The purpose of this guide is to provide assistance to local governments responsible for safety of unpaved rural roads. A national focus group assisted in identifying key safety issues for unpaved rural roads. Those issues which ranked highest are included in this guide. This easy to use guide will provide a convenient reference to help answer questions in the field and help providing a safer road environment for unpaved roads. This guide is not all encompassing.

This revised guide updates the information presented in the original guide dated March 1997, which was based on outdated editions of MUTCD, Green Book, Road Side Design Guide, etc. For a complete listing of references, see page 28. These references are useful, but the latest editions should be consulted.

This guide describes the application of traffic control devices, geometric guidelines and management techniques for unpaved rural roads and should not be constitute as a legal document. The decision to use a particular device at a specific location should be made on the basis of either an engineering study or the application of engineering judgment. Thus, while this guide provides guidance for design and application of traffic control devices, it should not be considered a substitute for engineering judgment.

Review the topics, check your unpaved roads, look for potential problems. Use this reference to help you check if you have a problem. BEGIN TO MAKE KEY IMPROVEMENTS. Document your efforts. Limited resources are the reality of the unpaved road world. Start an improvement program to make your roads safer.
TRAFFIC CONTROL DEVICES

Sign Placement
Traffic control devices are all signs, markings, and devices placed on or along a road. Traffic control devices assist the driver in traveling the road in a safe and efficient manner. Warning signs use black legends on a yellow background.

Traffic Control Devices should:
1. Command attention and be easily seen, providing time for driver response (See Table 1 on page 3).
2. Be properly positioned for the situation and convey the proper meaning.

Location Hints
1. Avoid placing signs on curves.
2. Select sign placement on a cut slope rather than a fill slope.
3. Avoid placing signs in the bottom of ditches.
4. Space signs along the roadway. Don’t crowd signs together. Provide 100' minimum spacing where possible.
5. Provide an unobstructed view of signs along the roadway.
6. Place signs behind guardrails where possible. (Minimum of 5' from face of guardrail, and not within the first 50' of guardrail section.)

Maintenance of traffic control devices should assure that legibility is retained for good visibility both day and night. Adequate retroreflectivity of a sign is necessary for good visibility at night. Maintenance includes removing weeds, brush, etc., which obstruct the driver’s view of the device. Signs should be removed when they are no longer needed. Check the Manual on Uniform Traffic Control Devices (MUTCD) for appropriate sign size.

Signing Consistency
Once you have decided how to sign a location, use similar signing at locations with similar situations. Locations with additional accident experience or different topography often require different actions, but treat similar situations consistently.

**Determining Operating Speed**

1. Travel a roadway section as if unfamiliar with the area and at a comfortable speed.
2. While driving a roadway section, note your speed.
3. Drivers may travel faster than this speed. For this reason, use your speed plus 10 mph as the operating speed for the tables in this guide.

**Advance Warning Sign**

Advance warning signs should be located in advance of unusual or potentially hazardous conditions. The values contained in Table 1 are for guidance purposes and should be applied with engineering judgement. (See MUTCD 2003 Edition, Sections 2A-18 through 2A-22 and 2C-1 through 2C-5 for further guidance.)
### TABLE 1. Guidelines for Advance Placement of Warning Signs  
(English Units)

