the aluminum panels that the sign is constructed from. Extruded aluminum panels are typically attached to supports using post clips that are held in place by bolts that run through the channel at the back of each extrusion. These clips can attach directly to the flanges of steel I-beam supports or can attach to aluminum angles that are bolted to wood supports. Sheet aluminum signs are typically bolted directly to the sign post; however larger sheet aluminum

signs come in 4-foot wide panels that must be assembled prior to installation.

Selecting a Support

There are two decisions that must be made in selecting a sign support. First, it must be determined whether the installation will be overhead or ground mounted. Then, within each category, an appropriate and economical selection must be made. Maryland's policy is to use overhead guide signs along controlled access expressways and freeways and where there are three or more lanes per direction. In most other situations, ground mounted signs will suffice; however, overhead signs may also be used to improve visibility or provide additional emphasis in problem situations. Except for special situations, warning, regulatory, and route marker signs are always ground mounted.

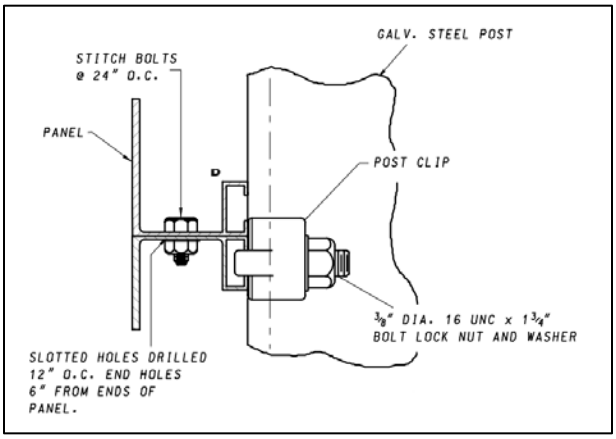


Figure SN.14 - Typical Extruded Panel

Overhead Structures

The decision to use overhead structures is based on the factors outlined in the Overhead Sign Installations section of the latest approved version of the MdMUTCD. If it is decided that guide signs will be installed overhead, then a choice must be made between Overhead Sign Structures and Cantilever Sign Structures for each location. Overhead Sign Structures have two roadside supports (also referred to as End Frames) and typically span over all lanes in a given direction. Cantilever Sign Structures have one end frame (or roadside support) and typically span up to two lanes.

In some instances, overhead and cantilever structures need to be installed on top of a bridge (for vehicles traveling on the bridge) and the foundation will need to be designed and constructed as part of the bridge overpass. Coordination and approval is required from the Office of Structures for these designs.

Throughout the state there are several signs which are installed on the face of a bridge (thus viewed by vehicles traveling under the bridge). New bridge mounted signs are not allowed per current MSHA policy.

Choosing the Right Sign Structure

This decision requires some judgment, as there are issues of function, cost and maintenance that are important. Overhead Sign structures cost more to install and maintain; however, the sign function and driver needs must be the first priority. Each situation needs to be evaluated on an individual basis to ensure that information is presented in the most appropriate manner. The following questions, which are listed in priority order, should be asked in making this decision:

1. Does the type of sign or site conditions (i.e. sight distance, etc.) require that the sign be at a particular location over the travel lanes? This is true for exit only, lane designation, and diagrammatic signs.
2. If the installation is ONE sign, can it be located over the shoulder and still function properly? This is true for most advance guide and exit direction signs.
3. Will the total sign width (for 2 or more signs, include space between signs) fit on a typical cantilever span (Usually 10 to 45

feet)? The span length calculation must include the shoulder setback and the required sign position above the roadway.

Overhead Sign Structures

Overhead sign structure spans are measured from centerline to centerline of the end frames. Typical span lengths range from 70 feet to 120 feet in length; however, structures up to 140 feet are included in the Book of Standards. The Administration requires the use of a minimum 70-foot span even if a shorter span would suffice. All new spans are designed as a box truss. Box truss spans allow signs to be attached on both sides of the span (i.e. both directions of traffic) and can support two span sections with a common center support on divided highways.

When determining the span length, consideration should be given to clear recovery areas, ditches, steep slopes, etc. It may be better to increase the span length than introduce a hazard in the recovery area. On divided highways, the center support should be located as close as possible to the center of the median, to allow for future roadway widening. If possible, the designer should determine if there are any outside widening projects scheduled for the roadway and locate proposed sign structure supports outside the impacts of the widening.

The following criteria must be met for the Design Sign Area of an Overhead Sign Structure:

1. Design sign must extend, at a minimum, the width of the roadway.
2. For actual signs beginning or ending outside the limits of the roadway, the design sign shall extend to the limit of the actual sign.
3. Design sign height shall be the height of the tallest actual sign on the structure. An exit panel shall be considered in addition to the main design sign panel.
4. Design chart sign size of standards shall be equal to or greater than the calculated design sign size.
5. The horizontal centerline of the design sign shall be placed at the horizontal centerline of the truss. The exit panel will be on top of the design sign.

Figure SN.15 - Box Chord Truss Overhead Sign Structure

Cantilever Sign Structures

Cantilevers are typically used to hold one or two signs, depending on the sign area. They have only one support, and spans are measured from centerline of end frame to end of truss. Typical spans range from 10 to 45 feet. Signs on the structure typically overhang the end of the truss. The maximum allowed overhang is 1 foot. Factors influencing the Design Sign Area and span length are:

1. Design sign height shall be 1.25 times the height of the tallest sign.
2. The design sign width shall be the width of the actual sign. When two signs are required, the design sign width shall be the out limits of the actual signs including the space between the signs.
3. An exit panel in addition to design sign of main panel shall be included in the design. The horizontal centerline of the design sign shall be placed at the horizontal centerline of the truss. The exit panel will be on top of the design sign.

4. The design sign size from the Book of Standards shall be equal or greater than the design sign size as calculated above.
5. Sign position over roadway.
6. Roadside features (curbs, shoulders, ditch lines, sidewalks, etc.).

Cantilever Sign structures also come in several truss arrangements, however Maryland most commonly uses the box and plane trusses. (See Figure SN.16 and Figure SN.17).

Figure SN.16 - Typical Box Truss Cantilever

Figure SN.17 - Typical Plan Truss Cantilever

Requesting Structure Design

Structure design can be requested once the designer knows the sign size, roadside elevations, and the horizontal location of the sign over the travel lanes. This is done by filling out the Structure Input Sheets with cross sections, which are included in the TEDD Document Manager and sending them to the Structural Design Team. Depending on the individual project, all the information necessary to complete the forms can be obtained from either the Field Review or the Highway Plans and Cross Sections. See Figure SN.18, Figure SN.19, and Figure SN.20 for examples of the forms used for new structures.

One item designers need to be careful of is the positioning of the sign above the roadway, which will be guided by the function of the sign. Lane designation signs will need to be positioned with down arrows pointing to the center of the lane to which they refer. Other signs have more flexibility. When the location is known, the designer can then calculate the distance from the center of the structure end frame to the edge of the sign. This is the exposed arm length (LA) on the Cantilever Input Sheet and Sign Offset (D) on the Overhead Input Sheet.

Using Existing Structures

When signs are being changed and/or removed on an existing structure, the structural capacity must also be checked. The structure verification form, also a part of TEDD Document Manager, should be used to supply the Structures Section with the information necessary to analyze the structure. On this form, the designer fills out the information pertaining to the size and location of all existing and proposed signs on the structure and any information regarding the contract under which it was installed. It is important to also submit the structure verification form when signs are removed from an existing structure or when a sign structure is removed entirely. This allows the Structures Section to maintain an accurate inventory of all existing structures and available capacity for future modifications. See Figure SN.21 for the form used for existing structures. The designer should submit the following information with this form:

- New sign layout
- Pictures of the front and back of existing structure
- Existing sign supports
- Existing sign attachments
- Existing foundation

Traffic Barrier and Roadside Design

Overhead sign structures are a roadside hazard that must be protected by traffic barrier. All new structures must either be located behind existing traffic barrier or new traffic barrier must be designed to protect the structure. Where new traffic barrier is proposed on insert projects, the structure locations must be provided to the Highway Design Division so that the traffic barrier can be included in their plans. On Areawide and Advertised projects, new traffic barrier should be designed in accordance with the MSHA's "Guidelines for Traffic Barrier Placement and End Treatment Design" as well as with AASHTO's Roadside Design Guide.

Ground Mounted Supports

Maryland SHA uses two main types of ground mounted supports: steel beam and wood. In unique cases, such as for streetscape projects or where local jurisdictions will maintain signs, tubular steel supports can also be used. Districts and other local jurisdictions should confirm project specific usage of tubular steel supports. Sometimes maintenance crews specifically request the use of tubular steel supports. Wood supports are used for warning, regulatory, and smaller guide signs. Steel supports are used for larger installations. Both support types are available as either breakaway or non-breakaway, but anything that is not protected by some form of traffic barrier (see Roadside Hazards section below) should be breakaway unless it's located beyond the clear zone. The Book of Standards shows what modifications are necessary to make both steel and wood supports meet breakaway requirements. The preferred sign location is outside of the clear zone. **If this condition cannot be met, the sign should be placed as far from the roadway as possible.**

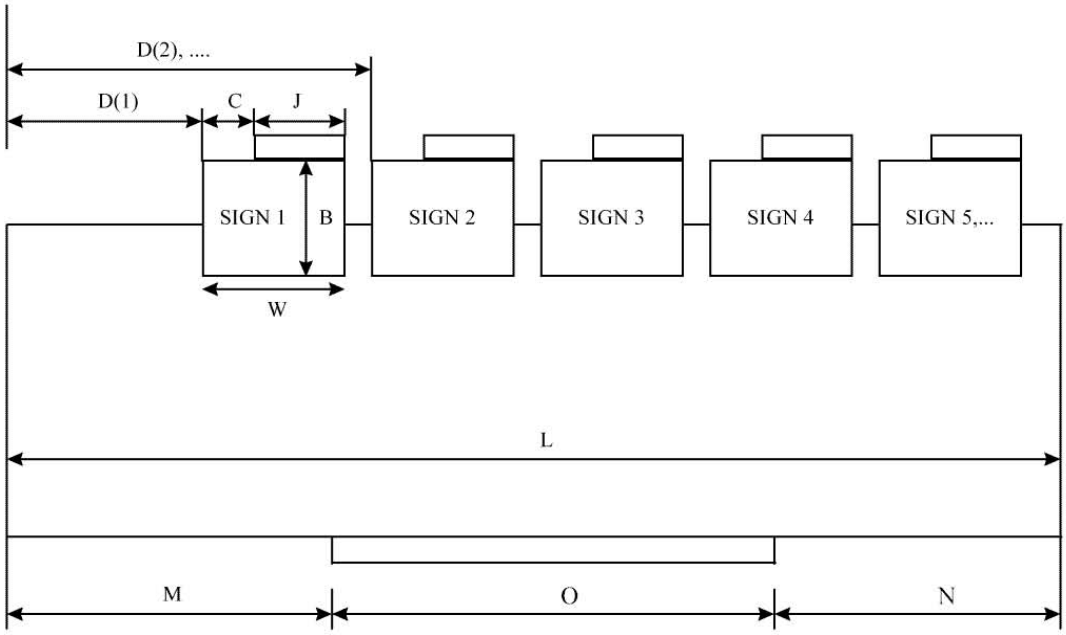
Ground Mounted Selection

There are a number of factors influencing the selection of ground mounted supports. Wood supports are the most economical; however, breakaway modifications have a significant impact on the allowable sign area.

