

Safety Evaluation for Roadways

SAFER Manual

- ✓ *Review road safety*
- ✓ *Identify potential hazards*
- ✓ *Rate safety needs*
- ✓ *Address immediate problems*
- ✓ *Budget for longer term safety improvements*



*Transportation
Information Center*

University of Wisconsin–Madison

This manual was prepared by the University of Wisconsin–Madison, Department of Engineering Professional Development with support from the Federal Highway Administration, the Wisconsin Department of Transportation, and UW–Extension.

It is designed to provide background information and offer an approach for reviewing safety conditions on local roads and streets. It also should help local officials with setting priorities and planning for both immediate action and future improvements.

There are no federal or state requirements for the improvement of roadway safety hazards. This manual is not intended to be a standard. The specific examples and suggestions are given only as examples.

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Safety Evaluation for Roadways

Safety is a major concern for street and highway agencies. Local elected officials and staff are responsible for reviewing their roads, identifying hazards, and making conditions safer. This is a challenge because conditions and hazards vary widely on local roads and because no federal or state standards identify specific hazards and require their improvement. The **SAFER (Safety Evaluation for Roadways) Manual** offers a practical, systematic approach to these safety reviews.

To help you recognize potential hazards, more than 100 photographs show typical conditions commonly found on local roads and streets. Potential hazards are grouped into categories: roadsides, intersections, railroad crossings, geometrics, warning signs, pavement markings, road maintenance, and special conditions. The specific conditions and suggestions presented are intended to be educational but they are just examples and do not create a standard.

Local conditions vary, and time and budgets are limited. To help you set priorities, the SAFER Manual recommends a rating system. Using this system will help you choose which conditions to address immediately and which to include in plans for future improvements.

Since studies show that removing hazards from the area closest to the pavement helps reduce fatal crashes, you should pay special attention to

conditions in this area during your safety review. The SAFER Manual describes and illustrates this *clear zone* on pages 5 and 6.

Inventory and analysis

The SAFER approach encourages local officials and staff to conduct a visual review of safety conditions on individual roads making note of the various hazards observed.

The top priority in conducting this review is to identify any conditions that need immediate correction such as serious roadside hazards or critical signs which are substandard.

Secondly, the data collected on safety hazards can be used to compile a system-wide list of needed safety improvements. To establish local priorities, rank this list according to the severity of the hazard, the road's functional classification (importance), and existing crash data.

Crash data for local roads is available from the Wisconsin Department of Transportation. Factsheets and training workshops offered by the Wisconsin Transportation Information Center will assist in safety review and analysis.

Inventory and data collection forms are not included in the manual, but you are encouraged to develop your own. Such forms, updated by annual reviews, can document existing conditions both for liability reviews and for budget development.



Safety rating

1 _____
Deserves immediate action

2 _____
Improve or protect in the near future

3 _____
Improve as priority allows

4 _____
Improve when other facility changes are being made

5 _____
No safety improvements recommended

Safety rating

In order to establish safety improvement priorities, a rating scale that relates to the immediacy of the need for improvement is useful. The SAFER Manual offers a safety rating scale based primarily on the recommended timing for the improvements. Some conditions deserve immediate attention. Others may be scheduled for future improvement as budget priorities permit.

Severity of conditions at the specific location and proximity to the road edge are other considerations in the rating system. Obviously, safety conditions that pose a greater threat of serious accidents would be higher priorities than those that do not. Hazardous

conditions located near the roadway would be higher priorities than those that are further from the edge of the traveled way. The relative severity of a potential hazard is helpful in setting priorities within a rating scale category.

The hazard rating scale follows. The accompanying photographs may make it easier for you to use the scale.

- 1 Deserves immediate action
- 2 Improve or protect in the near future
- 3 Improve as priority allows
- 4 Improve when other facility changes are being made
- 5 No safety improvements recommended

1 _____
Deserves immediate attention

Critical railroad advance warning sign in very poor condition. Also too low and on oversized post. Should be replaced and properly installed as soon as possible.



2 _____
Improve or protect in the near future

Guardrail that provides no protection but is a hazard itself. Should be removed and replaced (only if necessary) with guardrail that meets minimum standards.



3 Improve as priority allows



A hidden intersection may warrant reconstruction to improve visibility and reduce accidents. Since this requires plans and budget approval, include it in the next budget cycle as priorities dictate. In the meantime, use adequate warning signs.



Dropoff at a culvert can be improved by extending the culvert. Priority depends on depth of drop, distance from pavement, traffic volume and speeds, and accident history.

4 Improve when other facility changes are being made



A curve that may benefit from additional superelevation and paved shoulders. Schedule safety improvement when pavement is resurfaced.



Culverts at entrance could be improved with pipe grates or by building a storm sewer system when traffic volume and safety considerations warrant rebuilding the road.

5 No safety improvements recommended



Example of recent construction with good clear zone.



Safety rating

- 1 _____
Deserves immediate action
- 2 _____
Improve or protect in the near future
- 3 _____
Improve as priority allows
- 4 _____
Improve when other facility changes are being made
- 5 _____
No safety improvements recommended



Clear zone

Studies show that many accidents are caused by vehicles leaving the roadway and striking fixed objects. A flat, unobstructed roadside would help in preventing these accidents. Since a totally hazard-free right-of-way is not feasible, often the goal is to create a hazard-free zone immediately adjacent to the pavement. This is called the clear zone.

An estimated 70 percent of fatal crashes involving fixed objects occur within 20 feet of the pavement edge. Roads with higher traffic volumes and higher speeds, like freeways, deserve a wide clear zone. On urban and lower volume roads economics and

land uses often dictate that clear zones be narrower. Specific recommendations are provided in the *Roadside Design Guide*.

