Reduced Speed Limits or Curve Warning Signs?

Northeast Traffic Safety Conference
Cromwell, Connecticut
October 24-25, 2017
Overview/Objectives

• Curve signing overview
• State signing history for curved alignments
• Determining State Speed Zones
• Setting Credible Speed Limits
• Examples
Curve Signing overview

- Curves have long been identified as a common hazard
- Curve and Turn warning signs were included in the initial MUTCD (1935)
- Curve signing relatively unchanged through several subsequent editions
- Chevrons introduced with 1978 edition
Reference from 1935 MUTCD

Section 112—Slow-Type Signs

A slow-type sign shall be used only for the following conditions where permanent physical hazards always require a reduction in speed for safety:

(a) Turns having radii of less than 200 feet.
(b) Curves having radii of 200 feet or more where conditions require a reduction in speed.
(c) Reverse curves.
(d) Successions of curves with or without short tangents.
(e) Hills having down grades of 6 percent or more.
(f) Dips.
(g) Narrow bridges or roadways.
(h) Other points of limited clearance.
(i) Drawbridges.
(j) Safety zones of similar obstructions.
(k) Intersections which do not warrant a STOP sign but are sufficiently hazardous to require a reduction in speed.
(l) Street car crossings and turns.
(m) Advance warnings of obscured STOP signs.
(n) Stated speed locations.

CURVE signs should be used only where a reduction of speed is required for safety because of degree of curvature, visibility, width of pavement, banking or similar conditions.
2C-10 Chevron Alignment Sign (W1-8)

The Chevron Alignment sign shall be a vertical rectangle with a minimum size of 12 inches by 18 inches. It shall have a yellow background with chevron symbol in black. The size of sign used will be determined by an engineering investigation.

A Chevron Alignment sign may be used as an alternate or supplement to standard delineators and to the Large Arrow sign. The Chevron Alignment sign is intended to be used to give notice of a sharp change of alignment with the direction of travel. Chevron Alignment sign is intended to provide additional emphasis and guidance for vehicle operators as to changes in horizontal alignment of the roadway.
Curve Signing Overview

• MUTCD criteria for curve warning signing, Table 2C-5 significantly changed with 2009 edition
<table>
<thead>
<tr>
<th>Number of Alignment Changes</th>
<th>Advisory Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 50 km/h (≤ 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.

² Alignment changes are in opposite directions and are separated by a tangent distance of 180 m (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.
<table>
<thead>
<tr>
<th>Type of Horizontal Alignment Sign</th>
<th>Difference Between Speed Limit and Advisory Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn (W1-1), Curve (W1-2), Reverse Turn (W1-3), Reverse Curve (W1-4), Winding Road (W1-5),</td>
<td>5 mph</td>
</tr>
<tr>
<td>Combination Horizontal Alignment/Intersection (W10-1) (see Section 2C.07 to determine which sign</td>
<td>Recommended</td>
</tr>
<tr>
<td>to use)</td>
<td></td>
</tr>
<tr>
<td>Advisory Speed Plaque (W13-1P)</td>
<td>Recommended</td>
</tr>
<tr>
<td>Chevrons (W1-8) and/or One Direction Large Arrow (W1-6)</td>
<td>Optional</td>
</tr>
<tr>
<td>Exit Speed (W13-2) and Ramp Speed (W13-3) on exit ramp</td>
<td>Optional</td>
</tr>
</tbody>
</table>

Note: Required means that the sign and/or plaque shall be used, recommended means that the sign and/or plaque should be used, and optional means that the sign and/or plaque may be used.

See Section 2C.06 for roadways with less than 1,000 ADT.
Crash Modification Factors

• CMF ID 2435
  – Install new fluorescent curve signs or upgrade existing curve signs to fluorescent sheeting
  • CMF = 0.66
  • CRF = 34

• Safety Evaluation of Improved Curve Delineation, Srinivasan, et al, 2009
Crash Modification Factors

• CMF ID 2440
  – Install chevron signs on horizontal curves
    • CMF = 0.78
    • CRF = 22
  • *Safety Evaluation of Improved Curve Delineation*, Srinivasan, et al, 2009
Crash Modification Factors

• CMF 1905
  – Install chevron signs and curve warning signs
  • CMF = 0.592
  • CRF = 40.8
• Safety Evaluation of Curve Delineation Improvements, An Empirical Bayes Observational Before-After Study, Montella, 2009
NHDOT History for addressing curved alignments