Standard Signs

Warning, regulatory and route marker signs are installed on breakaway wood supports when not protected or within the clear zone. These installations have been standardized in the MSHA *Book of Standards for Highway and Incidental Structures* table on MSHA Standard No. MD 812.04, where the number and size of posts are given for each standard sign blank.

OVERHEAD INPUT SHEET – SINGLE SPAN



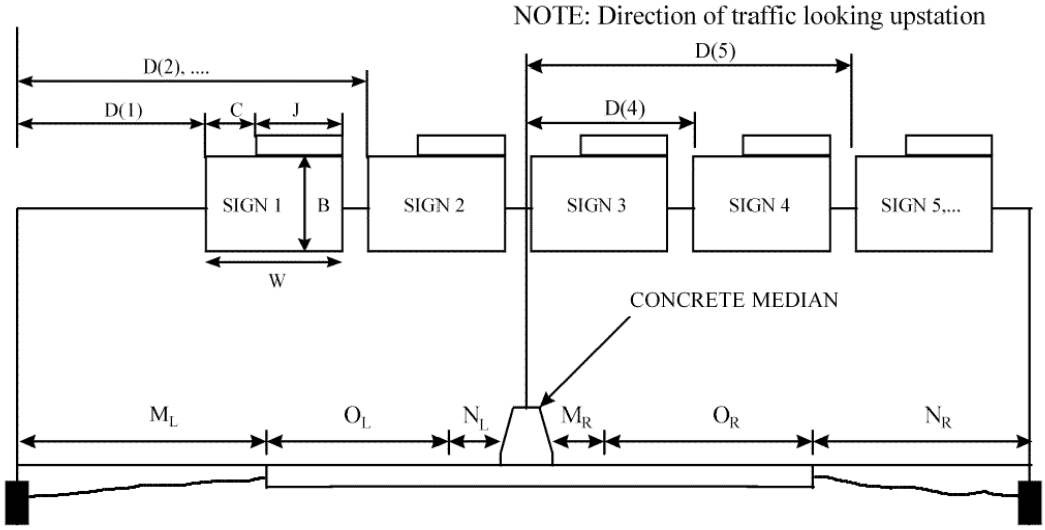
Structure Number: _____ Date: _____
Project: _____
Contract Number: _____ Designer: _____

Left Support Over (-) / Under (+) Roadway: _____
Right Support Over (-) / Under (+) Roadway: _____
Length of Span: _____
Number of Signs: _____
Offset from Left Support to Road Edge (M): _____
Offset from Right Support to Road Edge (N): _____
Road Width (O): _____

D(1)	D(2)	D(3)	D(4)	D(5)	D(6)
B(1)	B(2)	B(3)	B(4)	B(5)	B(6)
W(1)	W(2)	W(3)	W(4)	W(5)	W(6)
C(1)	C(2)	C(3)	C(4)	C(5)	C(6)
J(1)	J(2)	J(3)	J(4)	J(5)	J(6)

Figure SN.18 -Structure Input Sheet for New Structures with Two End Frames

OVERHEAD INPUT SHEET – DOUBLE SPAN



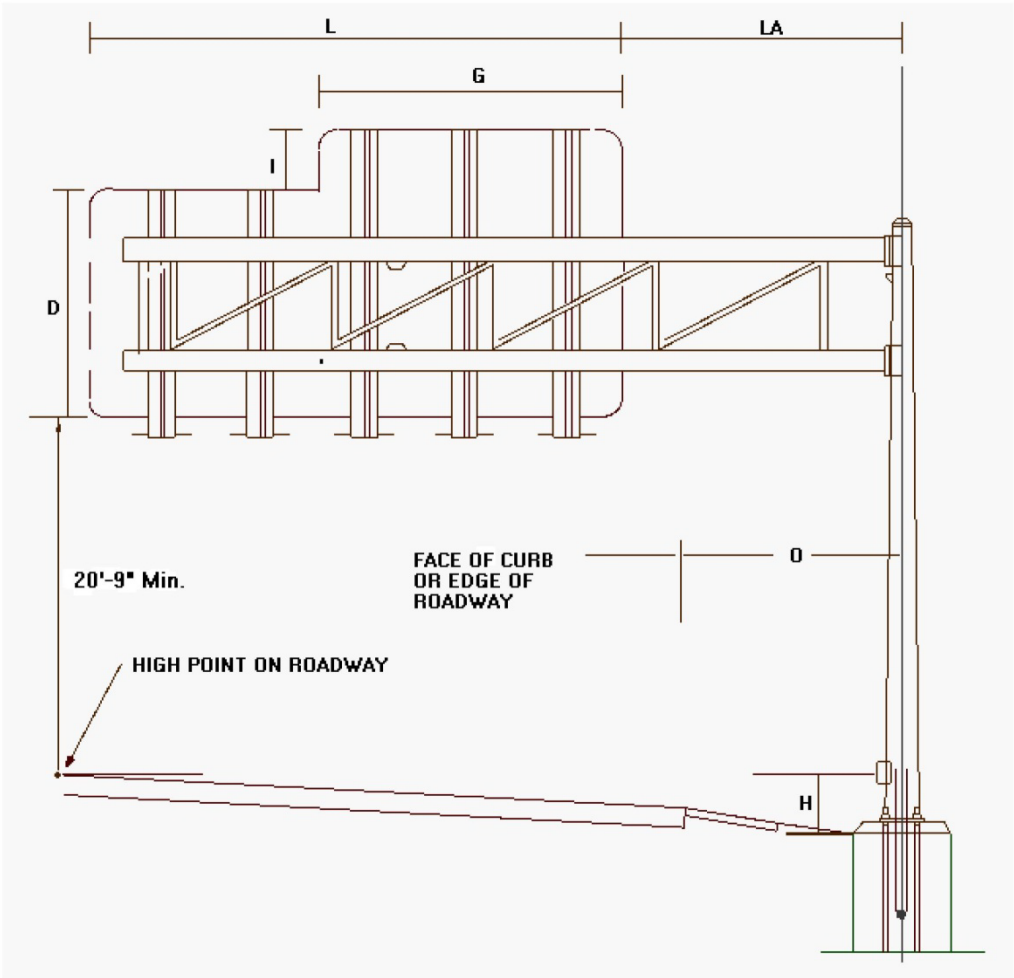
Structure Number: _____ Date: _____
Project: _____
Contract Number: _____ Designer: _____

Left Support Over (-) / Under (+) Roadway: _____
Center Support Over (-) / Under (+) Roadway: _____
Right Support Over (-) / Under (+) Roadway: _____
Length of Span: L: R:
Number of Signs: L: R:
Offset from Left Support to Road Edge (M_L): _____
Road Width - L (O_L): _____
Offset from Center Support to Road Edge (N_L): _____
Offset from Center Support to Road Edge (M_R): _____
Road Width - R (O_R): _____
Offset from Right Support to Road Edge (N_R): _____

D(1)	D(2)	D(3)	D(4)	D(5)	D(6)
B(1)	B(2)	B(3)	B(4)	B(5)	B(6)
W(1)	W(2)	W(3)	W(4)	W(5)	W(6)
C(1)	C(2)	C(3)	C(4)	C(5)	C(6)
J(1)	J(2)	J(3)	J(4)	J(5)	J(6)

Figure SN.19 - Structure Input Sheet for New Structures with Three End Frames

CANTILEVER INPUT SHEET



Date	
Location	
Contract Number	
Structure Number	
Designer	
Sign Depth (D)	
Sign Length (L)	
Exposed Arm (LA)	
Over (-) / Under (+) Road (H)	
Edge Road To Support (O)	
Barrier Wall Mounted (Y / N)	Please select option.
Exit Panel Justification (left / right)	Please select option.
Exit Panel Dimensions	G , I

Figure SN.20 - Structure Input Sheet for New Cantilever Structures

MEMORANDUM

TO: Jialin Tian, P.E., Chief
Traffic Engineering Design Division

FROM: Please select team leader, Team Leader, Structure Design Section
Traffic Engineering Design Division

DATE:

SUBJECT: Verification for Adding/Deleting/Modifying Signs on Existing Structures
Route:
County: Allegany
Contract No.:
Structure No.:
Location:

DESCRIPTION:

The below noted structures have been checked and verified.
Those noted with a Combined Stress Ratio of greater than one are inadequate.

Please submit picture of recent existing signs and drawings of new replacement signs.

NOTE: All existing sign sizes and locations on the structure to be checked must be included in the ensuing table. Once checked, copy must be given to Sign Designer.