Ideally, the right-of-way should be free of all hazardous objects. Removing or relocating the objects should be the first priority. When this is not possible, using guardrail between vehicles and objects may be warranted. Pay special attention to critical locations such as curves and bridges.

Reviewing the existing clear zone on individual roads along with the crash data for those roads can help local officials set priorities for safety improvements.

Obstacles close to road. Errant drivers have minimal chance to avoid or recover.



Limited clear zone but consistent and not unreasonable for low traffic volume and low speeds.



Desirable clear zone established with reconstruction.



ROADSIDES
Trees



Large tree located very close to the travel lane. Tree damage indicates previous vehicle accidents. Both points increase the desirability of tree removal.



Heavily wooded area close to the travel lane. Complete tree removal is difficult and expensive, but is critical in some locations like intersections, driveways, curves, etc.



Extensive and uniform tree removal decreases likelihood of vehicle damage and is appropriate in areas of high speed and high traffic volumes. It also daylights pavement for easier snow removal.



Isolated trees in lawn of adjacent property owner. Recognize landowner sensitivity to removal of individual trees. Removal should be based on hazard severity. First priority should be for removing trees closest to the road. Use accident experience and other contributing factors to decide where removal is justified.



This category of safety issues deals with hazards found adjacent to the traveled way. The roadside extends from the edge of the travel lane or curb line to the right-of-way line. A wide variety of conditions and facilities may be encountered in the roadside. Typical conditions are described here. Other unusual or unique conditions will likely be encountered and must be handled individually.

Trees

Trees larger than four inches in diameter can be a hazard to a vehicle. The closer the trees are to the travel lane the more likely the vehicle is to encounter them. Isolated, occasional trees provide a reasonable opportunity for removal as contrasted with solid forest conditions where removal requires significant cost. Trees in critical locations such as curves and intersections should be considered for removal. Finally, trees that have been struck deserve additional attention.

Trees

Trees are common in urban areas in the terrace between the curb and the sidewalk. Distance behind the curb helps minimize likelihood of impacts. Low speeds also help reduce likelihood and severity of accidents.



Tree removal is a higher priority in areas with greater likelihood of vehicles leaving the roadway such as along the outside of curves.



ROADSIDES

Utilities

Utility poles are among the many objects that must normally share right-of-way use. Careful consideration of pole location can benefit roadway safety.



Utility pole located very close to the edge of the shoulder. Relocation to tree line would be desirable.



Utilities



Utility pole located beyond ditch. However, existing tree line would allow even greater set-back and safety.



Utility pole in urban environment. Extremely narrow terrace between curb and sidewalk limits options. Low speeds reduce risk.



Municipal-owned utility poles can provide cost-effective sign supports, reducing the number of posts and, therefore, the number of crash opportunities in congested areas.

ROADSIDES

ROADSIDES *Side slopes*



Steep slope greater than 3:1.

Side slopes

The slope of an embankment can itself become a hazard if it is steep. Tests have shown that a roadside slope greater than 3:1 (horizontal to vertical) may cause a vehicle to roll. Less severe slopes may also cause vehicles that leave the roadway to travel to the bottom where they may encounter other hazards such as trees, water, etc. At some locations, like curves or sites with a crash history, there may be a greater likelihood of vehicles leaving the road. These sites may require a more extensive review of roadside slopes and hazards.



Steep slope will carry vehicle down to hazardous trees.



Large tree and water at bottom of slope create dangerous situation.



Deep water at the bottom of a steep slope can be dangerous.



Side slopes

This steep slope is short, approximately six feet in height, so it has less potential for causing damage than a steep slope 10 feet or more in height.



Flat and wide side slope, wide ditch, and flat backslope. Easy for vehicle to travel across this right-of-way without danger of rollover.



Heavy bridge railing with exposed end. Location close to the travel lane makes impacts more likely. Protection with approach guardrail would reduce the crash severity.



Inadequate bridge railing in very poor condition does not provide protection.

ROADSIDES Bridges

Hazards associated with bridges include the bridge headwall or railing. Finding these with no approach guardrail is not uncommon. This permits a vehicle to hit railings or headwalls directly on their ends. The severity of risk is related directly to the distance from the edge of the travel lane, traffic volume and speed.

Therefore, one-lane and narrow bridges would likely require more immediate attention than wider bridges and culverts. Additional hazards include the drop-off on the bridge approach or the possibility of railing failure and the associated drop-off into the adjacent stream, roadway, etc.



Bridges

Blunt end of bridge railing. Lack of an approach guardrail also increases likelihood of vehicles traveling down steep slope and into water.



Narrow bridge on a curve increases desirability of approach guardrail.



Below left: Guardrail is too low and is missing proper transition and connection to railing. Candidate for improvement due to narrow bridge and water hazard.



Above right: Poor approach guardrail installation with inadequate post spacing (strength) and rail anchorage.

Right: Proper guardrail transition and anchorage to bridge railing prevents vehicle from hitting end of bridge railing by reducing deflection in transition area.



ROADSIDES
Culverts



Concrete culvert headwall protruding above the shoulder creates a hazard.



Large dropoff at culvert located very close to edge of roadway is dangerous.



Vertical drop at a culvert inlet immediately adjacent to driving lane. Inlet could be adjusted to eliminate dropoff.

Bottom left: Metal culvert extended to ditch line allows flatter side slope. Use of apron end walls to match slope would enhance safety.

Bottom right: Concrete culvert opening protected with steel grating improves safety.



Culverts

Culvert headwalls and drop-offs are similar to bridge hazards. They occur more frequently and are easily overlooked.