<table>
<thead>
<tr>
<th>Posted or 85th-Percentile Speed</th>
<th>Condition A: Speed reduction and lane changing in heavy traffic&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Advance Placement Distance&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Condition B: Deceleration to the listed advisory speed (mph) for the condition&lt;sup&gt;4&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mph</td>
<td>225 ft N/A&lt;sup&gt;5&lt;/sup&gt;</td>
<td>0&lt;sup&gt;3&lt;/sup&gt; 10 20 30 40 50 60 70</td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
<tr>
<td>25 mph</td>
<td>325 ft N/A&lt;sup&gt;5&lt;/sup&gt;</td>
<td></td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
<tr>
<td>30 mph</td>
<td>450 ft N/A&lt;sup&gt;5&lt;/sup&gt;</td>
<td></td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
<tr>
<td>35 mph</td>
<td>550 ft N/A&lt;sup&gt;5&lt;/sup&gt;</td>
<td></td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
<tr>
<td>40 mph</td>
<td>650 ft 125 ft N/A&lt;sup&gt;5&lt;/sup&gt;</td>
<td></td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
<tr>
<td>45 mph</td>
<td>750 ft 175 ft 125 ft N/A&lt;sup&gt;5&lt;/sup&gt;</td>
<td></td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
<tr>
<td>50 mph</td>
<td>850 ft 250 ft 200 ft 150 ft 100 ft N/A&lt;sup&gt;5&lt;/sup&gt;</td>
<td></td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
<tr>
<td>55 mph</td>
<td>950 ft 325 ft 275 ft 225 ft 175 ft 100 ft N/A&lt;sup&gt;5&lt;/sup&gt;</td>
<td></td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
<tr>
<td>60 mph</td>
<td>1100 ft 400 ft 350 ft 300 ft 250 ft 175 ft N/A&lt;sup&gt;5&lt;/sup&gt;</td>
<td></td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
<tr>
<td>65 mph</td>
<td>1200 ft 475 ft 425 ft 400 ft 350 ft 275 ft 175 ft N/A&lt;sup&gt;5&lt;/sup&gt;</td>
<td></td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
<tr>
<td>70 mph</td>
<td>1250 ft 550 ft 525 ft 500 ft 425 ft 350 ft 250 ft 150 ft</td>
<td></td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
<tr>
<td>75 mph</td>
<td>1350 ft 650 ft 625 ft 600 ft 525 ft 450 ft 350 ft 250 ft 100 ft</td>
<td></td>
<td>N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; N/A&lt;sup&gt;5&lt;/sup&gt; - - - - - -</td>
</tr>
</tbody>
</table>

Notes:

1. The distances are adjusted for a sign legibility distance of 175 ft for Condition A. The distances for Condition B have been adjusted for a sign legibility distance of 250 ft, which is appropriate for an alignment warning symbol sign.
2. Typical conditions are locations where the road user must use extra time to adjust speed and change lanes in heavy traffic because of a complex driving situation. Typical signs are Merge and Right Lane Ends. The distances are determined by providing a PIEV time of 14.0 to 14.5 seconds for vehicle maneuvers (2001 AASHTO Policy, Exhibit 3-3, Decision Sight Distance, Avoidance Maneuver E) minus the legibility distance of 175 ft for the appropriate sign.
3. Typical condition is the warning of a potential stop situation. Typical signs are Stop Ahead, Yield Ahead, Signal Ahead, and Intersection Warning signs. The distances are based on the 2001 AASHTO Policy, Stopping Sight Distance, Exhibit 3-1, providing a PIEV time of 2.5 seconds, a deceleration rate of 11.2 ft/second<sup>2</sup>, minus the sign legibility distance of 175 ft.
4. Typical conditions are locations where the road user must decrease speed to maneuver through the warned condition. Typical signs are Turn, Curve, Reverse Turn, or Reverse Curve. The distance is determined by providing a 2.5 second PIEV time, a vehicle deceleration rate of 10 ft/second<sup>2</sup>, minus the sign legibility distance of 250 ft.
5. No suggested distances are provided for these speeds, as the placement location is dependent on site conditions and other signing to provide an adequate advance warning for the driver.
Advisory Speed Plaque *
Advisory speed plaques can be used to indicate a safe travel speed. On a horizontal curve, the advisory speed is a comfortable operating speed and can be determined by a ball bank indicator, also called a slope meter. The procedure given below is recommended for use with a driver and an observer.

1. Zero the ball bank indicator with the vehicle on level ground.
2. Make the first trial run at a speed below the expected maximum speed.
3. Make subsequent trial runs with 5 mph speed increments.
4. Evaluate the curve to determine the maximum comfortable speed in both directions.
5. The lower speed value should be posted below the curve or turn sign for both directions (See Figure 3).

<table>
<thead>
<tr>
<th>Speed (mph)</th>
<th>Ball Bank Reading of Maximum Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 20</td>
<td>14°</td>
</tr>
<tr>
<td>25 - 30</td>
<td>12°</td>
</tr>
<tr>
<td>35 - 50</td>
<td>10°</td>
</tr>
</tbody>
</table>

**FIGURE 2. Ball Bank Indicator and Readings**

If the speed of the curve is below the operating speed of the roadway, an advisory speed plaque may be used. Your judgement should be used to determine if the advisory speed plaque is desirable. (Typically when the speed of the curve or turn is less than or equal to 10 mph the operating speed of the roadway.)