• Multiple crashes on curved alignment often led to reduced speed limits

• Curve signing often determined independent of speed limit, except:
  – Advisory speeds determined by ball bank indicator
  – When measured advisory speed > posted speed limit, posted advisory speed arbitrarily 10 mph below speed limit
Statewide curve warning sign project(s)

- HSIP systemic/systematic projects
- Due to project scope, projects were designed and advertised by district over several years
- Initial projects revealed curve warning signing removed at historic crash locations, leading to questions about posted speed limits
Determining State Speed Zones

- Speed limits defined by statute
- State speed zones determined based on “engineering and traffic investigation”
- Speed limits historically determined by district maintenance engineers (curve signing determined by headquarters traffic engineers)
Determining State Speed Zones

• Statutory limits
  – RSA 265:60 Basic Rule and Maximum Limits
    • Establishes the “reasonable and prudent” standard
    • “No person shall drive a vehicle on a way at a speed greater than is reasonable and prudent under the conditions and having regard to the actual and potential hazards then existing.”
Determining State Speed Zones

• RSA 265:60, cont’d
  – Defines school zone speed limit
  – 30 mph for business or urban residence district
  – 35 mph for rural residence district and Class V highways (a.k.a. “town roads”)
  – 65 mph for interstates, turnpikes, and other multi-lane, divided highways, except I-93 north of Concord (70 mph)
  – 55 mph in other locations
Determining State Speed Zones

• RSA 265:62 Establishment of State Speed Zones
  – Requires an engineering and traffic investigation

• Commissioner’s authority delegated to State Traffic Engineer, August, 2013
  (from District Maintenance Engineer(s))
Determining State Speed Zones

• Components of an “engineering and traffic investigation”
  – Speed study
  – Horizontal and vertical geometry
  – Traffic volume and crash history
  – Segment length
  – Number of lanes and lane width
  – Offset to hazards
Engineering and Traffic Investigation

• 85th percentile speed
  – Based on research by David Solomon, US Bureau of Public Roads (now FHWA)
  – Compares the relationship between average speed and collision rates of automobiles
  – Generally regarded as the “reasonable and prudent” standard with regard to speed limits
Candia, NH 27
85th percentile approx. 47 mph
Posted speed limit – 35 mph
Engineering and Traffic Investigation

• Other factors:
  – Crash history compared to similar segments
  – Highway geometry: design speed does not necessarily relate to posted speed limit
  – Continuity with neighboring speed zones and length of segment relates to credibility
USLIMITS2

U.S. Department of Transportation
Federal Highway Administration
1200 New Jersey Avenue, SE
Washington, DC 20590
202-366-4000

Safety

USLIMITS2

A TOOL TO AID PRACTITIONERS IN DETERMINING APPROPRIATE SPEED LIMIT RECOMMENDATIONS

USLIMITS is a web based tool designed to help practitioners set reasonable, safe, and consistent speed limits for specific segments of roads. USLIMITS is applicable to all types of roads ranging from rural local roads and residential streets to urban freeways.

Disclaimer: The U.S. Government assumes no liability for the use of the information contained in this tool. This tool does not constitute a standard, specification, or regulation.

NEW PROJECT

Before beginning a new project, it is recommended that you read through the User Guide and be prepared to enter the necessary data (e.g., 50th and 85th percentile speed, roadway characteristics, and crash history).

To create a new project, click the new project link below. At the end of the process you will be asked to save a project file. The project file can be revised or updated later.
Setting Credible Speed Limits

• Individual drivers control their speed according to perceived and actual road conditions, most (85% +/-) are “reasonable and prudent”

• Posted speed limits should indicate the maximum legal speed for a specific roadway segment

• Unreasonably low speed limits are not respected by drivers, law enforcement, or the courts
**Hooksett, US 3/NH 28**

STEFPHEN G. PERNAW & COMPANY, INC.