ROADSIDES

ROADSIDES Driveways

Concrete block driveway headwall close to road creates a hazard. Vehicles leaving the roadway would likely follow ditch directly into headwall.



Driveways

The physical construction of the driveway adjacent to a roadway can present several hazards. Driveway culverts and their associated headwalls are obstacles. Vehicles that leave the roadway may travel parallel to pavement in the ditch which leads them directly to the culvert or headwall. The driveway embankment can also become an obstacle if it has a steep slope.

The visibility of the driveway is another concern as it relates to vehicles entering the roadway. The traffic volume of the intersecting driveway, its location, and the type of traffic are all design issues to be considered.

Retaining wall at road edge creates hazard and limits visibility.



Decorative railroad ties on the right-of-way are a hazard to traveling public and an obstruction for snow removal.



Good driveway entrance with adequate culvert and apron endwalls allows flatter driveway slopes and eliminates a headwall. Provides excellent visibility.



ROADSIDES
Mailboxes



Hazardous mailbox support using telephone pole.



Installation of mailboxes on plank is dangerous. Plank is at height that would allow it to penetrate into the vehicle's passenger compartment.



Left: Ornamental stove anchored to concrete pedestal.

Bottom left: Mailbox supported by loose concrete blocks. Block behind boxes could easily penetrate the windshield and enter the vehicle's passenger compartment.

Bottom right: Good installation. Post is set back from roadway and mailbox is firmly attached on a swing-arm system.



Mailboxes

Roadside mailboxes are very common. Heavy or large ornamental mailbox installations can be a significant hazard. Light wood or steel posts with the box firmly attached can be constructed in a safe location that serves the property owner and the letter carrier.

ROADSIDES



Guardrail

Guardrail is commonly used to protect vehicles from roadside hazards. Guardrail, itself, can become a hazard if it does not adequately restrain and safely redirect the vehicle. The construction and maintenance of guardrail will determine its ability to perform. Inadequate length, improper end treatments, improper height and support, and missing hardware can all lead to malfunctions under crash conditions. The end of the guardrail is of special concern; blunt ends are particularly hazardous.

Proximity of the guardrail to the travel lane edge is important. The further the guardrail is removed from the travel lane, the less likelihood there is of damage, because the driver has more opportunity to gain control of the vehicle before it hits the guardrail. The design and construction of the area between the roadway and the guardrail are important. Level and hazard-free areas are desirable.

ROADSIDES Guardrail

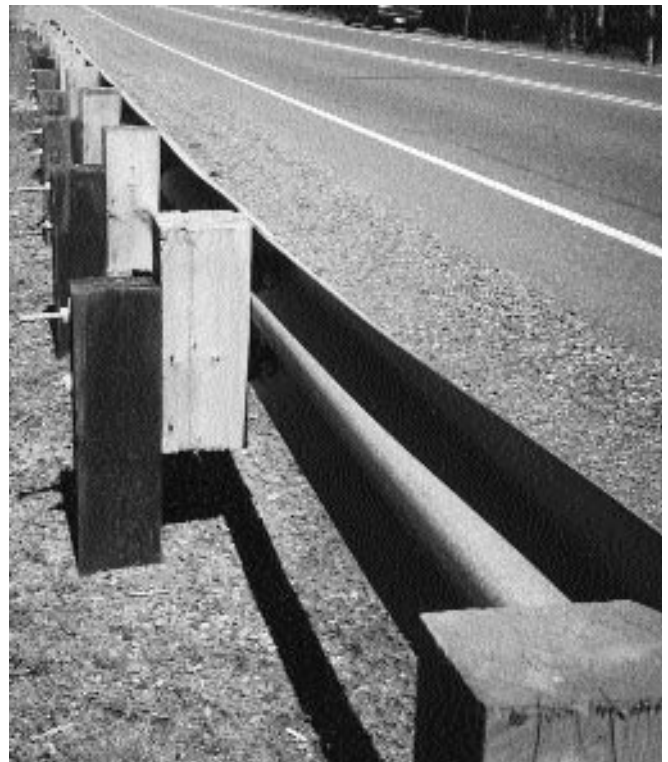
Poor guardrail installation. Blunt end with heavy post. Too low and missing support posts at mid-point of each rail section. Hitting the guardrail may be more hazardous to the vehicle than traveling off the roadway.



Very poor installation. Large asphalt curb which provides ramp up over guardrail largely eliminates the benefits of the guardrail installation.



Guardrail has to be raised after resurfacing to meet height standards. Blockouts protruding below rail are hazardous and should be cut flush with rail bottom.



Guardrail

Guardrail too close to utility pole. Rail will deflect several feet. The isolated utility pole hazard has been converted into a lengthy guardrail hazard.

Below left: Guardrail requires sufficient length and end anchorage to develop full strength. This short section would provide no restraint. Since rail is damaged, the location likely deserves a proper installation.

Right: Single guardrail section provides almost no protection and has exposed ends.



Left: Example of fitting guardrail into complex urban environment. Curb in front of guardrail and exposed utility pole may limit its effectiveness. Lower speeds in urban areas reduce impact severity at guardrail.

Below: Good guardrail installation. Flared end with breakaway design and flat approach.



ROADSIDES

ROADSIDES Other hazards

Large rock on top of backslope is a potential hazard. Fortunately, it is located a reasonable distance from edge of roadway.



Other hazards

Adjacent landowners often use portions of the right-of-way for temporary and permanent storage or display of materials. Control of this use is a local agency responsibility with safety being a primary consideration. The right-of-way should be kept clear of unsafe obstacles and maintenance forces must work with property owners to manage the right-of-way in a safe manner.