Shaded area is to be filled out by Structure Design Section.
* Measured from left post to center of sign on OH spans
* Measured from post to center of sign for cantilever structures
** Distance - Lowest luminaire support bottom to highest point of roadway

Structure No.	Sign Panel Letter	Near/Far Side	**Roadway Clearance	Existing Area Per Panel – W x H	*Location On Span	Proposed Area – W x H	*Location On Span	Structure Design Area – W x H	Design Wind Load - MPH	Critical Stress Ratio (CSR)

By, Sign Designer Checked By, Structural Designer Approved Please select team leader

Figure SN.21 - Structure Verification Form for Existing Structures

Non-Standard Signs

The general process for selecting ground mounted supports for non-standard signs is as follows:

1. Based on MdMUTCD guidelines, select an appropriate location for the sign.
2. Check for existing traffic barrier nearby. If so, use non-breakaway wood or steel. Be careful to ensure that the existing traffic barrier will provide adequate protection in terms of length of need. Use the non-breakaway wood and steel support charts in the Appendix.
3. If no existing traffic barrier is available and the sign is within the clear zone, check the breakaway wood support charts in the Appendix for the appropriate district.
4. If breakaway wood supports are insufficient or will not work due to minimum post spacing requirements or another reason, use the TRANSPO Industries Breaksafe support program to select the appropriate breakaway steel supports.
5. It is important to note that a cross section must be provided for all non-standard proposed ground mounted signs. The cross section shall include the high point of the road, the shoulder, edge of pavement, and elevations at each support. It is beneficial to include the cross section on the signing plan sheets. An example of a good cross section can be seen in Figure SN.22.

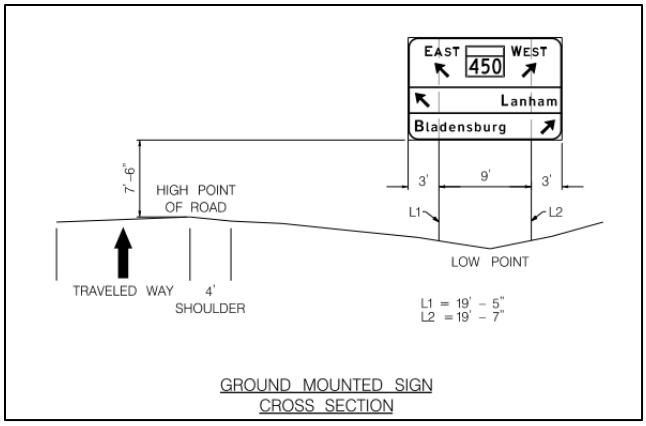


Figure SN.22 - Example of a Cross Section for Determining Sign Support Lengths

Figure SN.23 - Breakaway Wood Support

Figure SN.24 - Non-Breakaway Wood Support

Figure SN. 25 - Non-Breakaway Steel Support

Figure SN. 26 - Breakaway Steel Support

Wood Supports

Supports are sized based on sign area, mounting height, and post length. When using the design tables for wood supports, post length is measured from the ground line to the center of the sign, as shown in Figure SN.27. The designer should ensure that minimum vertical clearances stated in the Book of Standards are met based off of the near edge of pavement not from the ground line. Once the longest post length "L" is known, the tables in the Appendix can be used to determine the required supports. Note, that the actual length of wood support required is the total distance below the ground, from the ground to the bottom of the sign and the sign height.

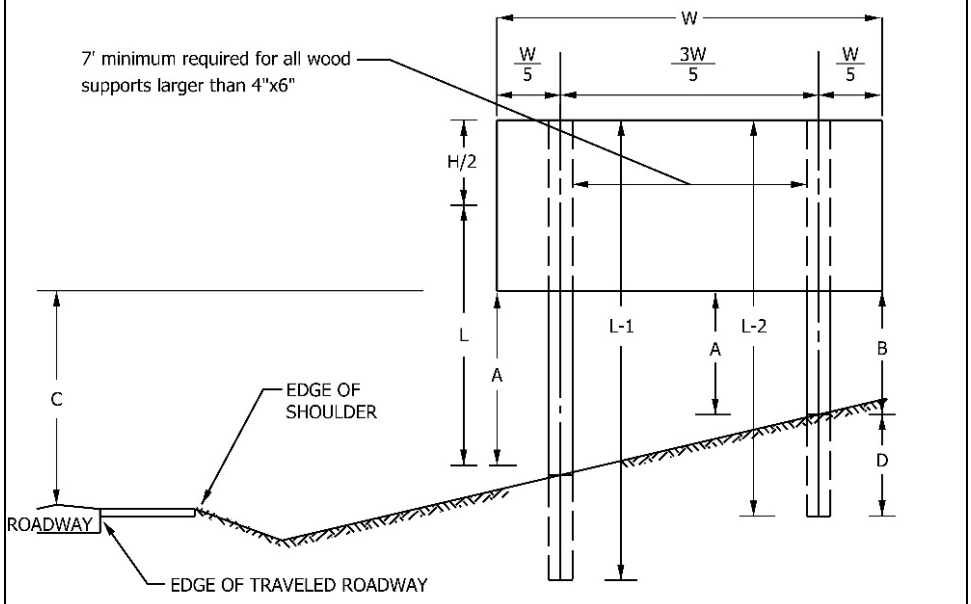
Steel Supports

Larger ground mounted signs require steel supports. This includes signs that are too large and signs that are too narrow to install on 6"x6" or 6"x8" wood posts because of the 7-foot minimum spacing requirement. Steel supports are sized in the same manner as wood supports, with the exception that the post length, which for steel is referred to as LMAX, is measured from the ground line to the bottom of the sign. In addition, steel supports must meet the following guidelines:

- Breakaway steel supports require a minimum ground to breakaway hinge distance of 7'-0" in order for the breakaway to operate properly. (See Figure SN.28) This requires a minimum distance from the ground to the bottom of the sign of 7'-6".

- The minimum distance from the high point of roadway to the bottom of the sign is 7'-6". This may force an increase in LMAX.

VERTICAL SIGN CLEARANCE FOR WOOD SUPPORTS



Minimum Vertical Clearance for Wood Supports

A. 7'-0" minimum for non-freeway (5'-0" for rural locations).
B. 2'-0" minimum
C. 7'-0" minimum & preferable. This dimension is to be increased only when required to meet A = 7'-0" B (min) = 2'-0"

Notes:

A. See appendix A-6 for ground mounted wood support tables.
'L' should be used as the design height for wood supports.
B. Secondary signs may be placed 1' less then the specified height above.
C. Both conditions 'A' and 'B' must be met.

Legend

D = 5'-0" for 4"x4" or 4"x6"
6'-0" for 6"x6" or 6" x 8"
H = Height of sign
L = Height from ground to center of sign (for longest support)
L-1 = Length of first support (Identified in the wood support chart on SN-4)
L-2 = Length of second support (Identified in the wood support chart on SN-4)

W = Width of sign

Figure SN.27 - Wood Support Vertical Clearance

- For breakaway sign supports, both the breakaway hinge minimum distance from the ground AND the minimum distance from the high point of the roadway to the ground need to be met.
- There are Type 'A' and Type 'B' breakaway steel couplings. The Type 'A' couplings are designed to work with W6x9 steel supports only and Type 'B' couplings are designed to work with W6x12 or larger steel supports.
- On cut-slopes, the farthest edge of the sign should be a minimum of 2'-0" above the ground line. This may also force an increase in LMAX.
- Where the steel supports are greater than 8 feet apart, additional stiffening angles should be installed in accordance with MSHA Standard No. MD 802.01 from the MSHA *Book of Standards for Highway and Incidental Structures*.
- Generally, avoid installing large signs on a single steel support due to wind twisting affects.

Support Spacing

Sign supports are spaced laterally based on sign width, without regard for material. Standard post clear spacing for two and three post installations are given in **Error! Reference source not found.** and Figure SN.30. It is important to note, however, that post spacing must be adjusted occasionally to maintain federal breakaway requirements. In order to meet breakaway requirements, supports should be designed to meet the following:

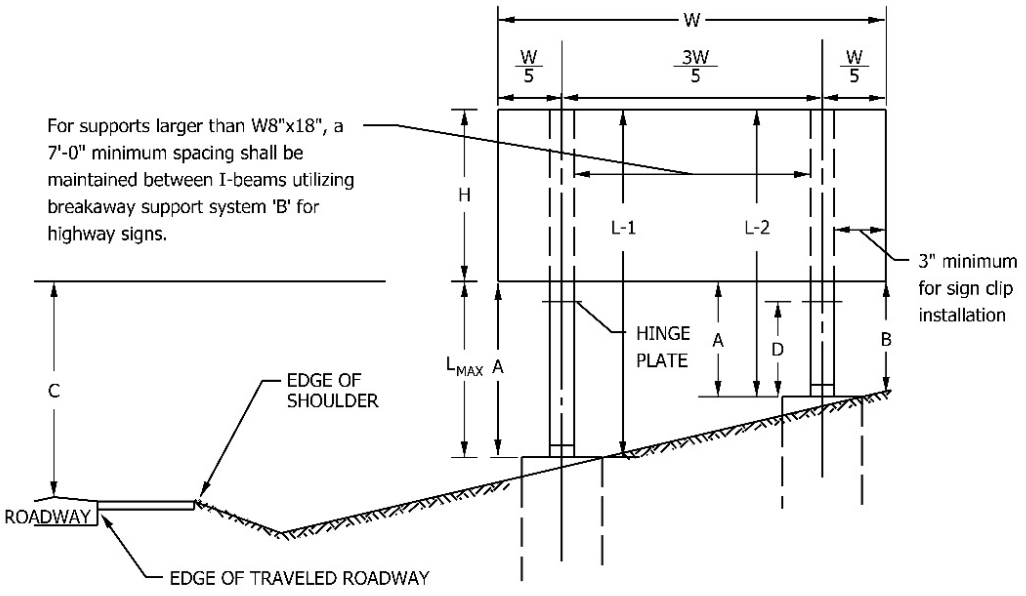
- All wood supports 4"x6" or greater shall be drilled per standards.
- No more than two (2) 4"x4" or two (2) drilled 4"x6" wood posts are permitted within a 7'-0" distance, regardless of the spacing between the supports.
- The minimum clear spacing (inside edge of support to inside edge of support) between all drilled 6"x6" and drilled 6"x8" posts is 7'-0".
- For steel supports, a single post spaced with a clear distance of 7 feet or more from another post, shall have a weight less than 44 pounds per foot. The total weight (for all supports) below the hinges but above the shear plate of the breakaway base, shall be less than 600 pounds (a W6x15 weighs 15 pounds per foot). See Table SN.10 for allowable support lengths.

