Field Guide for Rural Roads

A safety guide on application of traffic control devices and road management techniques for local road agencies.

Kansas LTAP meets the needs of road and bridge departments in local governments for information, training and technical assistance.

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The purpose of this guide is to provide assistance to local governments responsible for safety of rural roads. It provides a convenient reference to help answer questions in the field in order to provide a safer road environment for rural roads.

This revised guide updates the information presented in the previous edition (dated July 2004) to comply with the current editions of the MUTCD, Green Book, Roadside Design Guide, etc. For a complete list of references, see page 33. These references are useful, but the latest editions should be consulted. Special thanks to Norm Bowers, Kansas Local Road Engineer, for his contributions in updating this guide.

This guide is not all encompassing and should not be considered 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 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 rural road world. Start an improvement program to make your roads safer.
TRAFFIC CONTROL DEVICES

Traffic control devices are all signs, markings, and devices placed on or along a road. They assist the driver in traveling the road in a safe and efficient manner.

Traffic Control Devices should:
1. Fulfill a need
2. Command attention and be easily seen (e.g. warning signs use black legends on a yellow background)
3. Convey a clear simple message
4. Command respect
5. Be properly positioned for the situation to give adequate time for proper response (See Table 1 on page 3).

Sign Placement

**FIGURE 1. Rural Sign Placement**

![Diagram of sign placement](image)

Note:
* All signs should be located as far as practical from the edge of the shoulder. In areas where it is impractical to locate a sign with the lateral offset prescribed, a lateral offset of at least 2 feet may be used.

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.
Sign Location Hints
1. For better visibility, avoid placing signs on curves (except for chevrons).
2. To avoid long posts, select sign placement on a cut slope rather than a fill slope.
3. To avoid long posts, avoid placing signs in the bottom of ditches.
4. Space signs along the roadway, and don’t crowd signs together. Provide 100’ minimum spacing where possible.
5. Select locations that 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, where practical.)

Signing Consistency
Once you have decided how to sign a location, use similar signing at locations with similar situations. Locations with additional crash 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.

Warning Sign Placement
Warning signs give notice of a situation that might not be readily apparent. Advance warning signs should be located in advance of unusual or potentially unsafe conditions. The values contained in Table 1 are for guidance purposes and should be applied with engineering judgement. (See MUTCD 2009 Edition with revisions 1 and 2 incorporated, dated May 2012, Sections 2A-18 through 2A-22 and 2C-01 through 2C-05 for further guidance.)
Notes:

1  The distances are adjusted for a sign legibility distance of 180 feet for Condition A. The distances for Condition B have been adjusted for a sign legibility distance of 250 feet, which is appropriate for an alignment warning symbol sign. For Conditions A and B, warning signs with less than 6-inch legend or more than four words, a minimum of 100 feet should be added to the advance placement distance to provide adequate legibility of the warning 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 the driver a PRT of 14.0 to 14.5 seconds for vehicle maneuvers (2005 AASHTO Policy, Exhibit 3-3, Decision Sight Distance, Avoidance Maneuver E) minus the legibility distance of 180 feet.

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 2005 AASHTO Policy, Exhibit 3-1, Stopping Sight Distance, providing a PRT of 2.5 seconds, a deceleration rate of 11.2 feet/second², minus the sign legibility distance of 180 feet.

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 PRT, a vehicle deceleration rate of 10 feet/second², minus the sign legibility distance of 250 feet.

5  No suggested distances are provided for these speeds, as the placement location is dependent on site conditions and other signing. An alignment warning sign may be placed anywhere from the point of curvature up to 100 feet in advance of the curve. However, the alignment warning sign should be installed in advance of the curve and at least 100 feet from any other signs.

6  The minimum advance placement distance is listed as 100 feet to provide adequate spacing between signs.

* Source: MUTCD, 2009 Edition, Table 2C-4
Sign Installation Tips

1. Posts should be buried in firm ground 3 feet deep. Loose or sandy soil may require deeper post placement.
2. Use only crashworthy sign posts:
   a) 3 lb. max "U" channel
   b) 2" inside diameter max pipe
   c) 2.25" max square steel perforated
   d) 4"x4" wood
   d) 6"x6" wood, drilled.
3. Use earth plate to prevent round post twisting. (See Figure 2).
4. Sign panels should be bolted to the post with oversized washers.
5. Use sign connections that prevent vandalism.