Tree removal has left stump. Should be cut to ground level to remove hazard.



Harvested timber stored on right-of-way should be removed promptly.



Farm equipment stored adjacent to roadway on curve.





Other hazards

Old vehicles and junk left on roadway right-of-way close to travel lane should be removed.



Rocks and tree removal debris left close to road.



Exposed footing. Objects higher than four inches in clear zone should be removed or protected.



Very high grass obscures shoulder. Mowing to define edge of shoulder and ditch is desirable.



INTERSECTIONS

Roadway intersections increase the likelihood of vehicle crashes. Safe and efficient movement through an intersection requires adequate visibility and proper design. The following individual characteristics should be considered: side road vision, design of T-intersections, and intersection controls.

Side road vision

Drivers need to be able to see an intersection well in advance in order to make safe driving decisions. Each quadrant of the intersection must be surveyed by the driver for the presence of possible intersecting vehicles.

Detecting intersecting vehicles requires time because first the driver must be aware of an upcoming intersection. Situations where the side road is obscured, either partly or completely, can be improved by using stop signs for the intersecting traffic and by alerting drivers by installing advance warning signs.

INTERSECTIONS

Side road vision

Hidden intersections often deserve advance warning of both intersection and stop sign to improve safety.



Obscured intersection vision from road on right increases need for installation of stop signs.



Blind intersection in urban area. Contact adjacent landowners regarding plant selection and trimming.



Side road vision

Urban intersection visibility improved with tree trimming on near corner. Evergreen on far corner obstructs vision there.

INTERSECTIONS



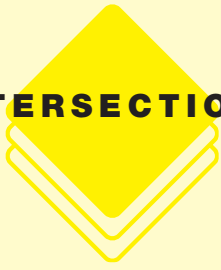
Left: Urban ordinance controls visibility at intersection for 25 feet. Reduces the need for stop signs.

Right: An obscured driveway limits one's ability to deal with vehicles entering or leaving the roadway. Reconstruction of roadway is both most effective and most costly. Warning signs can be a helpful intermediate measure.



A clear vision triangle at roadway intersections, like the one in the foreground, helps drivers avoid problems. Trees across the intersecting road in this photo obscure driver's vision.

INTERSECTIONS



T-intersections

T-intersections require investigation of several special conditions. In particular, the hazards beyond the T-intersection are important. If a vehicle fails to stop at a T-intersection and continues across the roadway, what specific hazards might it encounter? If hazard can't be removed, additional warning signs and rumble strips, etc., may be required.

INTERSECTIONS

T-intersections

T-intersection that leads to large tree. Removal may be warranted.



Rumble strips alert drivers to appropriate warning signs in advance of intersections with accident history.



INTERSECTIONS

Controls

The use of stop and yield signs is an important consideration at roadway intersections. The *Manual on Uniform Traffic Control Devices (MUTCD)* establishes warrants (criteria) to use in deciding where stop signs or yield signs should be installed. It is useful to review the adequacy of every intersection's controls, both periodically, and following crash instances.



Not all intersections require stop or yield signs. They should be used selectively at intersections that require control. The *MUTCD* provides warrants for installation. Lack of visibility and accident history are important factors.



RR CROSSINGS Visibility

Adequate vision is a high priority. Advance warning signs, pavement marking, and railroad crossbucks warning sign are normally required. Additional protection (flashing lights and gates) may be warranted depending on roadway and railroad traffic volumes and past accident experience.



Brush and trees almost totally obscure railroad tracks and any approaching trains. Should be cleared.



This railroad crossing has good visibility with additional protection of automated signals and gates.



The severity of impacts with trains requires special review of railroad crossings. Look at visibility of the crossing to the approaching vehicle traffic. Also review the adequacy of warning signs, pavement markings, and other protection equipment such as gates, bells, and signals. The Manual on Uniform Traffic Control Devices, along with federal and state standards, determine specific requirements for individual crossings. Information on the speed and volume of both vehicle and railroad traffic can help in assessing priority for crossing improvements.



RR CROSSINGS

Bike and pedestrian crossings

Construction and maintenance of sidewalks at railroad crossings deserve special attention.



Bike and pedestrian crossings

Bicycles and pedestrians need safe crossings at railroad tracks. To avoid having a wheel drop into the rail flange, bikes must cross tracks at a perpendicular angle.



Good example of separate pedestrian sidewalk and special bike turnout with adequate room for perpendicular crossing.

GEOMETRICS
Lane and
shoulder
width



Good geometrics with adequate lane and shoulder width.



Left: Edge of shoulder could be delineated with water reflectors to mark water hazard. Guardrail could be used if warranted by accident data and experience.

Bottom: Narrow and unsurfaced roads can provide an adequate and less costly level of service on lower volume roads.



The width of the travel lane and shoulder, along with the number and severity of hills and curves, influence the overall safety performance of the roadway. Higher volume loads can justify improvements in road widths and alignment. A field assessment of geometric issues can be a useful first step in reviewing the need for roadway reconstruction.

Lane and
shoulder width

Compare existing lane and shoulder widths to the appropriate roadway standards. In addition to safety concerns, lane and shoulder widths also impact the roadway's capacity. Roadway widening involves considerable expense. Safety benefits for these major investments should not be overlooked when analyzing priorities for major roadway improvements. Future traffic growth must also be an important element in analyzing roadway improvements.

GEOMETRICS



Curves

Curves are changes in roadway alignment where travel above 30 miles per hour is comfortable. Items to consider include appropriate superelevation (banking), as well as roadside hazards adjacent to the curves. Since the likelihood of a vehicle leaving the road is increased at curves, additional warnings and/or priority for improvement should be given in locations where severe roadside hazards cannot be eliminated.