  Signs on a single steel breakaway support shall be considered as small roadway signs and the max sign area where practical should be limited to 54 S.F. Larger signs induce harmonic resonance resulting in failure of the hinge plates and breakaway coupling. For two steel supports spaded less than 7 feet apart, each post should have a weight of 18 pounds per foot or less.

Table SN.10 - Maximum Steel Support Length Below Hinge

Support Weight (lb/ft)	Max Length (ft) - 1 support	Max Length per Support (ft) - 2 supports	Max length per Support (ft) - 3 supports
9	66.7	33.3	22.2
12	50	25	16.7
15	40	20	13.3
18	33.3	16.7	11.1
21	28.6	14.3	9.5
22	27.3	13.6	9.1
26	23.1	11.5	7.7
30	20	10	-
31	19.4	9.7	-
35	17.2	8.6	-
44	13.6	-	-

VERTICAL SIGN CLEARANCE FOR STEEL SUPPORTS



Minimum Vertical Clearance for Steel Supports

A. 7'-6" minimum for breakaway supports or 7'-0" for non-breakaway supports (5'-0" min in rural locations).
B. 2'-0" minimum
C. 7'-6" minimum & preferable. This dimension is to be increased only when required to meet A = 7'-6" for breakaway or A (min.) = 7'-0" for non-breakaway and B (min) = 2'-0"
D. 7'-0" minimum for breakaway supports

Notes:

A. See 'TRANSPO Industries' software and/or website for breakaway steel support calculations.
B. See Appendix A-6 for non-breakaway steel support tables.
C. Lmax should be used as the design height for steel supports.
D. The total weight below the hinges should be less than 600 pounds.
E. Both conditions 'A' and 'C' must be met.

Legend

H = Height of sign
Lmax = Height from top of foundation to bottom of sign (for longest support)
L-1 = Length of first support (Identified in the steel support chart on SN-4)
L-2 = Length of second support (Identified in the steel support chart on SN-4)
W = Width of sign

Figure SN.28 - Steel Support Vertical Clearance

- Also, for multidirectional breakaway, two I-beams shall not be placed within 7'-0" (measured from inside edge of support to inside edge of support), per manufacturer's requirements. However, two W6x9 supports with type 'A' breakaway couplings can be installed within 7'-0". This is common for Exit Gore signs
- W6x12, W6x15, and W8x18 breakaway supports with Type 'B' systems can be used for intermediate sized signs with no more than two supports spaced within a 7'-0" distance. W6x9 supports shall not be used with breakaway system 'B'; they should use system 'A' instead. For further guidance regarding the size of supports and breakaway system required for a particular sign, refer to TRANSPO software for calculations.
- The hinge plate for breakaway steel supports is located 7'-0" to 7'-2 ¾" above the ground. The bottom of the sign face should be approximately 3.25" to 12" maximum above the hinge plate in order for the breakaway coupling to function properly in the event of being struck, however, 6" above the hinge is the preferred minimum. Supplemental panels must be mounted above the hinge plate, because they will prevent them from operating properly. Where necessary, an aluminum angle can be used to hang a single plate, such as a generic service logo, below the hinge plates.
- NOTE: Standard sign support spacing is based on the distance from center of support to center of support. Therefore, for each steel support size there is a +- minimum sign width to achieve the standard spacing. For example, the minimum sign width for two W6x15 I-beams is 12.5 ft.

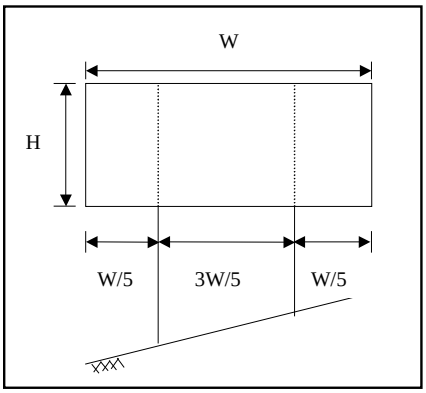


Figure SN. 29 - Standard Sign Support Spacing (Two Supports)

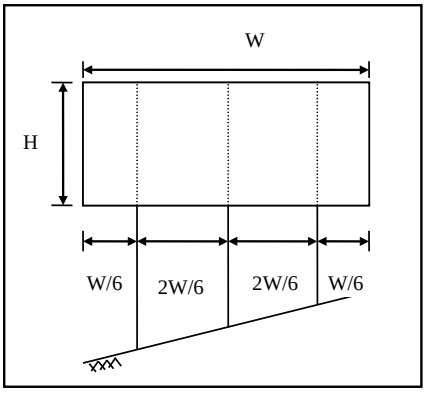


Figure SN.30 - Standard Sign Support Spacing (Three Supports)

Figure SN.31 - Breakaway Steel Support

Figure SN.32 - Breakaway Hinge for Steel Support

Where problems are encountered, designers should consider the following possibilities:

- Increase the sign width to accommodate breakaway spacing.
- Locate traffic barrier nearby and mount on non-breakaway posts.
- Over-design the supports. (i.e. use steel supports instead of wood).
- For additional options see Structural Design Team.

Supports on Steep Slopes

As defined in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals and the Maryland SHA Standard for Breakaway Poles Adjustment for Ground Slopes, "To avoid undercarriage snagging on convex ground profiles, the top of the footing shall not project more than 4" above any 60" chord aligned perpendicular to the edge of the roadway between a point on the ground surface on one side of the support to a point on the ground surface on the other side of the support." Based on this requirement, a 30" foundation is limited to a 10:1 slope, a 36" foundation is limited to a 12:1 slope, and a 42" foundation is limited to a 13:1 slope. Special considerations have to be made if the slope exceeds these values. The following steps should be taken when this occurs:

1. Determine if there is another suitable location to install the supports where the roadside slope is acceptable and the surrounding terrain is graded, where there is an existing roadside traffic barrier, on an existing structure, or similar non-accessible areas.
2. Determine if grading can be performed to obtain a desirable slope. A 10:1 slope is required in advance of the foundation.
3. Consider the use of a modified foundation:
   a. A Type B sign post foundation can be used if the conditions in the table below are met. When used, a portion of the exposed corner of the footing on the lower side of the slope shall be removed as per MSHA Standard No. MD 801.04-01 from the MSHA *Book of Standards for Highway and Incidental Structures*.

Table SN. 11 - Type B Sign Post Foundation Requirements

Max Slope	Foundation Diameter
7:1	30"
8:1	36"
9:1	42"

   b. A breakaway Type C sign post, or a modified saw tooth foundation, can be used if the conditions in the table below are met. When used, the foundation shall be installed as per MSHA Standard No. MD 801.04-02 from the MSHA *Book of Standards for Highway and Incidental Structures*.

Table SN.12 - Type C Sign Post Foundation Requirements

Max Slope	Foundation Diameter
3:1	30"
4:1	36" and 42"

4. Redesign the sign to be placed on smaller supports.

5. Install traffic barrier and mount sign on non-breakaway posts. Typically, barrier should not be installed for the sole purpose of protecting ground mounted signs. There are few situations that may warrant this as a last resort.

Additional steps should be taken to ensure that a breakaway support would fall in a safe and predictable manner when struck by a vehicle. First, it is important to keep in mind that breakaway supports are designed for impact at a bumper height of 20 inches. To maintain this height, signs should not be located near ditches or on a back slope near the drainage channel where vehicles could be funneled into the sign or become airborne. It is also important to keep sign foundations outside ditch lines so that water is not pushed onto the road surface and the water does not cause excessive wear on the foundation and support. To prevent the chances of an errant vehicle becoming airborne on a fill slope, slopes can be rounded to create a more traversable terrain.

It is also important to determine an appropriate clear zone based on the steep slope. Non-breakaway foundations can be used if they are installed outside of 1.3 times the clear zone or behind traffic barrier.

Figure SN.33 - Improper Supports on Steep Slopes

Foundations for non-breakaway supports, for ground mounted signs or overhead sign structures should be raised 3" minimum above the high elevation of the grade. This will allow rain runoff to flow around the foundation. This eliminates corrosion of the base plate and anchor bolts.

For larger foundations for overhead or cantilever sign structures in fill sections 3:1 or greater, slope stabilization with rip rap should be provided to prevent erosion around the foundations. Small earth retaining walls formed around the foundation can be used to divert run off where the slope in a cut section is 3:1 or greater.

Other Small Sign Supports

Maryland SHA most commonly uses either wood or steel sign supports for the installation of small signs. A variety of other small support types exist which may be more appropriate for certain situations. These include square tube, round tube, and posts made from alternative materials such as fiberglass. These posts are grouped into two categories, yielding and breakaway, depending on how they meet breakaway requirements. Care should be used when using these types of supports to provide a minimum 7' ground clearance and a minimum 9' clearance to the top of the sign to avoid impact with the windshield of a car.

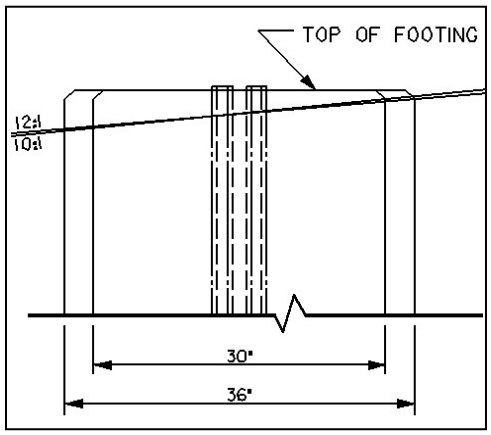


Figure SN.34 - Slope Limits for Foundations

Yielding supports are not currently used in Maryland. They are designed so that the post will bend at the base when struck by a vehicle, causing the sign to hit the ground and pass underneath the impacting vehicle. They are typically smaller metal supports, such as Square Tube or U-Channel, buried directly in the ground without the use of a separate base. These supports have been known to snag on the underside of cars, pulling the post from the ground.