PROJECT: US RT 3 & NH RT 28 (0.3 miles North of Greens Marine, Hooksett, NH)

NUMBER: 1024A

POSTED SPEED LIMIT: 40 mph

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**SPOT SPEED SURVEY**

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Mean Speed (mph)</th>
<th>85th Percentile (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
<td>5/22/06</td>
<td>52.85 mph</td>
<td>58.12 mph</td>
</tr>
<tr>
<td>Tue</td>
<td>5/23/06</td>
<td>52.33 mph</td>
<td>57.54 mph</td>
</tr>
<tr>
<td>Wed</td>
<td>5/24/06</td>
<td>52.31 mph</td>
<td>57.47 mph</td>
</tr>
<tr>
<td>Thu</td>
<td>5/25/06</td>
<td>52.74 mph</td>
<td>57.96 mph</td>
</tr>
<tr>
<td>Fri</td>
<td>5/26/06</td>
<td>52.62 mph</td>
<td>57.78 mph</td>
</tr>
<tr>
<td>Sat</td>
<td>5/27/06</td>
<td>53.28 mph</td>
<td>58.49 mph</td>
</tr>
<tr>
<td>Sun</td>
<td>5/28/06</td>
<td>50.92 mph</td>
<td>56.04 mph</td>
</tr>
<tr>
<td>AVG</td>
<td></td>
<td>52.44 mph</td>
<td>57.63 mph</td>
</tr>
<tr>
<td>Location</td>
<td>Posted speed limit (mph)</td>
<td>85(^{\text{th}}) percentile speed (mph)</td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
<td>--------------------------</td>
<td>------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>South of NH 123</td>
<td>45</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Between NH 123 and Forest Road</td>
<td>55</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Through Forest Road</td>
<td>40</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>South of NH 137</td>
<td>50</td>
<td>54</td>
<td></td>
</tr>
</tbody>
</table>
Recent Case Studies

• Wakefield, NH 153
• Lincoln-Livermore, NH 112 (a.k.a. Kancamagus Highway)
• Thornton, NH 175
Wakefield, NH 153
Wakefield, NH 153

- Lake community bordering Maine
- NH 16 (a.k.a. White Mountain Highway) provides regional access to points north
- NH 153 serves as local collector-distributor (scenic route to White Mts)
- Posted 35 mph due to curvilinear highway alignment
Wakefield, NH 153

• Local police chief reached out to evaluate speed limits
  – Enforcement records indicated speeds typically 10-15 mph over speed limit
  – Officers were not stopping vehicles until they were traveling $\geq 60$ mph, which at 25 mph over speed limit was an increased fine and a “must appear”
Wakefield, NH 153

- Engineering and traffic investigations performed in several locations
  - Average speed, 39-44 mph
  - 85\textsuperscript{th} percentile speed, 47-49 mph
- Met with Board of Selectmen to review results
- Evaluated curve warning signs, adding 200 new signs over 12 miles
Lincoln-Livermore, NH 112 (a.k.a. Kancamagus Highway)
Lincoln-Livermore, NH 112 (a.k.a. Kancamagus Highway)

• Popular scenic highway, formerly closed through winter, includes highest highway point in New Hampshire

• Speed Limit was posted at 40 mph for majority of route when opened to year round traffic, due to “curvilinear alignment”
Lincoln-Livermore, NH 112 (a.k.a. Kancamagus Highway)

- Speed studies revealed 85th percentile speeds in tangent sections of approximately 55 mph
- Reached out to Town of Lincoln for input (Livermore exists in name only)
- Due to nature of route, curve signing was fairly current; however,
- 8 of 9 passing zones closed
Thornton, NH 175

- Local police contacted DOT for reminder 35 mph signs
- Speed studies conducted, supplemented by USLIMITS2 evaluation
- 85th percentile speeds roughly 45 mph, recommended speed limit, 40 mph (due to higher than expected crash rates)
Thornton, NH 175

- Contacted board of selectmen, offering to discuss recommendation to increase speed limit
- Board not only supported increase, but asked that we consider increasing speed limits on two other routes
- Additional curve signing installed prior to change
Figure 2C-2. Example of Warning Signs for a Turn

Legend - Direction of travel

Notes:
1. See Table 2C-4 for advance placement distance guidelines
2. See Table 2C-5 for the selection of horizontal alignment signs
3. See Table 2C-6 for spacing of W1-8 signs
4. A 25-mph advisory speed is shown for illustrative purposes only

Figure 2C-1. Horizontal Alignment Signs and Plaques

Note: Turn arrows and reverse turn arrows may be substituted for the curve arrows and reverse curve arrows on the W1-10 series signs where appropriate.
Questions?

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