GEOMETRICS

Curves

Highway curve and additional delineation with chevron signs. Warning drivers with advance signs and delineation may be justified when curves are not readily visible, have a history of accidents, or have unusual hazards such as trees or sharp drop-offs.



Delineation markers help define the curve. Adding chevrons would provide more visual clues and new edge line would be very helpful.



Tree near pavement on curve is good candidate for removal.



Curve with narrow bridge compounds hazards.



GEOMETRICS

Turns



Unexpected turns may deserve additional warning due to low speed required to navigate turn. Additional warning or delineation may be warranted when turn has accident history or unusual hazards such as water, large trees, etc.



Traffic often cuts curves or turns short, causing maintenance problems on the inside. Using marker posts may help reduce maintenance problems. Marker posts should meet size requirements for sign supports. Heavy duty posts like these may be hazardous.



Turns

Turns are changes in roadway alignment that require safe and comfortable speeds at or below 30 miles per hour. The safety review is similar to curves, but the priority is greater due to the more severe change in alignment.

GEOMETRICS

Hills



Combination of hills and curves requires additional driver attention. Advance warning can be helpful.

Hills obstruct vision and restrict ability to make safe passing maneuvers. Very steep grades cause additional operating problems for heavy vehicles, and during adverse winter weather conditions. Unexpected steep grades require additional attention.

WARNING SIGNS



Warning signs are necessary because it is impossible to construct and maintain roadways that are completely free of hazards. This portion of the safety inventory is intended to identify the need to replace existing signs or add new ones. Typical locations include intersections, hills and curves, narrow bridges, school bus loading zones, etc. Some hazards make it essentially mandatory that warning signs be used. Others permit discretion. Sign installation should be based on the Manual on Uniform Traffic Control Devices and judgment of the relative severity of the hazard, crash data, and past experience.

Sign condition

Signs which are in poor condition, used or installed improperly, or missing must be corrected. A detailed sign inventory program would help in managing field signs.

WARNING SIGNS

Sign condition

Stop sign in very poor condition. Message not visible day or night. Loss of this critical message can be serious.

Below left: Very old warning sign in obviously poor condition. If warning is justified then adequate signing under day and night conditions is necessary.

Below right: Cracks in reflective sheeting may indicate poor nighttime visibility.



Railroad advance warning sign is missing. Field reviews should identify needs for additional signing.

WARNING SIGNS

Sign use



Incorrect sign usage. Inconsistent message. Turn signs are to be used where advisory speed is 30 mph or less.



Left: Incorrect sign use. Hazard marker signs are intended for use on specific roadside objects, not to call attention to other warning signs.

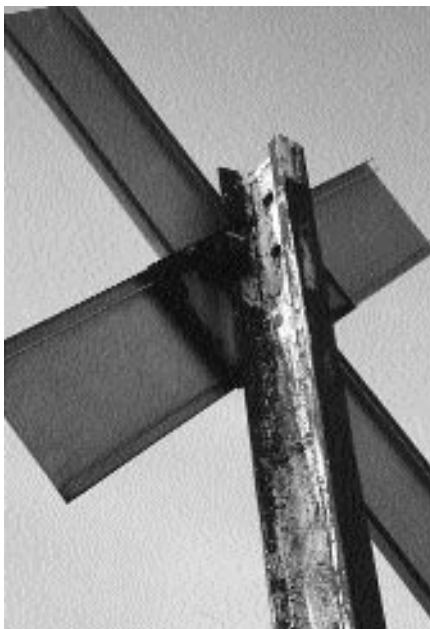
Right: Sign not authorized for use by MUTCD.

WARNING SIGNS



Sign use

The Manual on Uniform Traffic Control Devices (MUTCD) describes the correct use of signs. Following this national standard ensures that all highway agencies use consistent messages.



Steel rail used as post is too strong.



Sign support exceeds allowable strength and is a hazard.

Sign supports

The safe maximum size of sign supports has been established through crash testing. Standard materials and installation procedures should be used to ensure that posts break away on impact reducing damage to vehicles and their occupants.

WARNING SIGNS



Sign installation

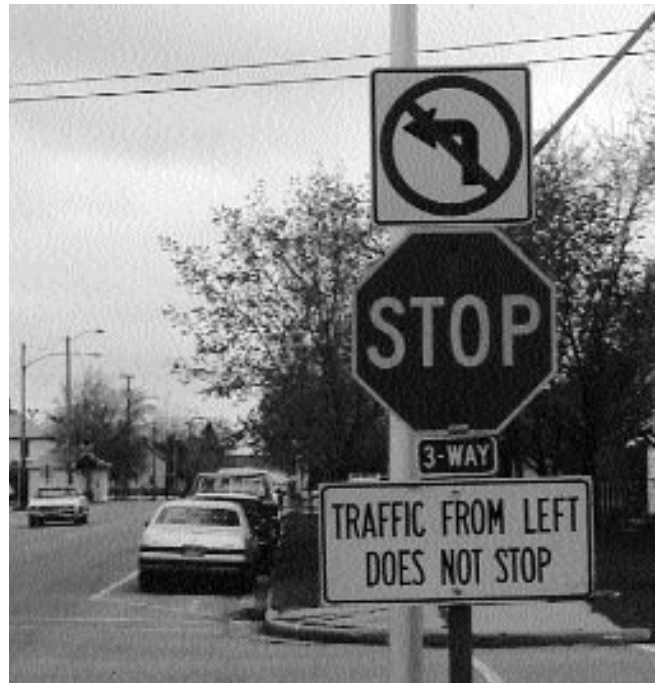
Basic sign installation guidelines are in the *Manual on Uniform Traffic Control Devices*. Applying the guidelines requires practical judgment to achieve safe and reasonable installations that meet varying road conditions. Regular inspections and maintenance are necessary.