Note:
RAILROAD CROSSINGS

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

1. Crossbuck (R15-1) signs shall be used on each approach at all railroad crossings. A white retroreflective strip (width >= 2 in) should be used on the back of each blade of each Crossbuck sign for the length of each blade. If automatic gates are not present and if there are 2 or more tracks at a grade crossing, the number of tracks shall be indicated on a supplemental Number of Tracks (R15-2P) Plaque of inverted T shape mounted below the Crossbuck sign. (See MUTCD 2009 Edition, Section 8B-03 for further guidance.)

2. A YIELD (R1-2) or STOP (R1-1) sign shall be installed on either the Crossbuck sign support or on a separate support. (See Figure 3 and MUTCD 2009 Edition, Section 8B-04 for further guidance.)

3. A Grade Crossing Advance Warning (W10-1) sign should be used at all railroad crossings. (See Figure 4 and MUTCD 2009 Edition, Section 8B-06 for further guidance.)

4. Vegetation should be removed to improve the sight distance at the railroad crossing.

5. The roadway approach grade to the railroad crossing should be flat enough to prevent truck snagging.

Notes:

1. K.S.A. 66-2, 121 requires railway corporations to erect crossbucks.
2. STOP or YIELD signs may be responsibility of the railway corporations.
Notes:
1. YIELD or STOP signs are used only at passive crossings. A STOP sign is used only if an engineering study determines that it is appropriate for that particular approach.
2. Mounting height shall be at least 4 feet for installations of YIELD or STOP sign on existing Crossbuck sign supports.
3. Mounting height shall be at least 7 feet for new installations in areas with pedestrian movements or parking.
Notes:
1. YIELD signs are used only at passive crossings.
2. Place the face of the signs in the same plane and place the YIELD sign closest to the traveled way. Provide a 2-inch minimum separation between the edge of the Crossbuck sign and the edge of the YIELD sign.
Notes:
1. STOP signs are used only at passive crossings and only if an engineering study determines that it is appropriate for that particular approach.
2. Place the face of the signs in the same plane and place the STOP sign closest to the traveled way. Provide a 2-inch minimum separation between the edge of the Crossbuck sign and the edge of the STOP sign.
FIGURE 4. Railroad Crossings

* Distance = Condition A; Table 1

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.
HORIZONTAL CURVES

Hidden or unexpected horizontal curves should be signed. If the curve speed is lower than the operating speed of the roadway (typically by 10 mph or more) then an advisory plaque may be attached below the curve, or turn sign. (See page 12 to determine the advisory speed, and Table 2 on page 11 for Horizontal Alignment Sign Usage.)

FIGURE 5. Example of Warning Signs for a Turn

Notes:
1. See Table 1 for advance placement distance guidelines
2. See Table 2 for the selection of horizontal alignent signs
3. See Table 5 for spacing of W1-8 signs
4. A 25-mph advisory speed is shown for illustrative purposes only
In rolling or mountainous terrain, crests of 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>2²</td>
<td>Reverse Turn³ (W1-3)</td>
</tr>
<tr>
<td>3 or more²</td>
<td>Winding Road³ (W1-5)</td>
</tr>
</tbody>
</table>

Notes:
1. Engineering judgment should be used to determine whether the Turn or Curve sign should be used (see Figure 6).
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 (see Figure 6).

In rolling or mountainous terrain, crests of 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.

### FIGURE 6. Horizontal Alignment Signs

<table>
<thead>
<tr>
<th>W1-1</th>
<th>W1-2</th>
<th>W1-3</th>
<th>W1-4</th>
<th>W1-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn</td>
<td>Curve</td>
<td>Reverse Turn</td>
<td>Reverse Curve</td>
<td>Winding Road</td>
</tr>
</tbody>
</table>
Advisory Speed Plaque

Advisory speed plaques* are mounted under a curve or turn sign to indicate a safe travel speed around the curve. The 2009 MUTCD states the advisory speed is to be determined by an engineering study. The following methods may be used to determine a reasonable advisory speed. Agencies will have to decide if they want to risk the liability associated with determining the advisory speed without an engineering study. On turns and sharper curves, it may be less risky and safer for the travelling public to post a reasonable advisory speed plaque as compared to not having an advisory speed plaque.

One method is to just drive the curve a number of times. The first trial run should be on the slow side, then increase the speed 5 MPH on each trial run. When the trial run becomes too fast to be comfortable then the advisory speed would be a lower speed.