Breakaway supports are designed to break away at the base when struck by a vehicle. They may be weakened to cause fracture or installed with a separate anchor base and post, which are designed to separate under vehicle impact. This allows the sign and support to pass over the vehicle after being struck therefore it is important to maintain proper sign height. This type of support includes some Square Tube installations as well as fiberglass and other post types.

Sign Banding

Sometimes it is more practical to band a sign to an existing light pole or overhead sign support rather than install a brand new sign support. Maryland SHA prefers to use sign banding when applicable because it involves fewer supports which means fewer roadway obstructions and less items to maintain. Table SN.7 specifies the maximum sign sizes and mounting heights for various light pole types.

NOTES:

1. See MSHA Standard No. MD 813.08 **from the MSHA *Book of Standards for Highway and Incidental Structures*** for more information regarding sign banding and installation.
2. 3’ x 3’ or 4’ x 4’ sign panels can be square or diamond shape. Reference the appropriate standard plate for proper attachment devices.
3. All sign panel sizes have been calculated based on the max allowable loading on either poles or breakaway transformer bases.
4. All sign placements shall conform to the MdMUTCD.

Table SN.13 - Allowable Sign Banding Sizes

Pole Type (feet)	Arm Length (feet)	Maximum Allowable Sign Size (Total SF)	Maximum Height to Bottom of Sign (feet)
30	15 or Less	16	7
		9	7-15
	20	9	7
40	15 or Less	16	7
		9	7-15
	20	9	7
	25	16	7
		9	7-15
	30	9	7
	35	16	7
		9	7-15
50	10 or Less	16	7
		6	7-15
Bridge Mount Poles	All Sizes	1.5	7

TRANSPO Design Software

The MSHA standard for the selection of breakaway steel supports is the TRANSPO Industries design program. A screen shot of the input screen can be seen in Figure SN.35. To use the program, the design engineer inputs the sign parameters and the program will automatically select a support size and provide an output. The following should be used for inputs:

1. Wind Speed: A design speed of 100 mph should always be used.
2. Design Life: A design life of 10 years is recommended by AASHTO.

3. Yield Stress: 36,000 psi is to be used.
4. Sign Width: Input the width of the sign under consideration.
5. Sign height: Input the height of the sign under consideration.
6. Maximum Under Sign Clearance: A minimum under clearance of 7'-6" should be used but this input value is based on the maximum under clearance with respect to the roadside slope.
7. Number of Posts: Input the desired number of sign posts here.

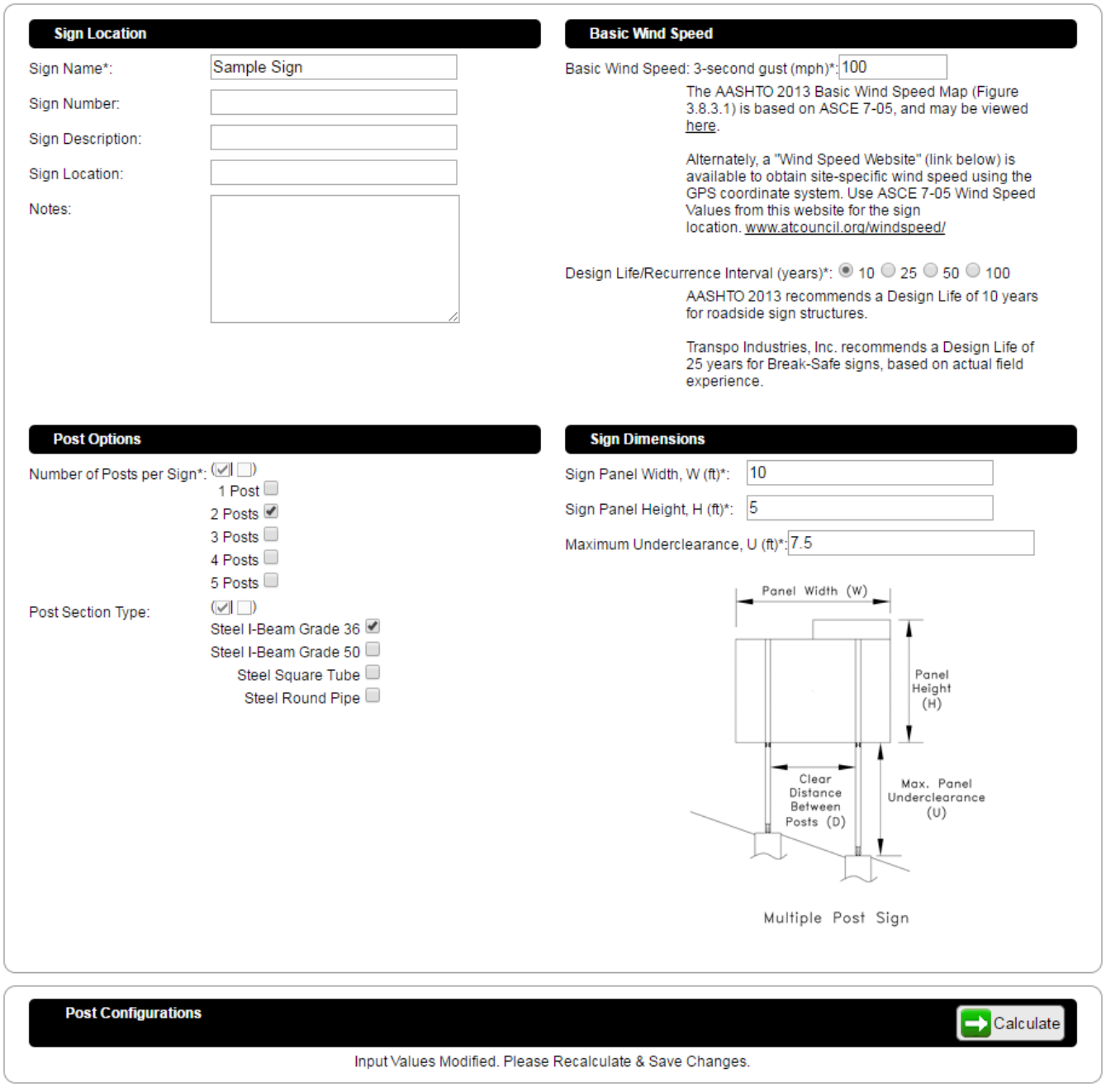


Figure SN.35 - TRANSPO Design Software

Checking the Design

Once the sign and support design is complete and a location has been determined, the following items (that are sometimes overlooked in design) should be reviewed to ensure proper placement:

1. Right of Way
2. Geometrics
3. Landscaping
4. Verify overhead signs do not impede visibility of signals
5. Verify sign structures are not located behind obstructions such as light poles
6. Utilities (overhead and underground)
7. Adjacent Construction Projects

Roadside Hazards

Any objects that are located along the roadside and are not shielded from the driver present a hazard to the motorist. This includes trees, utility poles, sign supports, light supports, and traffic barrier. The AASHTO Roadside Design Guide defines the clear zone concept as an unencumbered roadside recovery area. This distance is typically 30 feet for a freeway, and may vary based on design speed, traffic volumes, and roadway geometry. Clear zone distances can be looked up in the Clear Zone Distances table of the AASHTO Roadside Design Guide and should be used as a guide in determining what objects need to be protected with traffic barrier.

Any sign supports located within the clear zone of a roadway must either meet federal breakaway requirements or be protected by traffic barrier. For ground mounted supports, breakaway modifications are detailed in the MSHA *Book of Standards for Highway and Incidental Structures*. All overhead and cantilever installations within the clear zone must be protected by traffic barrier.

Traffic Barrier Design

The design of traffic barrier is outlined in Chapter 5 of the AASHTO's Roadside Design Guide as well as in the MSHA's Guidelines for Traffic Barrier Placement and End Treatment Design. The process generally involves the following steps:

1. *DETERMINE CLEAR ZONE DISTANCE*. This is selected from Table 3.1 of the AASHTO Roadside Design Guide and/or Table 1 of MSHA's Guidelines for Traffic Barrier Placement and End Treatment Design and is based on design speed, traffic volumes and roadside slope.

2. *DETERMINE IF BARRIER IS WARRANTED*. If the support is within the clear zone and is not breakaway, traffic barrier is required. For ground mounted sign supports, breakaway modifications can be added per the MSHA *Book of Standards for Highway and Incidental Structures* because traffic barrier should not be installed for the sole purpose of protecting a new ground mounted sign.

3. *CHECK IF EXISTING TRAFFIC BARRIER CAN BE EXTENDED TO PROTECT THE SUPPORT.*

4. *DETERMINE LATERAL OFFSET OF TRAFFIC BARRIER*.

Traffic barrier is typically installed 2 feet from the edge of paved shoulder. When practical, traffic barrier should be installed beyond 12 feet on fill slopes (6:1 or steeper) and as far out as possible on cut slopes. The offset from face of traffic barrier to face of sign support or foundation, typically 8 feet for single post installations, is determined by the dynamic deflection distance of the traffic barrier.

Where adequate deflection distance cannot be provided between the back of the traffic barrier and the face of the obstacle, stiffening systems can be used. These include reducing the post spacing (i.e. double posting or quarter posting), and nesting of traffic

barrier. Where stiffening systems are used, they must be installed for an appropriate length upstream and downstream of the roadside hazard. All stiffening systems should be designed in accordance with MSHA's "Guidelines for Traffic Barrier Placement and End Treatment Design".

5. *CALCULATE LENGTH OF NEED*. This is done using the formulas given in the AASHTO Roadside Design Guide and MSHA's Guidelines for Traffic Barrier Placement and End Treatment Design.