WARNING SIGNS Sign installation

Critical stop sign obscured by foliage. Ongoing review by maintenance crews is very desirable.



Multiple signs introduce confusion at a critical location. Separation of messages on different supports is desirable.



Bottom left: Railroad advance warning should be located in advance of railroad crossing. Stop sign should be located at point where vehicle is to stop.

Bottom right: Improper location. Too close to the road and too low.



Sign installation



Urban sign installation too low. Can be obscured by parked vehicles and is a hazard to pedestrians.

WARNING SIGNS



Above left: Low sign installation. Visibility blocked by vegetation and vehicle. Sign mounting height should be measured from edge of pavement not adjacent ground.

Above right: Sign obscured by utility pole.



Left: Lack of maintenance reduces effectiveness of signs.

PAVEMENT MARKINGS

Pavement markings are an important warning and control device. Their placement and use is described in Part III of the Manual on Uniform Traffic Control Devices (MUTCD). Pavement markings include center line, edge line, lane lines, pedestrian crossings, railroad crossings, railroad crossing warnings, etc.

Center and edge lines

Use of center lines and edge lines is determined by traffic volume. When a center line is used, the no passing zones must also be marked in accordance with criteria established in the MUTCD.

PAVEMENT MARKINGS Center and edge lines

No passing zones must be marked if center line is used. Edge line is optional.



Center lines should be maintained. Do not use edge line without a center line.



Below: No passing zones must be located according to standards. Edge line is not required, but improves roadway delineation.



PAVEMENT MARKINGS
Crosswalks and stop lines

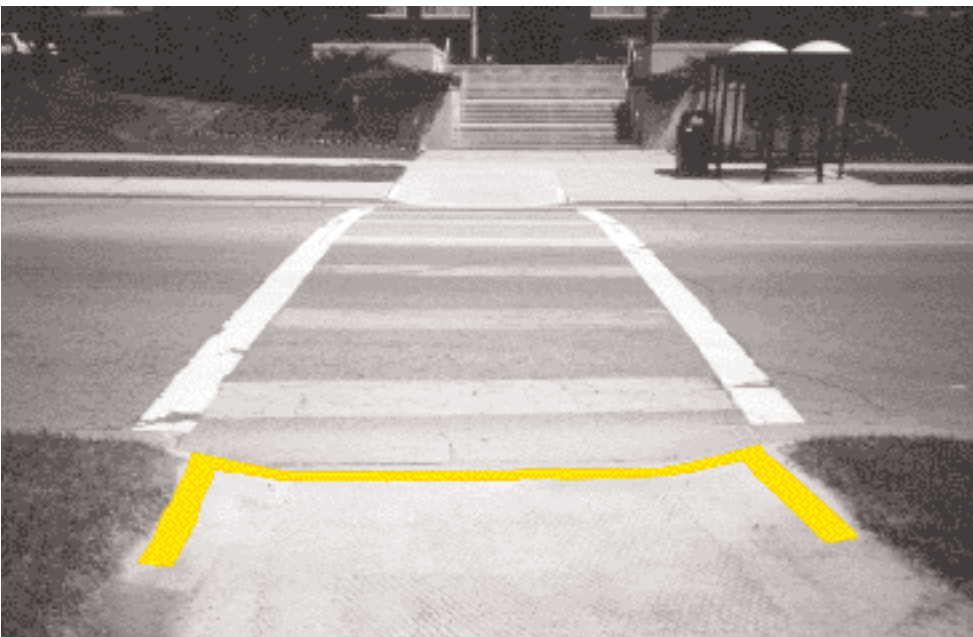
PAVEMENT MARKINGS



Incorrect crosswalk. Minimum crosswalk width is six feet. Optional diagonal stripes should be at 45 degrees or perpendicular to crosswalk lines.



Narrow crosswalk. Proper stop line.



Below: Wide crosswalk with handicap ramp. Note that yellow marking and texture are required on ramps.



Above: Using glass beads on pavement markings improves visibility and gives skid resistance for pedestrians.

PAVEMENT MARKINGS

Parking control

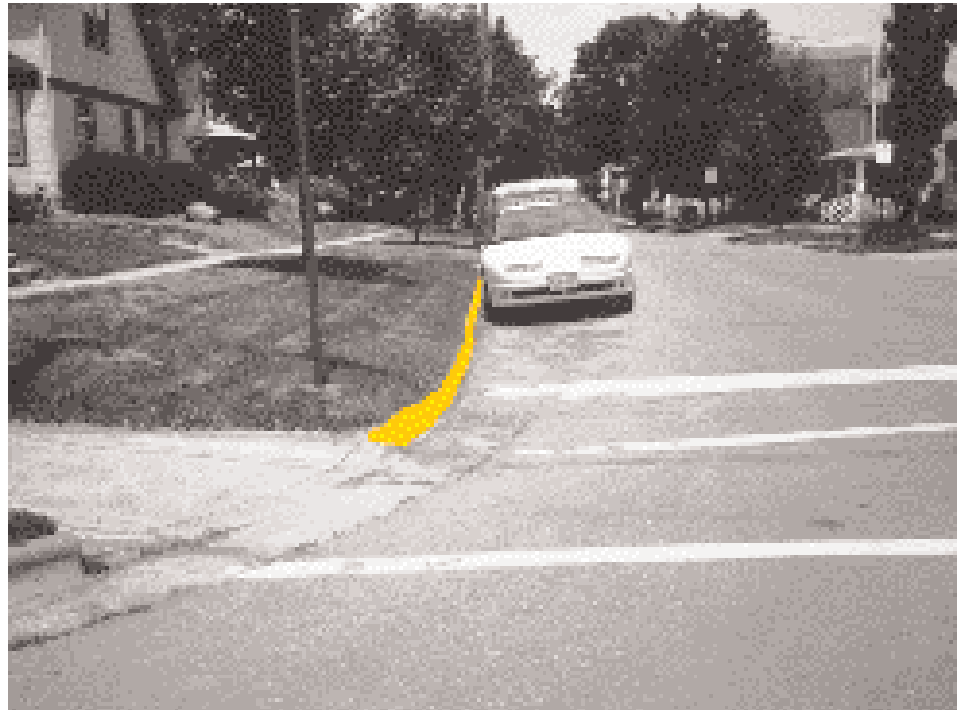
Pavement markings on curbs help to control no parking zones. Markings must conform to local parking ordinances. *No parking* signs are the primary control device. Curb marking is a helpful supplement.