**FIGURE 3. Advisory Speed Plaque**

*Note: See MUTCD 2003 Edition, Section 2C-46 for further guidance.*
**Sign Installation Tips**

1. Posts should be buried in firm ground 3 feet deep.
2. Loose or sandy soil may require deeper post placement.
3. Use earth plate to prevent round post twisting (*See Figure 4*).
4. Breakaway sign supports should be used to enhance roadside safety.
5. Sign panels should be bolted to the post with oversized washers.
6. Use sign connections that prevent vandalism.

**Note:**


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**FIGURE 4. Post Placement**
RAILROAD CROSSINGS

Accidents involving railroads are severe and often result in fatalities. Adequate sight distance and signing are important.

1. Crossbucks shall be used on each approach at all railroad crossings. (See MUTCD 2003 Edition, Section 8B-03 for further guidance.)
2. Railroad advance warning signs should be used at all railroad crossings. (See MUTCD 2003 Edition, Section 8B-04 for further guidance.)
3. Vegetation should be removed to improve the sight distance at the railroad crossing.
4. The roadway approach grade to the railroad crossing should be flat enough to prevent truck snagging.
Sign placement when parallel road is under 100 feet from unsignalized crossing.

* Distance = Condition A; Table 1

Sign placement when parallel road is over 100 feet from unsignalized crossing.

* Distance = Condition A; Table 1

FIGURE 5. Railroad Crossings
HORIZONTAL AND VERTICAL CURVES

Hidden or unexpected horizontal curves should be signed. If the curve speed is lower than the operating speed of the roadway then an advisory plaque may be attached below the curve, or turn sign. (See page 4 to determine the advisory speed, and Table 2 for Horizontal Alignment Sign Usage.)

*FIGURE 6. Horizontal Curve Signing*
Notes:
1. Engineering judgment should be used to determine whether the Turn or Curve sign should be used.
2. Alignment changes are in opposite directions and are separated by a tangent distance of 600 ft or less.
3. A Right Reverse Turn (W1-3R), Right Reverse Curve (W1-4R), or Right Winding Road (W1-5R) sign is used if the first change in alignment is to the right; a Left Reverse Turn (W1-3L), Left Reverse Curve (W1-4L), or Left Winding Road (W1-5L) sign is used if the first change in alignment is to the left.

In rolling or mountainous terrain, crest vertical curves often limit sight distance. Where this is the case, check that the roadway width is maintained over the crest, i.e., there is no narrowing of the roadway. You may want to consider posting a cross road warning sign if there is an access location close to the crest of the curve.

### TABLE 2  Horizontal Alignment Sign Usage

<table>
<thead>
<tr>
<th>Number of Alignment Changes</th>
<th>Advisory Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(&lt;=30 MPH)</td>
</tr>
<tr>
<td>1</td>
<td>Turn (W1-1)(^1)</td>
</tr>
<tr>
<td>2(^2)</td>
<td>Reverse Turn(^3) (W1-3)</td>
</tr>
<tr>
<td>3 or more(^2)</td>
<td>Winding Road(^3) (W1-5)</td>
</tr>
</tbody>
</table>
INTERSECTIONS

Stop and yield signs are often installed at intersections. Checking sight distance is an important consideration (See page 11). Other stop and yield sign placement considerations include intersections with high volume roads and the intersection of roads with different classifications.

**FIGURE 7. Intersection Signing**

4-Way Intersection

* Install when Stop/Yield sign cannot be seen an adequate distance ahead of the intersection to stop.

** May be installed when the intersection cannot be seen an adequate distance ahead to stop.

T-Intersection
INTERSECTION SIGHT DISTANCE *

Intersections should be checked for adequate sight distance. Sight distance is often improved by flattening the backslopes and lengthening the horizontal and vertical curves. Intersection sight distance should be checked for sight obstructions and the need for signing. Summer crops, winter snow and changing development need to be considered. The MUTCD should also be consulted for additional stop and yield sign placement factors. These factors include issues such as approach volumes and accident history.