6. *SELECT AN APPROPRIATE END TREATMENT*.

When designing traffic barrier, it is important to consider the following:

- It is important to check fixed objects for hazard potential to vehicles traveling in BOTH directions. This is especially true for two lane highways and divided highway medians. This will influence the choice of end treatment and single versus double face traffic barrier.
- Where traffic in the reverse direction is not a concern, the departure section of traffic barrier typically extends 25 Feet past the sign support and terminates with a Trail End Anchorage (sometimes called a Boxing Glove).

End Treatments

The selection of an appropriate end treatment is a critical component of traffic barrier design. A full list of types of end treatments and descriptions can be found in the MSHA *Guidelines for Traffic Barrier Placement and End Treatment Design.* The end treatment is designed to prevent vehicles from spearing, riding on top of the traffic barrier, and rolling over. When selecting an end treatment, the following items should be considered:

- Wherever possible, traffic barrier should be extended and the end buried in the back slope of cut sections, as detailed in MSHA's *Book of Standards for Highway and Incidental Structures*. This is economical and safe and should be considered as a first option for all installations. Typically, an extension of 200 to 300 additional feet is justifiable.
- Many end treatments require roadside grading of 10:1 or flatter. Be sure to check slopes and make the appropriate adjustments.
- It is important to use the correct end treatment for a given situation. Roadside end treatments are not intended to be struck from both front and back, and should not be used in medians where they may be struck from behind by opposing vehicles.
- Enclosed and enveloped treatments are acceptable for median applications.

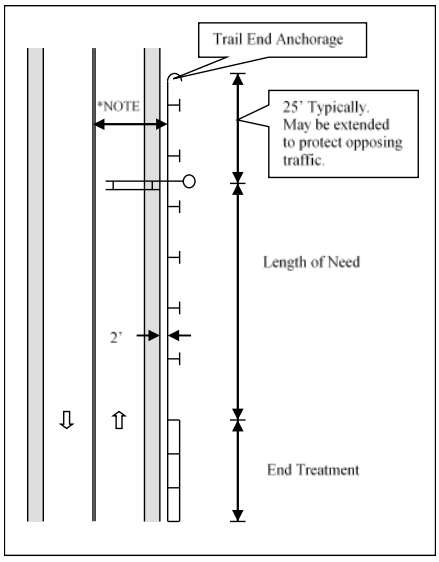


Figure SN.36 - Typical Traffic Barrier Installation

*NOTE: Check the clear zone distance from opposing direction of travel for undivided highways. Extend barrier and install crash worthy end treatment in place of the trail end anchorage if required.

Delineation Design

Delineation devices are effective aids for night driving and are to be considered as guidance rather than warning devices. Delineation devices are used along continuous sections of highway, through locations where there are changes in horizontal alignment, and at other potentially hazardous locations. Refer to the MSHA Roadway Delineation Policy and *Book of Standards for Highway and Incidental Structures* for more guidance. Check with individual districts for additional information since some districts use alternative treatments.

The most common types of roadway delineation devices are: pavement markings, snowplowable raised pavement markers (SRPMs), typical traffic barrier installations, post mounted delineators, w-beam barrier mounted "rail riders" and barrier wall mounted delineators, chevron alignment signs, and object (hazard) markers. Delineators shall be yellow in color when placed on the left, median-side of the road, and white when placed on the right shoulder-side of the road.

DO NOT FORGET TO ADD DELINEATORS TO A PROJECT. Delineators are paid for per each and are not incidental to the price of the traffic barrier of which they are to be mounted. Therefore, delineators must be included on the plans and as a separate pay item in the estimate.

Pavement Markings, Raised Pavement Markers (RPM's)

See the Materials section of this manual for more information regarding RPM materials.

Post Mounted Delineators

These delineators consist of flexible posts with reflective sheeting, as well as wood snow stakes. Placement of delineation is based upon roadway classification, need, and at locations such as intersections, channelizing islands, spot hazards, horizontal curvature, crossovers, auxiliary and turn lanes, lane drops/merges, narrow bridges, narrowed roadway sections, etc.

Single yellow delineators (or snow stakes) should be provided along the left side of expressway and freeway roadways during winter months. Single white delineators shall be provided along the right side of expressway and freeway roadways if RPMs and/or roadway lighting is not present. If RPMs are continuously placed on lane lines and/or roadway lighting is present, right side delineators are optional and left side delineators can be removed during non-winter months.

For non-expressway and non-freeway type divided highways, left and right side delineators are optional if RPMs and/or roadway lighting are present. In the absence of RPMs and/or roadway lighting on these roadways, right side delineation should be placed in rural areas if speeds are 50 mph or greater; left side delineation is optional.

The spacing of delineators along expressway and freeway roadways, when used, shall be 264 feet, except that snow stakes may be spaced at 528 feet. On accel/decel and C/D roads, double delineators shall be used with spacing of 100 feet.

Utility Identification Markers are delineators which are used to mark the location of drainage features and water sources. These should be blue to mark the location of water sources (fire hydrants, streams, ponds, etc.) and green to mark the location of drainage inlets.

Figure SN.37 - Single Yellow Delineator

Figure SN.38 - Single White Delineator

Figure SN.39 - Single White Delineator

W-Beam Traffic Barrier Delineators

W-beam traffic barriers within 6 feet of the shoulder (or road edge if no shoulder is present) along either side of one-way roadways or on the right hand side of two-way roadways shall be provided with barrier mounted delineators, or “rail riders.” Along tangent sections in excess of 500 feet in length, the spacing of delineators shall be 100 feet. For tangent sections less than 500 feet in length and curves of less than 1,000-foot radius, the spacing of delineators shall be 50 feet.

Figure SN.40 - Top Mounted Yellow W-Beam Marker

Barrier Wall Delineation (Barrier Markers)

Barrier walls within 15 feet of the travel lane along either side of one way roadways shall be provided with barrier markers. The spacing of barrier markers shall be 100 feet along tangent sections of roadway and 75 or 50 feet along curves having a radius of less than 1000 feet and less than 300 feet, respectively. Double delineators should be used for accel/decel and C/D roads as shown in Figure SN.41, otherwise a single delineator should be used on the side only for single face barrier.

Figure SN.41 - Top and Side Mounted White Barrier Wall Markers

Lateral Clearance of Signs

- The lateral clearance from edge of roadway to near edge of sign should be consistent with the roadway type and use.
- **The preferred sign location is outside of the clear zone.** If this condition cannot be met, the sign should be placed as far from the roadway as possible.
- The edge of sign should be a MINIMUM of 6 feet behind the face of traffic barrier. Note that this exceeds the offset requirements identified in the latest MSHA *Guidelines for Traffic Barrier Placement and End Treatment Design*.
- The edge of sign should be a MINIMUM of 6 feet beyond the edge of shoulder.
- In urban areas, the edge of sign should be 6 feet preferred minimum and 2 feet absolute minimum behind the face of curb.

MATERIALS

Reflective Sheeting

The use of reflective sheeting on highway signs improves nighttime visibility and gives drivers more time to read, comprehend and react to roadway information. The actual performance of a given sheeting is a function of sheeting type and sheeting manufacturer.

There are eleven (11) types of sheeting used for traffic control. The Standard Sign Book gives sheeting types for all standard signs. Sheeting types are defined by ASTM D-4956 and are given the designations Type I through Type XI. A summary of these types along with descriptions and typical applications is as follows:

Type I: This is an enclosed lens glass-bead sheeting that is commonly referred to as “Engineering Grade”. This type of sheeting has the lowest reflective properties of all categories.

Type II: This is another type of enclosed lens glass-bead sheeting commonly referred to as “Super Engineering Grade”. Typical applications would be for highway signs, delineators, and Work Zone Traffic Control. This type of sheeting is used on No Parking, No Stopping, No Standing, and Hiker-Biker signs.

Type III: This is an encapsulated glass-bead sheeting commonly referred to as “High Intensity”. Typical applications are for highway signs, delineators, and Work Zone Traffic Control.

Type IV: This is a non-metallic microprismatic sheeting also referred to as “High Intensity”. Typical applications would be for highway signs, delineators, and work zone traffic control.

Type V: This is a metallic microprismatic sheeting, also referred to as “Super-High Intensity”. This material is typically used on delineators.

Type VI: This is a vinyl microprismatic sheeting typically used for roll-up signs and on traffic cones.