PAVEMENT MARKINGS

Parking control

Right: Curb marking reinforces no parking at busy intersection. Signs are not blocked by snow, leaves or vehicles as are marked curbs.

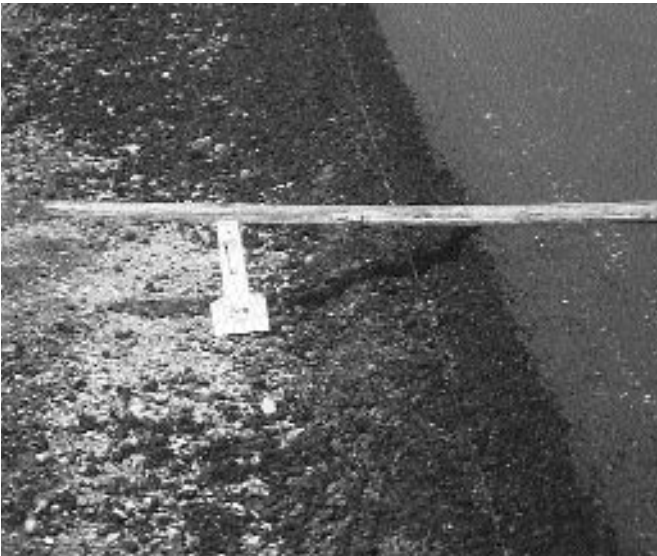
Below: Marked *No Parking* zone maintains visibility of crosswalk and intersection.



**ROAD
MAINTENANCE**
Low shoulders



Low shoulder often occurs on the inside of curves. Can create loss of control for vehicles when drop-off exceeds two inches.



Low shoulder created with resurfacing improvement. Helpful to minimize the time between paving and reshouldering. Warning signs are also helpful.



Left: Pavement widening may be warranted in areas with continual shoulder erosion problems.

Below: Settled inlet creates hole along curb. Barricade provides temporary warning until repairs are made.



The general condition of a roadway's driving surface and shoulders can impact its safety. Deficiencies may be corrected with routine maintenance or may require complete reconstruction. It is desirable to integrate information on safety-related roadway deficiencies with plans for pavement maintenance and improvements by using a pavement management system so that safety improvements can be made in a cost-effective manner.

Low shoulders

Unpaved shoulders are subject to erosion through the action of traffic and water. The resulting pavement drop-off can cause control problems for vehicles that leave and attempt to re-enter the traveling lane. Drop-offs as small as two inches can be problems. Greater drop-offs create more severe control problems. Routine shoulder grading may be the solution. Persistent problems may be treated through stabilization or paving. Low shoulders frequently occur at intersections and curves.

ROAD MAINTENANCE

Surface friction

Roads can become slippery when lack of surface texture reduces friction or traction between tires and pavement. This condition may be difficult to detect. Crash data may indicate a problem, especially during rain, freezing rain, or icy conditions. Devices that measure roadway friction can supplement visual inspection.

ROAD MAINTENANCE *Surface friction*

Asphalt rich surface (flushing) may create slippery road conditions.



Rough pavement

Minor surface irregularities may cause only irritation to the traveling public. Major irregularities, such as potholes, washboarding, etc., can cause unpredictable driver behavior. Extremely severe defects can affect vehicle control.

Ruts or depressions in the wheel paths may develop due to heavy traffic loads or poor quality construction. Deep ruts may affect control of the vehicle. Even minor rutting can collect water and cause hydroplaning.

Pavement deterioration with numerous potholes impacts vehicle control and driver attention.

Below left: Ruts and washboarding contribute to difficulty with vehicle control.

Below right: Slight rutting collects water. Can cause hydroplaning.



**SPECIAL
CONDITIONS**
Dead ends



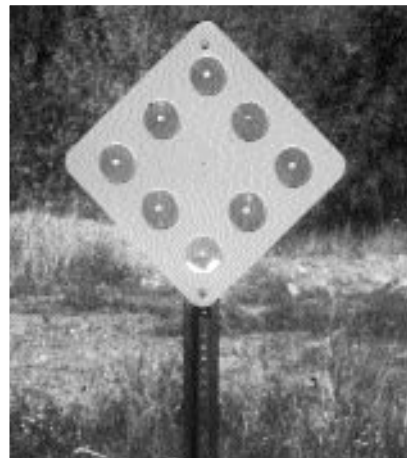
Dead end road with no approved warning. Inappropriate sign left in place as warning.