Use the following procedure for determining required signing based on sight distance:

1. Determine the operating speed for each intersection approach (See page 2).
2. Using the operating speed, determine the intersection sight distance from Table 3.
3. The observer with the sighting rod and the assistant with the target rod should position themselves on different approaches at the appropriate distance from the intersection (See page 22 for target rod design).
4. The observer sighting over the sighting rod should determine if the top of the target rod is visible. If the target rod is visible, then the clear sight triangle has been achieved.
5. If the clear sight triangle is less than the distance given for stop control, stop signs should be used.
6. If the clear sight triangle is greater than the distance given for stop control, yield signs may be used.
7. If the clear sight triangle is greater than the distance given for no control, no control signs are required based on sight distance.
8. The intersection sight triangle analysis should be performed for all legs considering traffic approaching from both the right and the left.

*Note:
### TABLE 3. Intersection Sight Distance

<table>
<thead>
<tr>
<th></th>
<th>Distance (ft)</th>
<th>Operating Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td><strong>Stop Control</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>110</td>
<td>225</td>
</tr>
<tr>
<td>A</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td><strong>No Control</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>-</td>
<td>90</td>
</tr>
<tr>
<td>A</td>
<td>-</td>
<td>90</td>
</tr>
</tbody>
</table>

**Note:**
- Values in the Table are for passenger cars on 3% grades
- Downgrades require an increased distance.
- Remove vegetation higher than 3 feet in the clear sight area.

**FIGURE 8. Intersection Sight Triangle**
DELINEATION

Post mounted delineation is used to outline the edge of the travelway or to mark locations such as culverts. Potential locations for delineators are:

1. Confusing horizontal alignment,
2. Sharp or unexpected curves,
3. Curves or turns at the end of long, straight road sections,
4. Before narrow bridges and culverts, and
5. Intersections.

Delineators should be placed at a constant offset from the travelway edge. When delineating an obstruction where the road narrows, the line of delineation should make a smooth transition to the inside of the obstruction. When delineators are used with guardrails, they should be attached to or placed behind the guardrail.

Spacing

1. Space evenly throughout the curve or along the roadway. (See Table 4)
2. Three delineators should be visible to the driver throughout the curve.
3. Three delineators should be placed ahead of the curve. (For distances, see Table 4.)

![Figure 9: Curve Delineator Placement](image)

**TABLE 4. Guidelines for Delineator Spacing (feet).**

<table>
<thead>
<tr>
<th>Radius of Curve (ft)</th>
<th>Operating Speed (mph)</th>
<th>On Curve Spacing</th>
<th>Spacing Before and After Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>115</td>
<td>20</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>250</td>
<td>30</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>500</td>
<td>40</td>
<td>65</td>
<td>130</td>
</tr>
<tr>
<td>800</td>
<td>50</td>
<td>80</td>
<td>160</td>
</tr>
<tr>
<td>1000</td>
<td>55</td>
<td>90</td>
<td>180</td>
</tr>
</tbody>
</table>

* Approximates MUTCD curve radius spacing (See MUTCD section 3D-04).
Chevrons
Chevron signs may be used as an alternate or supplement to standard delineators on curves or to the One-Directional Large Arrow Sign. Chevron signs provide additional emphasis on sharp curves and may also be used as an alternative to the large arrow sign.

Placement of chevron signs should be on the outside of the curve in line with and at right angles to approaching traffic. Chevron signs should be visible for a sufficient distance to provide the driver with adequate time to react to the change in alignment. Spacing should be such that at least two or three chevrons are visible to the driver throughout the curve.
CLEAR ZONE *

A clear zone is an area adjacent to the travelway that has a mild slope (1:4 or flatter) and is free of obstructions. Adequate clear zones allow errant vehicles to leave the travelway safely. The width of the clear zone is dependent upon speed, traffic volume and embankment slope. While a minimum clear zone width of 10 feet is desirable, it may not be economically feasible in mountainous terrain or other areas with low traffic volumes and steep embankments. Focus initial efforts to improve clear zones on the outside of horizontal curves. Roadside safety can also be enhanced by:

Removing - Removing fixed objects and providing traversable terrain features.

Relocating - Relocating objects further away from the roadside.