The second method is more scientific and is determined by a ball bank indicator. 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 and note Ball Bank Readings.
4. Evaluate the curve to determine the maximum comfortable speed in both directions, using the chart in Figure 7.
5. The lower speed value should be posted below the curve or turn sign for both directions (see Figure 8 on page 13). The speed displayed shall be a multiple of 5 mph. In addition, an optional Combination Horizontal Alignment/Advisory Speed sign may be installed at point of curvature.

*Note:

See MUTCD 2009 Edition, Section 2C-06 through 2C-08 for further guidance.
If the speed that is determined comfortable is below the operating speed of the roadway, an advisory speed plaque should be considered. Usually when the comfortable speed is 10 MPH or more less than the operating speed, an advisory speed plaque is appropriate. Advisory speed plaques are made in 5 mph increments. Remember to use a turn sign (W1-1) when the advisory speed is less than 35 mph.

**FIGURE 8. Advisory Speed Plaque**

Example of Horizontal Alignment Signs

Example of Combination Horizontal Alignment/Advisory Speed Signs
INTERSECTIONS

Stop and yield signs are often installed at intersections. Checking sight distance is an important consideration (See page 15). Other stop and yield sign placement considerations include intersections with high volume roads and the intersection of roads with different classifications.

* 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.
INTERSECTION SIGHT DISTANCE

The driver of a vehicle approaching an intersection needs a view of vehicles approaching the intersection from the intersecting roads. The unobstructed views to intersecting traffic form triangular areas known as sight triangles. Approach sight triangles provide the driver of a vehicle approaching an intersection an unobstructed view of potential conflicting vehicles. Long sight triangles provide better safety so it is important to keep trees trimmed and weeds mowed in the vicinity of the intersection. Many times sight distance can be improved by tree removal, flattening backslopes, and lowering hills.

If sight distance is restricted, it may be appropriate to install YIELD or STOP signs*. At a 4 way intersection it is seldom appropriate to put a sign on one leg of the intersection, as this may cause driver confusion. The normal signing should be a 2-way yield or 2-way stop either east & west, or north & south. If the sight distance is about equal, the signs are placed on the road with the smallest amount of traffic. However, sight distance restrictions may make it appropriate to put the YIELD or STOP signs on the road with the best sight distance when stopped at the proposed YIELD or STOP.

The following method maybe used to determine if STOP or YIELD signs are appropriate by measuring the available sight distance. The MUTCD should also be consulted for additional guidance. The MUTCD requires an engineering study for an all-way stop, and for stopping traffic on the higher volume road.

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, Page 16.
3. An observer with a sighting rod and an assistant with a target rod should position themselves on different approaches at the appropriate distance from the intersection (See page 26 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 sight triangle analysis should be performed for all intersection legs considering traffic approaching from both the right and the left.

Figure 10. Intersection Sight Triangle

TABLE 3. Intersection Sight Distance

<table>
<thead>
<tr>
<th>Distance (ft)</th>
<th>Operating Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop Control</td>
<td>D</td>
</tr>
<tr>
<td>Control</td>
<td>A</td>
</tr>
<tr>
<td>No Control</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>A</td>
</tr>
</tbody>
</table>

Note:
- Values in the Table are for passenger cars on grades between -3% and +3%.
- Downgrades require an increased distance, where upgrades require a decreased distance.
- Remove vegetation higher than 3 feet within the clear sight triangle.
DELINEATION

Post mounted delineation may be used to outline the edge of the travelway. 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; and
4. At transitions before narrow bridges and culverts.

Delineators should be placed at a constant offset from the edge of shoulder (typically between 2 feet and 8 feet). 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 a guardrail or other longitudinal barriers, they should be attached to or placed just behind the guardrail or longitudinal barrier.

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

**FIGURE 11. Curve Delineator Placement**

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

<table>
<thead>
<tr>
<th>Radius of Curve (ft)</th>
<th>Curve 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 3F-04).
Chevrons

Chevron (W1-8) signs may be used as alternates or supplements 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.