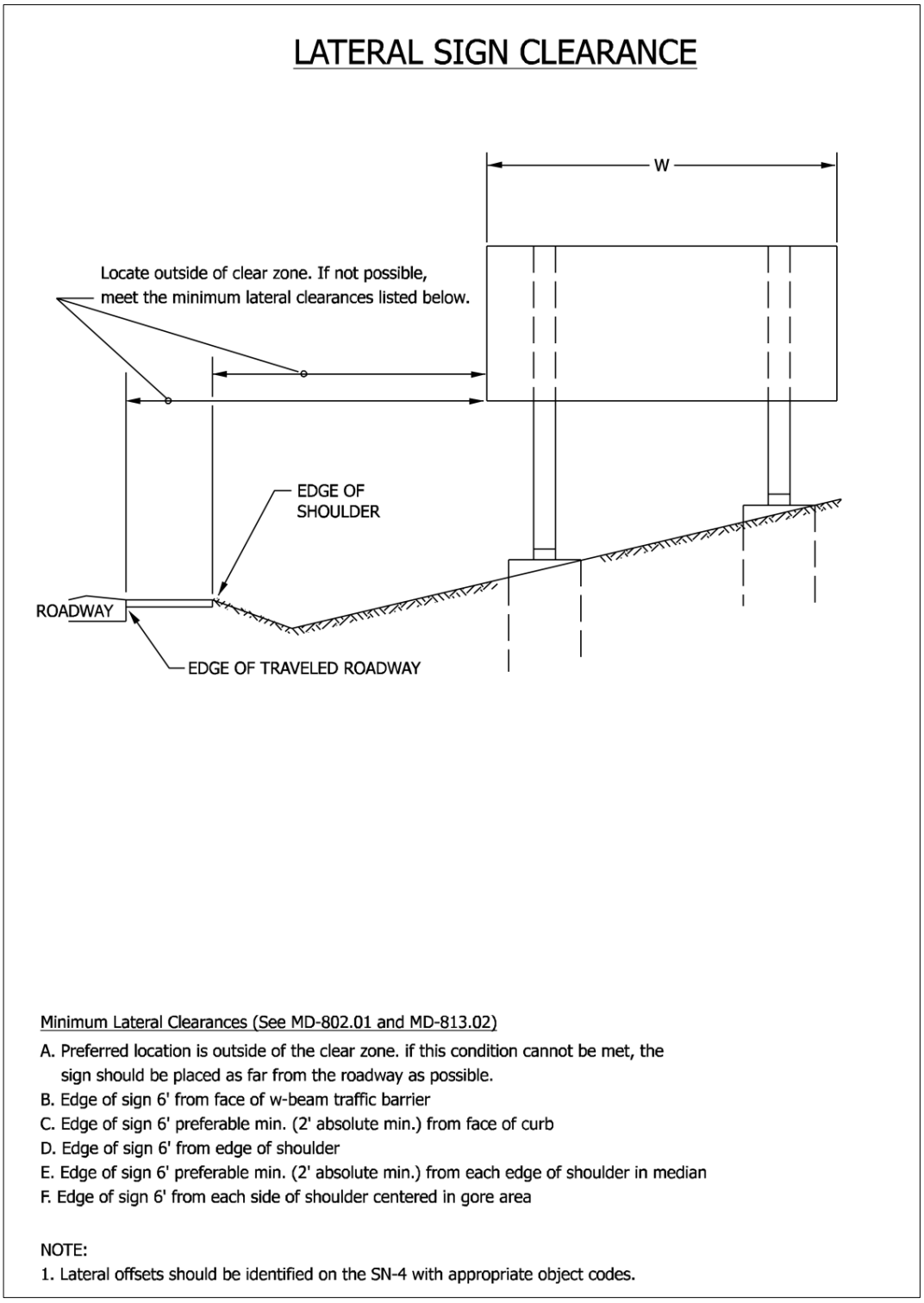


Figure SN.42 - Lateral Sign Clearance

Type VII: This material designation has been discontinued and has been reclassified as Type VIII.

Type VIII: This non-metallic microprismatic retroreflective element material is commonly referred to as "Super High Intensity". It is a retroreflective sheeting which has the highest retroreflective characteristics at long and medium road distances. Applications for this material are permanent highway signing, construction zone devices, and delineators. This type of sheeting is the minimum acceptable type for rigid temporary traffic signs.

Type IX: This non-metallic microprismatic retroreflective element material is commonly referred to as "Very High Intensity". It is a retroreflective sheeting which has the highest retroreflective characteristics at short road distances. This type of sheeting is used for Stop, Yield, Chevrons, Turn Warning, Do Not Enter, Wrong Way, and Guide signs.

Type XI: This is a high performance sheeting offering excellent visibility at wide viewing angles that is utilized in Type IV thru Type IX sheeting. Trade names for this type of sheeting include Diamond Grade, Long Distance Performance (LDP), which is used for Work Zone signs, overhead guide signs, and Visual Impact Performance (VIP), which is used for Turn Warning, Do Not Enter, and Wrong Way signs. The removal of sign lighting can be considered when Type XI sheeting is used on signs.

The following guidelines should be used when selecting sheeting to be used for standard signs.

- Guide, Exit Gore, and General Information, Warning, and School signs shall meet or exceed the requirements of Type IX sheeting.
- Regulatory Signs fall into three categories:
    - Red Regulatory Signs shall meet or exceed the requirements of Type IX sheeting.
    - R7 and R8 series parking related signs and supplemental panels to R7 and R8 series signs, No Trespassing signs, and signs directed at pedestrian and bicycle traffic shall meet or exceed Type I sheeting.
    - All other regulatory signs shall meet or exceed Type IV sheeting.
- Route markers shall meet the requirements of guide signs if they are used on a guide sign. Route Markers for independent use and their auxiliary panels shall meet or exceed Type IV sheeting.
- Logos and/or graphics shall follow the guidelines for the respective sign classification unless otherwise specified in contract documents or directed by the project engineer.
- Civil Defense signs and other signs not in the categories above shall follow the guidelines for the sign classification that most closely matches the color(s) of the proposed sign.

Color

Sign color is dictated by the guidelines specified in the MdMUTCD for all signs including but not limited to regulatory, warning, guide, services, recreational, and emergency. State standards require the use of fluorescent yellow for all warning messages not used in a temporary traffic control zone, fluorescent orange for all warning messages in temporary traffic control zones, and fluorescent yellow green for all school signs, "school" portions of speed limit signs, and supplemental plaques in school zones.

Night Driving

The mechanics of nighttime visibility differ somewhat from daytime conditions in that the available light levels are a function of vehicle headlights, roadway lighting, sign lighting, ambient lighting from surrounding land uses, and sign sheeting material. The interaction of light between vehicle headlight, sign (or sign sheeting) and driver is referred to as retroreflection. In American Society for Testing and Materials (ASTM) standard E-808, retroreflection is defined as "reflection in which reflected rays are preferentially returned in directions close to the opposite of the direction of the incident rays". In other words, light from vehicular headlights is intentionally directed back at the approaching vehicle. Two of the primary measures of light and sheeting performance, called Observation Angle and Entrance Angle, are depicted in Figure SN.43 and Figure SN. 44.

Both Observation Angle and Entrance Angle are used to determine the performance criteria for sign sheeting. Each point along the roadway, for example 250 feet in advance of a warning sign, corresponds to an Entrance and Observation Angle Pair. The performance of sign sheeting is measured by taking luminance measurements at standard angles (typically Observation Angles of 0.2° or 0.5° and Entrance Angles of –4° and 30°). When these criteria are exceeded under driving conditions, the sign may appear either "dull" or completely black depending on the sheeting type (Type I through XI), manufacturer, and condition. Some situations where this is of concern include Keep Right (R4-7) signs, which are commonly placed at a 15° angle and Added Lane (W4-3), or Merge (W4-1) signs at the end of a loop ramp. In both of these situations, the angle of approaching vehicles may reduce nighttime visibility of these signs for some approaches.

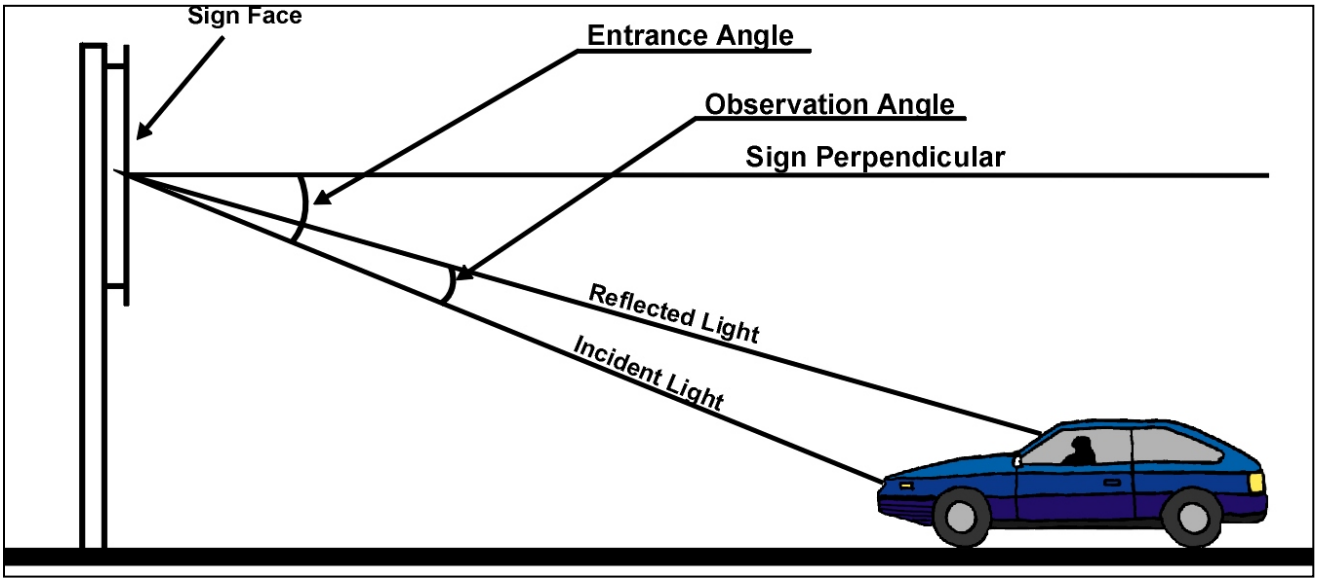


Figure SN.43 - Observation and Entrance Angle (Elevation View)

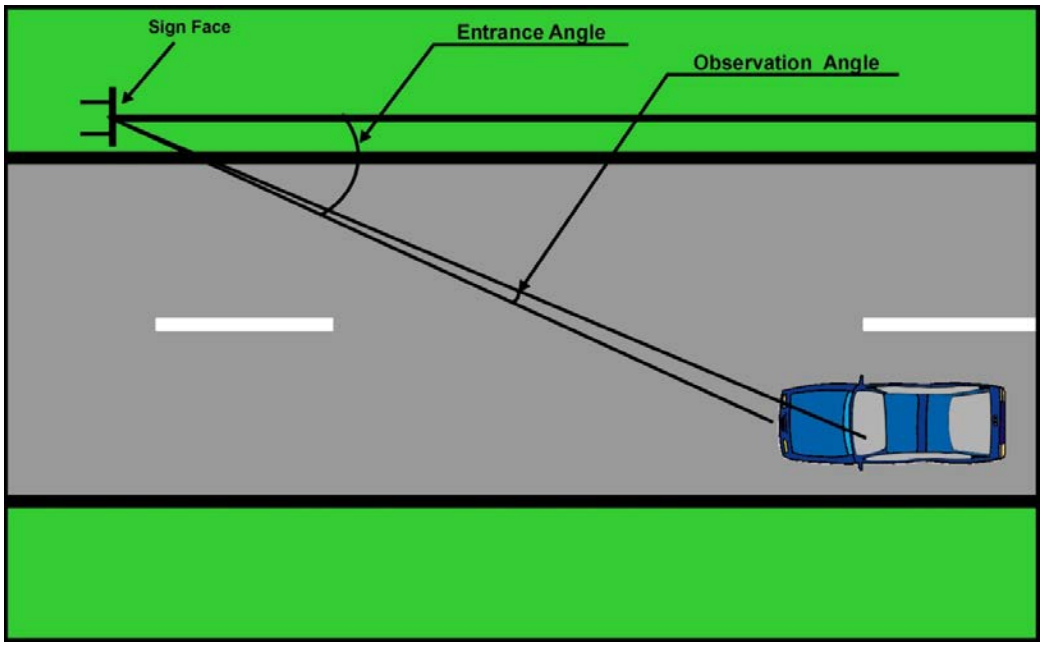


Figure SN. 44 - Observation and Entrance Angle (Plan View)