Retrofitting - Improving objects which cannot be removed or relocated by making them breakaway or crashworthy.

Shielding - Installing guardrails, barriers, or crash cushions to shield the hazards that cannot be improved.

Delineate - If the above are impractical, as a temporary measure delineate the hazard.

Major hazards

Trees represent the largest category of roadside hazards. Any tree in the clear zone may be, or grow to be, a hazard and should be removed. It is easier to remove trees as saplings before they cause a problem. A tree trunk greater than 4 inches in diameter should be cut to less than 4 inches above the groundline to prevent vehicle rollover or snagging.

Utility poles should also be removed from the clear zone when possible. Removing utility poles outside of curves should be given priority.

Culverts can be treated by removing the headwall and contouring the shape of the end to match the slope of the embankment. The openings of large culverts should be covered with traversable grates.

Mailboxes should be placed outside of a minimum 8 foot wide usable shoulder or use a turnout. Mailboxes should be located at least 70 feet away from an intersection. Mailboxes should be firmly attached to supports that yield or breakaway safely if struck by a vehicle. For additional information on mailbox placement and location, contact your Local Technical Assistance Program (LTAP) Center.

*Note:
BRIDGES AND CULVERTS

Narrow Bridge

1. The narrow bridge sign should be placed in advance of any bridge or culvert having a two-way roadway clearance width of 16 to 18 feet, or any bridge or culvert having roadway clearance less than the approach travel lanes.

2. Approaches to the structure should be tapered (See pages 17 to 18).

3. Approach guardrails should be used to protect the motorist from the bridge abutments (See page 19).

4. Delineators may be used to provide better guidance to the approach.

5. If the bridge or culvert is less than 16 feet wide, or less than 18 feet wide where the sight distance is limited on the approach to the structure, a one lane bridge sign should be used.

6. Type 3 object markers should be used on bridges less than 20 feet wide.

*Other distance may be used based on engineering study results per Condition B in Table 1.

Note: Inside edge of object marker shall be installed flush with the inside edge of the bridge rail or culvert headwall (See MUTCD 2003 Edition, Section 3C.01 for further guidance.)
**Tapering**

Structures such as culverts and bridges should be built or modified to maintain the full width of the travelway. If the full width does not exist, the approaches should be tapered. A tapered travelway edge will help guide the driver through the narrow structure.

Procedure:
1. Estimate the operating speed of the roadway (*See page 2*).
2. Determine the width difference (W) between the obstacle and the road.
3. Determine the length (L) from Table 5.
4. Gradually taper the roadway to the obstacle.
5. Object markers should be used at the structure with delineators optional through the travelway taper.

### TABLE 5. Taper Length, L (feet)

<table>
<thead>
<tr>
<th>Operating Speed (mph)</th>
<th>Width, W (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Under 30</td>
<td>30</td>
</tr>
<tr>
<td>30 to 40</td>
<td>50</td>
</tr>
<tr>
<td>Over 40</td>
<td>100</td>
</tr>
</tbody>
</table>

*FIGURE 13. Tapering Travelways for Narrow Structures*
FIGURE 14. Before Tapering Road

FIGURE 15. After Tapering Road
GUARDRAIL

A guardrail is intended to redirect a vehicle back on the travelway and aid in delineating the travelway edge. A guardrail should only be installed if the severity of hitting the hazard is greater than striking the guardrail. The decision to use a guardrail should consider engineering factors along with social, economical, environmental, and accident probability factors. To function correctly, guardrails need to be designed and properly placed. Important installation considerations are type of guardrail, installation height, block outs, offset from the travelway, crash worthy end terminals, proper post spacing, and guardrail length.

Guardrail placement on structures include: stiffened guardrail sections adjacent to the structure, connections between guardrail and bridge rail, and guardrail flares or tapers. Culverts that are not extended or modified due to size or cost may require a guardrail. Roadside slopes and dropoffs may also require guardrail placement. Alignment, traffic volumes, fill height and embankment slope are factors to consider in determining the cost effectiveness of installing a guardrail. Existing guardrail on gravel roads should be inspected periodically to insure desired height is maintained. The latest guardrail design requirements should be used when checking existing guardrail. (See AASHTO Roadside Design Guide, 2002 for further guidance.)