### FIGURE 13. Chevron Sign Placement

**TABLE 5. Typical Spacing of Chevron Alignment Signs on Horizontal Curves**

<table>
<thead>
<tr>
<th>Advisory Speed</th>
<th>Curve Radius</th>
<th>Sign Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 mph or less</td>
<td>Less than 200 feet</td>
<td>40 feet</td>
</tr>
<tr>
<td>20 to 30 mph</td>
<td>200 to 400 feet</td>
<td>80 feet</td>
</tr>
<tr>
<td>35 to 45 mph</td>
<td>401 to 700 feet</td>
<td>120 feet</td>
</tr>
<tr>
<td>50 to 60 mph</td>
<td>701 to 1,250 feet</td>
<td>160 feet</td>
</tr>
<tr>
<td>More than 60 mph</td>
<td>More than 1,250 feet</td>
<td>200 feet</td>
</tr>
</tbody>
</table>

Note: The relationship between the curve radius and the advisory speed shown in this table should not be used to determine the advisory speed.
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 that 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.
Delineating - 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 break away safely if struck by a vehicle. For additional information on mailbox placement and location, contact your Local Technical Assistance Program (LTAP) Center (see page 32).

*Note: See AASHTO Roadside Design Guide, 4th Edition (2011) for further guidance. Also, see AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT <=400)
BRIDGES AND CULVERTS

Narrow Bridge
1. The narrow bridge (W5-2) 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. 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 (W5-3) sign should be used.
3. Approaches to the structure should be tapered (See pages 21 to 22).
4. Approach guardrails should be used to protect the motorist from the bridge abutments (See page 23).
5. Delineators may be used to provide better guidance to the approach.
6. Type 3 object markers (OM-3) should be used on bridges having a roadway clearance less than approach travel lanes.

*Distance = 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 2009 Edition, Section 2C.63 for further guidance.)
Tapering
Structures such as culverts and bridges should be built or modified to maintain the full width of the travelway. If not the full width, 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 6.
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>
<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 15. Tapering Roadway for Narrow Structures**

**TABLE 6. Taper Length, L (feet)**

![Diagram: Tapering Roadway for Narrow Structures](image)
FIGURE 16a. Before Tapering Road  
(Roadway wider than culvert or bridge with edges leading into culvert headwalls or ditch)

FIGURE 16b. After Tapering Road  
(Roadway width is gradually reduced to width of structure with edges leading away from ditch or culvert headwalls)
GUARDRAIL

Guardrail is intended to protect a vehicle from hitting a more hazardous object. Guardrail itself can cause serious damage to vehicles and injury when struck. Guardrail warrants and standards are quite complicated and so guardrail at new locations should not be considered without consulting an engineer. The engineer will determine if the guardrail is warranted based on guidelines in the AASHTO Roadside Design Guide. New guardrail needs to be engineered and designed to current standards to insure it will function properly. Locations where guardrail might be appropriate are high fills and narrow bridges and culverts.

Installed guardrail should be inspected periodically to insure that it will function properly. Inspect the guardrail for damage, rotten posts, and that the guardrail is at the right height. Usually existing guardrail is repaired to maintain the function as it was originally designed. In the past, guardrail was installed at locations where it was not appropriate, such as fills and culverts less than 7 feet high. In situations where existing guardrail may no longer be warranted, it is best to contact an engineer to see if the guardrail can just be removed.

FIGURE 17. Guardrail Sections
**FIGURE 18. Guardrail Types**

**Blocked-out W-beam Steel (strong post) system**  
AASHTO Designation: SGR04a

- TL-2, speed <45 mph  
- (Steel block) TL-3, speed <=62 mph

**Blocked-out W-beam Wood (strong post) system**  
AASHTO Designation: SGR04b

- TL-3, speed <=62 mph

**Three-Strand Cable Steel (weak post) system**  
AASHTO Designation: SGR01a, SGR01b

**W-Beam Steel (weak post) system**  
AASHTO Designation: SGR02

- TL-3, speed <=62 mph
- TL-2, speed <45 mph
**USEFUL TOOLS**

**FIGURE 19a. Building Your Own 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.  

- 1. Pipe handle about 4 feet long.  
- 2. Metal U-shape the size of the post.
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 15.

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 feet long and 1/2 feet deep.
Crown
A crown is used on straight road sections to remove water from the road surface. Preferred grade 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.

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.
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 the crown and provide correct shoulder slope.
4. Remove any bumps, dips, or loose material at the edge of the paved road.

Railroad Crossing
When blading a road crossing railroad tracks:
1. Gradually eliminate the crown on the road, starting about 50 to 100 feet before the road intersects the 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 the crown and to meet the grade of the railroad tracks.
4. Correct bumps an dips as explained in smoothing on the 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 24).
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 the 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.

FIGURE 23. Motorgrader Moldboard

Tilt the moldboard for a dragging action (*See Figure 24)

Tilt the moldboard back to cut into ridges and potholes (*See Figure 24)
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 24.)
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 the 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. Compacting 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.

