OREGON DEPARTMENT OF TRANSPORTATION TECHNICAL SERVICES Traffic-Roadway Section BULLETIN				
SUBJECT State-wide Policy for Installing Chevrons, Arrows and Advisory Speed Plaques.	FINAL NUMBER TR14-01(B)	EFFECTIVE DATE 00/00/0000	VALIDATION DATE 00/00/0000	SUPERSEDES or RESCINDS 00/00/0000
	WEB LINK(S) http://www.oregon.gov/ODOT/HWY/TECHSERV/Pages/technicalguidance.aspx			
TOPIC/PROGRAM Highway Safety	APPROVED SIGNATURE [DRAFT – no approval signature] Bob Pappe, PE, PLS State Traffic-Roadway Engineer			

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PURPOSE

The purpose of this Technical Bulletin is to obtain statewide consistency for the determination of need and use of Advisory Speed Plaques, Chevrons and Arrows.

This Technical Bulletin provides direction to ODOT's sign designers, district sign crews, and region traffic personnel relating to the installation of Chevrons, Arrows and Advisory Speed Plaques on state highways as ODOT updates signage to match the requirements of the current MUTCD. This bulletin also establishes criteria for deviations to the MUTCD requirements for installation of chevrons and arrows that may be allowed on State highways in Oregon. This bulletin is not intended to, nor does it cover, all circumstances of curve signing that may benefit from an engineering evaluation of the appropriate application of the MUTCD. There is a federal compliance date of December 31, 2019 for substantial conformance to these requirements.

GUIDANCE

Safety funds will pay for the initial installation of advisory speed plaques, chevrons and arrows required by the evaluation or reevaluation of curves under the current MUTCD advisory speed criteria in Section 2C.08 *Advisory Speed Plaque* and Table 2C-5 *Horizontal Alignment Sign Selection* of the 2009 MUTCD. Safety funds may also be used to pay for the initial evaluation or re-evaluation of curves (ball-banking) as required by the 2009 MUTCD to update curve warning signage.

Use ball-bank indicator values in Section 2C.08(07) of the 2009 MUTCD to establish advisory speeds for curves. Refer to chapter 6.28 of the ODOT Traffic Manual, the information available at the Traffic Standards SIGNING web site http://www.oregon.gov/ODOT/HWY/TS/pages/signing.aspx and the following rules for evaluation of each curve in each direction:

a. The Ball bank indicator values in Section 2C.08(07) of the 2009 MUTCD are not-to-exceed values.

b. Establishing, changing, or removing an advisory speed plaque requires a ball-bank indicator evaluation using the enhanced ball-banking equipment capable of measuring vehicle speed, curve radius, and side friction. If the curve is located such that these data cannot be collected (e.g.: because GPS signal is lost in a canyon), use an electronic ball-bank indicator. (Contact the Traffic-Roadway Section for further information if necessary.)

The MUTCD allows deviations to be determined on a case-by-case basis to ensure the best practice is applied to any section of the roadway. Several circumstances and locations are common enough to warrant a statewide strategy to ensure consistent deviation from the MUTCD. Region Traffic Engineers may deviate from the guidance in Section 2C.09 and Table 2C-05 of the 2009 MUTCD in the following special circumstances and locations. Retain documentation explaining reasons for each deviation in the Region Traffic Files

Special Circumstances and locations are:

1. **Curves in snow zones or locations of heavy plowing**:

   a. In locations where repeated damage to chevrons or arrows from snow plowing operations is likely to occur, chevrons or arrows may be installed substantially above the recommended minimum height in the MUTCD section 2C.09 or ODOTs' current standard installation height of 7 feet. Consider how vertical alignment may affect sign visibility when implementing this measure. Upgrading supports to resist snow thrown by plowing operations and addition of a vertical strip of retro-reflective material to the post is recommended.

   b. In locations where repeated damage to chevrons or arrows from snow plowing operations is likely to occur and installation at an alternate height is not achievable, chevrons or arrows may be omitted. Alternative warning methods should be considered.

2. **Curves for on/off Ramps**:

   a. Guidance for application of horizontal alignment signing is dependent on posted speed and advisory speed. Because ramps are not part of the mainline or cross road, speed is governed by basic rule when the ramp is not within a designated or statutory speed zone.

   b. In locations where crash history indicates horizontal alignment signing would be beneficial, chevrons or arrows should be installed.

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c. In locations where the crash history is of a type that would not benefit from installation of chevrons or arrows, chevrons or arrows may be omitted. Alternative warning methods targeting the crash history should be considered.
d. In locations without positive separation of on/off traffic or other geometric issues, chevrons or arrows may be omitted. Alternative warning methods should be considered.

3. **Multiple Curves**: In some cases, multiple curves in a series may limit driver speed on entering a curve from one or both directions. Chevrons or arrows may be omitted for locations where all of the following are true:
   i. one or more curves are located between curves having lower advisory speeds that would limit the speed of the interior curve **and**
   ii. The curves meet the criteria in Section 2C.07 (04) of the 2009 MUTCD allowing the installation of a WINDING ROAD (W1-5) sign **and**
   iii. The crash history for those specific curves is of a type that would not benefit from installation of chevrons or arrows.