Answer the following questions before installing a guardrail.

1. Is the guardrail needed?
2. Is there a better way of improving safety at the location?
3. Is the guardrail long enough?
4. Is the guardrail constructed to current standards?
5. Is the guardrail located correctly?
6. Is the guardrail economically justified?

FIGURE 16. Guardrail Sections
FIGURE 17. Guardrail Types

- **Blocked out W-beam**
  - Steel (strong post) system
  - AASHTO Designation: G4 (1S)
- **Blocked out W-beam**
  - Wood (strong post) system
  - AASHTO Designation: G4 (2W)

- **Strand cable system**
  - AASHTO Designation: G1-a

- **W-Beam**
  - Steel (weak post) system
  - AASHTO Designation: G2

For speed <=45 mph use steel block
For speed >45 mph use steel block

Test level 2, speed <=45 mph

TOOLS

Sign Height Check Tool
This tool can quickly check the proper height of roadway signs.
1. 2" x 4"
2. 2" x 4"
3. Level
4. 3/4" plywood cross brace

Metal Post Straightener
This tool is used to straighten bent metal posts.

A. 1 piece, 1 1/2" Black pipe - 50" long

B. 1 piece, 5/8" x 3" x 10" long
C. 1 piece, 3/4" x 3/4" x 5/8" long
D. 1 piece, 1/4" x 3/4" x 20" long
E. 1 piece, 3/8" x 3/8" x 3" long
F. 1 Clevis slip hook (remove eye)

Sign Turner
This tool is used to align the sign and post before final tamping. One person checks the sign to make certain it is facing the roadway at the proper angle to be seen at night, while the other person rotates the post with the tool. Small signs should be mounted at 90° to the road.

FIGURE 18. Building Your Own Tools
**Sight Distance Target Rods**
Target rods are used to determine clear sight distance triangles and stopping sight distances. A distance wheel should also be used with the rods. The procedure for use is given on page 11.

![Sighting Rod](image1)

**Embankment Slope Meter**
The embankment slope meter is used to measure the slopes of embankments along the roadway. Cut a 3/4" sheet of plywood to a right triangle with the side CB equal to the run of the slope and the side CA equal to the rise. For slopes of 1:6 to 1:10, reduce the size by half to make the tool easier to handle. For example, to measure a 1:8 slope, cut the plywood to 4' long and 1/2' deep.
ROAD SURFACE MANAGEMENT

Crown
Crown is used on straight road sections to remove water from the road surface. Preferred rate of crown is at least 1/2 inch per foot of lane width (approximately 4%). On a 20' wide road, a slope of 1/2 inch per foot yields a crown of 5 inches. The proper crown should be A-shaped, NOT a parabolic shape to maintain proper surface drainage.

<table>
<thead>
<tr>
<th>Cross Slope Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inch per Foot</td>
</tr>
<tr>
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</tr>
<tr>
<td>1/2</td>
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<tr>
<td>2/3</td>
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</tbody>
</table>

*FIGURE 19. Crown Slope*

Superelevation
Superelevation on curves helps keep vehicles on the road. The transition between the crown and the superelevation should be smooth.

Procedure:
1. Gradually eliminate the crown 100 to 150 feet before starting into the curve.
2. A constant bank should be maintained throughout the curve. Do not blade a crown on the curved part of the road.
3. Maintain proper shoulder slopes on the superelevated section of the road.
4. Gradually transition the road surface back from superelevation to crown.

*FIGURE 20. Superelevation On Curve*
Intersections
The crown of the major road through an intersection should be maintained.
1. Gradually eliminate the crown on the unpaved road at about 50 to 100 feet before the intersection.
2. Pull any aggregate off the paved road.
3. Perform extra passes as needed to eliminate crown and provide correct shoulder slope.
4. Remove any bumps, dips, or loose material at the edge of the paved road.