FIGURE 24. 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.
### Typical Material Weights

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STATEWIDE AVERAGE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>150 lbs per c.f.</td>
<td>In place</td>
</tr>
<tr>
<td>Hotmix</td>
<td>145 lbs per c.f.</td>
<td>Compacted</td>
</tr>
<tr>
<td>Coldmix</td>
<td>140 lbs per c.f.</td>
<td>Compacted</td>
</tr>
<tr>
<td><strong>Aggregates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AB-3(dry wt.)(KDOT)</td>
<td>140 lbs per c.f.</td>
<td>Compacted</td>
</tr>
<tr>
<td>AB-3(wet wt)(KDOT)</td>
<td>156 lbs per c.f.</td>
<td>Compacted</td>
</tr>
<tr>
<td>AS-1(dry wt.)(KDOT)</td>
<td>135 lbs per c.f.</td>
<td>Compacted</td>
</tr>
<tr>
<td>AS-1(wet wt.)(KDOT)</td>
<td>150 lbs per c.f.</td>
<td>Compacted</td>
</tr>
<tr>
<td>Road Rock(dry wt.)*</td>
<td>125 lbs per c.f.</td>
<td>Compacted</td>
</tr>
<tr>
<td>Road Rock(wet wt.)*</td>
<td>135 lbs per c.f.</td>
<td>Compacted</td>
</tr>
<tr>
<td>Screened rock 3/8&quot;</td>
<td>96 lbs per c.f.</td>
<td>In stockpile</td>
</tr>
<tr>
<td>Screened rock 3/4&quot;</td>
<td>100 lbs per c.f.</td>
<td>In stockpile</td>
</tr>
<tr>
<td>AB-3(pile-wet)</td>
<td>105 lbs per c.f.</td>
<td>In stockpile</td>
</tr>
<tr>
<td>Sand(dry)</td>
<td>95 lbs per c.f.</td>
<td>In stockpile</td>
</tr>
<tr>
<td>Sand(damp)</td>
<td>101 lbs per c.f.</td>
<td>In stockpile</td>
</tr>
<tr>
<td>Soil</td>
<td>110 lbs per c.f.</td>
<td>Compacted</td>
</tr>
<tr>
<td>Road Salt</td>
<td>80 lbs per c.f.</td>
<td>In stockpile</td>
</tr>
<tr>
<td><strong>Liquids</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asphalt (AC)</td>
<td>8.33 lbs per gal</td>
<td></td>
</tr>
<tr>
<td>Asphalt cutback</td>
<td>7.81 lbs per gal</td>
<td></td>
</tr>
<tr>
<td>Asphalt-emulsion</td>
<td>8.24 lbs per gal</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>8.435 lbs per gal</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>62.43 lbs per c.f.</td>
<td></td>
</tr>
<tr>
<td>MGCL(summer)(30%)</td>
<td>10.8 lbs per gal.</td>
<td></td>
</tr>
<tr>
<td>CAACL (winter)(32%)</td>
<td>11.0 lbs per gal.</td>
<td></td>
</tr>
<tr>
<td>CAACL(summer)(38%)</td>
<td>11.5 lbs per gal.</td>
<td></td>
</tr>
</tbody>
</table>

* Road Rock is good crusher run or screened limestone with no more than 12% passing the 200 sieve.
Resources for Kansas Road Officials

Training:
All three of the contacts listed below provide training to local government employees at all levels.

Local Technical Assistance Program at KU (LTAP Center)
Phone: 785-864-5658
FAX: 785-864-3199
http://www.ksltap.org
Email: kutc@ku.edu

Rural Transportation Center at KSU
Phone: 785-532-1595
FAX: 785-532-7717
http://transport.ksu.edu
Email: drbobb@ksu.edu

Kansas Association of Counties (KAC)
Phone: 785-272-2585
FAX: 785-272-3585
http://www.kansascounties.org

Other Resources:

Kansas Department of Transportation (KDOT)
Dwight D. Eisenhower State Office Building
700 S.W. Harrison Street Topeka, KS 66603-3754

Bureau of Local Projects in KDOT
Phone: 785-296-3861
FAX: 785-296-2079
http://www.ksdot.org/burllocalproj/

Kansas County Highway Association (KCHA)
http://www.kansascountyhighway.org

National Association of County Engineers (NACE)
Phone: 202-393-5041
FAX: 202-393-2630
http://www.countyengineers.org
Email: nace@naco.org
REFERENCES


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.