Left: Dead end road terminates in lake. No approved warning signs. Inappropriate use of dead end sign.

Below left: Dead end road with barricade and road closed sign.

Below right: Proper road end sign.



A variety of other situations require attention. These include dead ends, overpass bridges, school zones, and sidewalks.

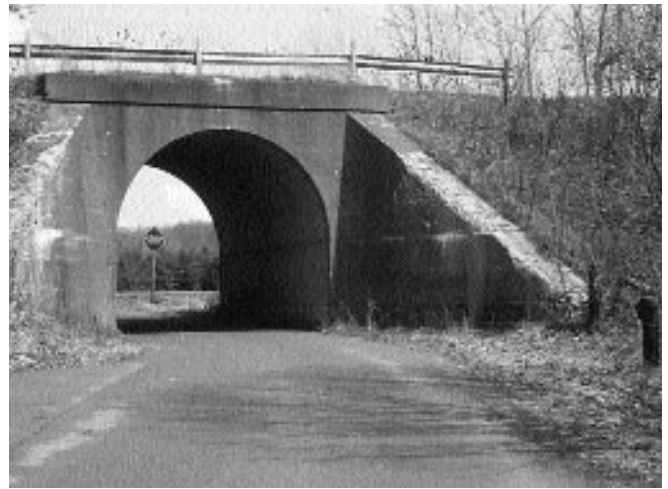
Dead ends

Dead end roads and streets may terminate in private driveways, cul-de-sacs or abrupt termination of the roadway. The extent of warning should be based on the physical conditions and traffic volume. The *Manual on Uniform Traffic Control Devices* offers guidance on appropriate signing, etc.

SPECIAL CONDITIONS

SPECIAL CONDITIONS *Overpass bridges*

Overpass bridges often impinge on the clear zone. In this case, a narrow roadway, concrete wing walls, and location on a curve before an intersection all compound the possibilities for accidents. Advance warning and hazard marking at the structure may be desirable.



Overpass bridges

Overpass structures present problems due to potential narrow roadways, exposed pier and foundations, and height restrictions. The general visibility of the overpass structure is an important consideration along with adequacy of guardrail protection and other crash devices.



Complex situation requires special study. Poor guardrail needs improvement.

Access control

Access control along busy streets improves safety. Locate drives at points of good vision. Design width and grade for efficient movement. Avoid narrow or unusually wide drives. Combining entrances and using frontage roads is desirable on high volume streets.

Consolidating several drives into one entrance and adding median opening improves traffic flow and safety.



**SPECIAL
CONDITIONS**
School zones



Improper
school crossing
warning sign.



Special school
crossing advance
warning signs like
this one are used
properly at this
location.



Special speed limits
apply to school areas
and speed zone signing
is unique to school
areas. This is a proper
sign assembly.



School zones

School zones and school crossings deserve special attention. Part VII of the *Manual on Uniform Traffic Control Devices* requires unique signing for school zones and school crossings. A careful study should be used to locate school crossings.

SPECIAL CONDITIONS

SPECIAL CONDITIONS *Sidewalks*

Sidewalks

Sidewalks provide safety and convenience for pedestrians in an urban environment. Policies on sidewalk width and location are helpful. Timely maintenance and replacement are important factors in pedestrian safety and risk management.

Narrow sidewalk
in poor condition.



Right: Current standards require accommodation of disabled by building ramps and eliminating steps.



Below left: Restricted right-of-way may limit availability of a terrace between curb and sidewalk. This exposes pedestrians directly to traffic and compounds snow removal problems.

Bottom right: Sidewalk sections not connected forcing pedestrians to walk in street.





Sidewalks

Traffic control island forces pedestrians to climb over it or walk out into gutter line very close to crossing street traffic.



Some new developments do not provide sidewalks. This raises a policy question relating to cost and safety.



Left:
Sidewalk lip may cause pedestrians to trip.



Right:
Temporary repair is better than doing nothing.



Left:
Grinding off the exposed edge improves safety without the cost of slab replacement.



Right:
Extensive cracking and deterioration. Replacement required.





References and resources

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Mailbox Safety, No. 14

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**Transportation
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Brick and Block PASER Manual, 2001, 8 pp.

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Unimproved Roads PASER Manual, 2001, 12 pp.

Drainage Manual

Local Road Assessment and Improvement, 2000, 16 pp.

SAFER Manual

Safety Evaluation for Roadways, 1996, 40 pp.

Flagger's Handbook (pocket-sized guide), 1998, 22 pp.

Work Zone Safety, Guidelines for Construction, Maintenance, and Utility Operations, (pocket-sized guide), 2002, 58 pp.

Wisconsin Transportation Bulletins

- #1 Understanding and Using Asphalt
- #2 How Vehicle Loads Affect Pavement Performance
- #3 LCC—Life Cycle Cost Analysis
- #4 Road Drainage
- #5 Gravel Roads
- #6 Using Salt and Sand for Winter Road Maintenance
- #7 Signing for Local Roads
- #8 Using Weight Limits to Protect Local Roads
- #9 Pavement Markings
- #10 Seal Coating and Other Asphalt Surface Treatments
- #11 Compaction Improves Pavement Performance
- #12 Roadway Safety and Guardrail
- #13 Dust Control on Unpaved Roads
- #14 Mailbox Safety
- #15 Culverts-Proper Use and Installation
- #16 Geotextiles in Road Construction/Maintenance and Erosion Control
- #17 Managing Utility Cuts
- #18 Roadway Management and Tort Liability in Wisconsin
- #19 The Basics of a Good Road
- #20 Using Recovered Materials in Highway Construction
- #21 Setting Speed Limits on Local Roads