**FIGURE 21. Intersection Grading**

Railroad Crossing
When blading a road crossing railroad tracks:
1. Gradually eliminate crown on road, starting about 50 to 100 feet before road intersects railroad tracks.
2. Do not blade loose aggregate onto railroad tracks. Always stop the grader after you have bladed on each side of the tracks and check to make sure there is no loose aggregate on any part of the tracks or between tracks and metal flanges along the tracks. If there is, use a broom or hand shovel to remove it.
3. Check to see if an extra pass or two is needed to eliminate crown and to meet the grade of the railroad tracks.
4. Correct bumps and dips as explained in smoothing on next page.
**Smoothing**

Road surfaces are smoothed by dragging without breaking the hard surface crust. A dragging, rolling action created by the curve of the grader's moldboard helps compact the road surface as it is bladed. Smoothing is usually done when aggregates and fines are moist.

Procedure:

1. Determine the road length limits for smoothing.
2. Place the work zone traffic control devices as needed.
3. Check the condition of the grader blade cutting edge.
4. Tilt the moldboard forward to get a dragging action (*See Figure 23*).
5. Angle moldboard at about 30° to 45° to spread loose material to the center of the road.
6. Tilt the front wheels approximately 10° to 15° from vertical in the direction the aggregate rolls across the blade.
7. Stop to repair minor road defects by hand. Always have a shovel available.
8. Periodically blade surface of the road against the flow of traffic to eliminate drifting of aggregate onto ends of bridges, culverts, intersections, and railroad crossings. If management's policy does not allow blading against the flow of traffic, the excess material from humps formed on one side of the road at the ends of bridges, culverts, intersections and railroad crossings, should be bladed across the road periodically to fill the dips formed on the other side.

*Tilt the moldboard for a dragging action (*See Figure 23)*

*Tilt the moldboard back to cut into ridges and potholes (*See Figure 23)*

**FIGURE 22. Motorgrader Moldboard**
**Reshaping** *

The purpose of reshaping is to remove surface irregularities, restore surface drainage, and to remix the aggregate to improve surface stability. Reshaping should be done when aggregate and fines are moist.

1. Place the work zone traffic control devices as needed.
2. Check if more aggregate or fines need to be added to the road surface.
3. Tilt the moldboard to a cutting position. (*See Figure 23.*)
4. Angle the moldboard at about 30° to 45°. Move aggregate to the center of the road.
5. Tilt the front wheels approximately 10° to 15° from vertical in the direction aggregate rolls across the blade.
6. Put enough pressure on the blade to cut shoulders and washboard ridges. Remove gravel material from the bridges.
7. Scarify the surface when necessary.
8. Check to see if more passes are needed.
9. Windrow remixed aggregate to the center of the road.
10. Distribute aggregate evenly, blading material to the proper crown.
11. Blade the shoulder downward toward ditch so the slope is equal or greater than the slope of the road.
12. Compaction of the surface aggregate by roller instead of traffic will extend the life of the reshaping job.

*Note:*

*See* Blading Aggregate Surfaces, NACE, 1990, pages 22-29 for further guidance.

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*FIGURE 23. Motorgrader Operations*

To reshape road surface without blading shoulders, on the first pass shift moldboard to edge of road surface. To reshape with shoulders, shift blade to outside edge of shoulders.
GEOMETRIC GUIDELINES

The following are guidelines determined from the American Association of State Highway and Transportation Officials (AASHTO) Green Book, 2001 Edition. (See pages 384-393 for further guidance.)

**TABLE 6. Geometric Guidelines**

<table>
<thead>
<tr>
<th>ADT (VPD)</th>
<th>Terrain</th>
<th>Minimum design speed (mph)</th>
<th>Minimum traveled way width (ft)</th>
<th>Graded shoulder width (ft)</th>
<th>Maximum grade (%)</th>
<th>Minimum curve radius (ft)</th>
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<td>14</td>
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**Note:**
- Minimum curve radius applies to a maximum superelevation rate of 0.08 ft/ft.
- Vertical clearance is 14 feet for all conditions.
- Curve widening may also be required for off tracking of long wheelbase vehicles.
REFERENCES

2. The Bridge, Michigan Technological University, Spring 1993.
11. Vegetation Control for Safety, FHWA, FHWA-RT-90-003, 1994. (Contact your LTAP or T² Center for additional information and latest reference editions.)

The mission of the National Local Technical Assistance Program is to foster a safe, efficient, environmentally sound transportation system by improving skills and knowledge of local transportation providers through training, technical assistance and technology transfer.
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