Aluminum Backing

Signs are constructed as reflective sheeting on an aluminum backing material. In the case of standard warning and regulatory signs, the legend is typically silk screened or "inked" onto a background consisting of reflective sheeting mounted on sheet aluminum. Maryland uses two types of aluminum backing material for sign construction, depending on the purpose:

Sheet Aluminum

Sheet aluminum is used for standard warning and regulatory signs, and for most guide signs with a surface area less than 40 square feet. It is also used for temporary signs that are mounted on skids or wood posts and for overlaying existing signs. The 40 square foot criteria is a rule of thumb based on support type and manufacturing considerations. **The primary consideration is that sheet aluminum cannot be mounted on steel supports using Maryland Standards;** therefore, any sign requiring steel supports must be made from extruded aluminum.

Extruded Aluminum

Extruded aluminum is used for all large guide signs and non-standard warning and regulatory signs over 40 square feet. Extruded panels are available in 6" and 12" heights that are cut to width and bolted together to build the correct sign height. **For signs constructed by the MSHA Sign Shop, heights should be designed to even multiples of 12" as 6" panels are not kept in stock.** Details regarding the construction and dimensions of extruded panels are given in the MSHA *Book of Standards for Highway and Incidental Structures*.

Pavement Markings

Pavement markings covered in this chapter include lines and markings applied to the pavement, raised pavement markers and special pavement treatments such as: rumble strips, tubular markers, contrast markings, and colored raised pavement markers. The design criteria and standardization of application are covered in the MdMUTCD. Pavement marking material selection is specified in the most recent edition of the

MSHA Pavement Marking Material Selection Policy and Guidelines.

The traveled portions of a highway are defined by pavement markings such as centerlines, lane lines, edge lines, channelizing lines, etc. Typical application details are included in the MdMUTCD. On state highways, the approval of the Asst District Engineer-Traffic or the Director of Office of Traffic & Safety is required to make any modifications to pavement markings that would change the functional operation of the roadway.

Materials

Material selection may vary by jurisdiction. For example, District 6 uses paint for most applications and the pavement markings are typically installed by maintenance rather than the contractor. As a result, if there is any uncertainty, material selection should be confirmed with the TEDD Project Manager at an early stage of the project. Additionally, the latest MSHA Pavement Marking Selection Policy should be used in the selection of pavement marking materials as there are always new materials being tested and reviewed. Generally, all markings applied on state highways are reflectorized. The black markings typically used for covering existing markings and as contrast markings are non-reflectorized. The MdMUTCD and the MSHA Pavement Marking Selection Policy dictate the widths and patterns of pavement markings. Pavement markings come in various compositions and each have different characteristics, costs, application methods, durability, and maintenance. Following is an outline describing the different typical permanent pavement marking material:

Waterborne Paint: Waterborne paints are used as permanent markings for rural and urban minor arterial, rural major collector, rural minor collector and rural and urban local roadways. They should not be used as permanent markings on new roadway pavement surfaces but can be used for re-striping over existing longitudinal pavement marking materials on both Portland Cement Concrete (PCC) Pavements and Hot Mix Asphalt (HMA) Pavements. Additionally, waterborne paints may be used in parking lots or for temporary pavement markings. The service life of waterborne paints is 6 months to 1 year, however longer service lives have been experienced in some areas. For application on new HMA surfaces (such as parking lots), two coats of paint may be needed as the paint tends to soak into the surface.

Thermoplastic: Thermoplastic pavement markings are durable markings applied on new asphalt surfaces and for re-stripping existing asphalt surfaces. MSHA uses thermoplastic markings for all longitudinal lines along multi-lane or divided highways other than Interstates/Freeways and any roadway with a lower classification including arterials, collectors and minor local roads. The service life of thermoplastic markings is 1.5 to 3 years. Specially formulated thermo may be applied as a thin retrace over existing pavement markings. The service life of the retrace is 1.5 to 2 years with the typical cost reduced. Thermoplastic is not typically used on PCC Pavements.

Epoxy: Epoxy pavement markings are durable markings applied on new asphalt. MSHA uses epoxy markings for all longitudinal lines along multi-lane or divided highways other than Interstates/Freeways and any roadway with a lower classification including arterials, collectors and minor local roads. Epoxy may be used for restriping if existing markings are 80% removed before the restriping occurs. The service life of epoxy markings is 1 to 3 years. This may be the material of choice where sections of the roadway have both concrete and asphalt pavements.

Pavement Marking Tape: Preformed tape markings are durable markings that can either be inlaid in new asphalt surfaces, applied with a primer on existing asphalt and applied with a primer on PCC surfaces. They are applied for all longitudinal lines on the following types of facilities:

- Bridge decks
- Interstate highway/freeways
- Multi-lane or Divided Highway (Not interstate)
- Single Lane NHS roadway
- Multi-lane or divided NHS roadway

When used on PCC, contrast tape is applied for lane lines for increased visibility. The service life of tapes is 4 to 6 years. These markings typically have a high initial cost. However, their greater durability and visibility compared to other durable markings make them desirable for high volume freeway applications where retracing is expensive and is very disruptive to traffic flow.

Preformed Thermoplastic Pavement Marking Lines: Preformed thermoplastic markings are heat applied using a propane torch for asphalt surfaces and applied with a primer on PCC surfaces. They are used for transverse markings, raised rumble strips, and for arrows, letters, numbers and symbols. These markings can be applied on pavement surfaces above freezing temperature. The material can be fused onto itself with a propane torch for routine maintenance. This material provides very good durability where cross shear resistance is required for stop line and crosswalk applications.

Snowplowable Raised Pavement Markers (SRPMs): Snowplowable markers supplement lane lines and channelizing lines approaching gore areas. They delineate the lanes during inclement weather and under low ambient light conditions. Snowplowable markers typically used along state highways are the raised type on a steel holder. Plastic holders can also be used as per the standard specifications and qualified products list. An epoxy adhesive (rapid setting, low viscosity, water resistant type) should be used to hold the housing and reflector unit in place in a grooved pavement slot to provide resistance to being removed by snow plowing.

Figure SN.45 – Snowplowable Raised Pavement Marker

Snowplowable markers can also be installed recessed or below the pavement surface. Recessed pavement markers (RPMs) are typically installed in but not limited to the heavily plowed western area of the state (Districts 6 and 7). The installation consists of grooving the pavement surface longitudinally and directly installing a reflector unit (lens) within the groove.

Figure SN.46 - Recessed Pavement Marker (RPM)

Special Pavement Treatments:

Rumble Strips: Rumble strips are bands of raised material or indentations formed or grooved in the traveled way, centerline or shoulders of roadways. Rumble strips call the motorist's attention to standard warning or regulatory devices or otherwise alert drivers by transmitting sound and vibration through the vehicle. Locations where rumble strips have been used include shoulders along freeways, ends of freeways, roadway centerlines, approaches to roundabouts, and in advance of sharp curves where other devices have not provided a significant reduction in off the road accidents.

Traveled way rumble strips are ¾ inch or less in height if raised or 1 inch or less in depth if indented and generally extend across the travel lanes. There are significant disadvantages to the use of rumble strips across travel lanes. These include:

- An abrupt rise or depression in the roadway can present problems to bicyclists and motorcyclists. Provisions should be made for cyclists to traverse through or around rumble strips.
- Nearby residents may be subjected to continuous noise and vibration in the residential areas prompting citizen's complaints.
- All motorists are subjected to the noise and vibration where only a few are in need of the affect to be alerted.
- Motorists may make unusual maneuvers to avoid rumble strips.
- Frequent maintenance may be required.

Shoulder rumble strips are usually 1 inch or less in depth and less than 3 feet wide indented along the roadway shoulder. They can be grooves rolled into the hot mix as part of a resurfacing project. The use of shoulder rumble strips may reduce drift-off-road accidents along freeways. They are not suitable as a riding surface for bicycles. Where bicycles are permitted adequate (4'-5') of clear shoulder width should be provided between the rumble strips and the outer edge of the shoulder. For further guidance regarding bike lanes and bike boxes, refer to the latest approved version of the Maryland SHA "Bicycle Policy & Design Guidelines."

Contrast Treatment: Contrast treatment of the pavement surface is used to provide lane guidance information to motorists. Typically for concrete pavements, the shoulders are built with a darker color than the travel lanes. Similarly, black non-reflective stripes can supplement lane lines to enhance visibility of the markings. These contrast treatments are typically used for lightly textured pavement surfaces and relieve the washout effect of the markings during dusk, dawn and under direct sunlight. Contrasting black markings should be the same width and placed longitudinally preceding the lane markings. For information regarding the materials used for contrast treatments, see the most recent version of the Maryland SHA Pavement Marking Material Selection Policy.

Colored Pavements: Colored pavements may be used as a traffic control device or for purely aesthetic purposes. Non-retroreflective colored pavement is used for aesthetics and could consist of brick patterns and other patterned surfaces which may be used in crosswalk designs. For more information and guidelines, see the “Colored Pavements” Section of the latest approved version of the MdMUTCD.