   For example, on a 40 mile per curve that is closely bound by a 35 mile per hour curve on both sides, if those bounding curves reduce operating speeds into the approach of the 40 mile per hour curve, it may not be necessary to use chevrons or arrows.

DEFINITIONS

Electronic Ball-bank Indicator – Device that gives a degree reading indicating the combined effect of superelevation, lateral (centripetal) acceleration, and vehicle body roll.

Enhanced Ball-banking Equipment – Ball-bank indicator capable of measuring vehicle speed, curve radius, and side friction

Ball-bank indicator evaluation – Using enhanced ball-banking equipment, the averaged calculated advisory speed of at least three runs rounded down to the nearest 5 mph (Rieker Curve Advisory Reporting Service (CARS)).

Using only an electronic ball-bank indicator, the averaged results of the three final ball-bank runs for a curve at the proper speed allowing the ball-bank values to approach but not exceed the threshold values in Section 2C.08(07) of the 2009 MUTCD.

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Calculated Advisory Speed – the speed the threshold value will be reached, calculated using the AASHTO side friction equation (referred to as the simplified curve formula in the *AASHTO Green Book*).

Manual on Uniform Traffic Control Devices (MUTCD) – Traffic control devices installed on highways within the State of Oregon are required to conform to the Manual on Uniform Traffic Control Devices (MUTCD), published by the Federal Highway Administration. This requirement is established by Oregon Revised Statute (ORS) (see ORS 810.200) and Oregon Administrative Rule (OAR) (see OAR 734-020-0005).

BACKGROUND/REFERENCE

In 2011, ODOT adopted the 2009 MUTCD including the values for determining the advisory speed on curves using an inclinometer, an instrument commonly called a ball-bank indicator. The discussion leading to the decision to continue to evaluate curve advisory speeds using the ball bank method included consideration of other methods and an evaluation of the effectiveness of previous practice.

- Dixon and Avelar[(1)] studied ODOT's practice for evaluating advisory speeds up to 2011 and found advisory speed posting practice was not consistent throughout the state. Dixon and Avelar concluded the ball-and-vial type of ball bank instrument likely contributed to the inconsistency and developed and recommended a design speed equation. They acknowledged the ball-bank practice used statewide for many years produced advisory speeds at least as conservative, and often more conservative (if somewhat inconsistent), than the design speed equation they developed and recommended.
- Some of the variables in the design speed equation required data ODOT does not currently collect and would need to measure in the field.
- Local jurisdictions also do not collect some of the data required for the design speed equation.
- ODOT and the Oregon Traffic Control Devices Committee (OTCDC) agreed that a consistent approach to assigning advisory speeds available to all jurisdictions and understood through years of application, such as the ball banking system was the best alternative for statewide consistent advisory speeds.
- To further the efforts at consistency and improve repeatability of results, ODOT developed an application for an electronic digital ball bank instrument and has made the application and instrument available to local jurisdictions.

[1] Dixon, K. K., and R. E. Avelar. Safety Evaluation of Curve Warning Speed Signs. School of Civil and Construction Engineering, Oregon State University, Salem, Oregon, FHWA-OR-RD 11-14, 2011. http://www.oregon.gov/ODOT/TD/TP_RES/docs/reports/2011/warningspeedsignsspr685.pdf.

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As required by the 2009 MUTCD and the ball-bank indicator values in Section 2C.08, all advisory speeds will need to be reevaluated and curve signage updated. Because statewide practice used up to this point developed more conservative advisory speed values, existing signage can remain in place until each corridor can be reevaluated and resigned to new standards.

In addition to the change in ball bank practices, the 2009 MUTCD added requirements for the use of horizontal alignment (Chevron W1-8 or Arrow W1-6[r-l]) signing. These requirements are set out in Section 2C.09 and Table 2C-05. There is a compliance date of December 31, 2019 in the 2009 MUTCD for substantial completion of horizontal alignment signing.

While the requirements in Section 2C.09 and Table 2C-05 are only applicable to roadways with an ADT of 1000 or greater, similar signing can be applied to any location where it may enhance safety.

EXPLANATION

ODOT shall follow the MUTCD and install chevrons or arrows at all locations marked "Required" or "Recommended" in table 2C-05 with deviations noted in this guidance. As noted above, decisions are to be documented for each location by highway name, number and mile point(s) including the specific reason for each finding. File documentation in the Region Traffic Files. Past practice has been for ODOT to install an advisory speed plaque when the recommended safe speed is 10 MPH or more below the posted speed. However, with the adoption of the 2009 MUTCD an advisory speed plaque is now required when the recommended safe speed is 5 MPH or more.

RESPONSIBILITIES

Region Traffic Engineers approve the application of the deviations listed above.

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