Speed and Crash Reduction of DSFSs (and Maybe a Couple Low Cost Treatments) on Rural Curves

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Background

- Crash rate 3 times higher on horizontal curves than tangent roadway sections
- Iowa: 12% of fatal and 15% of major injury crashes occur on curve
- 56% of fatal run-off-road curves are speed related
- Project sponsored by FHWA, IHRB, IDOT, and the Midwest Transportation Consortium

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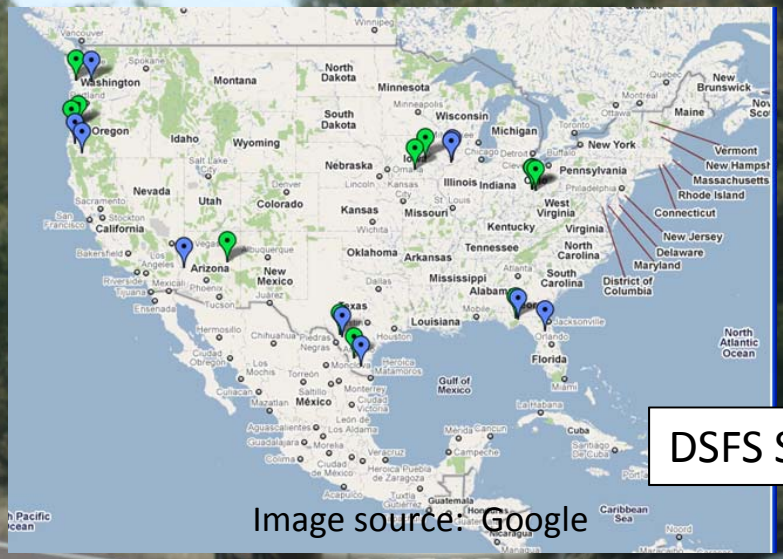
Objectives

- Evaluate effectiveness of 24 dynamic curve signs in 7 states
- Identify low-cost safety treatments which have been used to address speed and safety on rural horizontal curves for an additional 6 sites in Iowa

Site Selection

- Worked with seven states to select potential locations
  - Crash problem
  - Speeding problem
  - 2-lane rural paved curve
  - No changes 3 years before or 3 years after application of treatment
  - Made site visits
- Installed 22 signs in 7 states (IA, WA, OR, OH, FL, AZ, TX)
- Selected 6 additional high crash curve sites in Iowa for low cost



DSFS Sites

Iowa Low Cost Sites

MN Project Installations

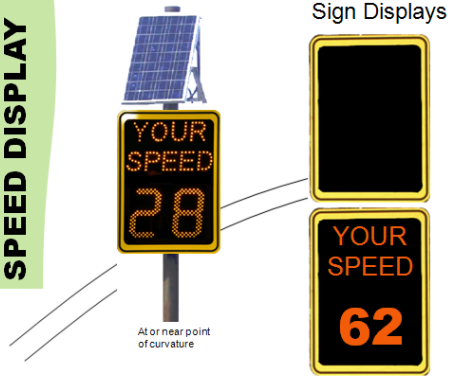
Evaluation of DSFS

- Dynamic speed feedback signs (DSFS) have been used in other applications to slow drivers
  - School zones
- DSFS consist of speed measuring device and sign message
  - message only displayed to drivers who are traveling over a set threshold
  - Only targets “problem” drivers

DSFS

- Evaluated different types of signs and messages
- Determined 2 was optimum number
  - Sample size
  - Ability to test multiple messages
- 2 sign types were used
  - Speed display
  - Corresponding curve warning sign

SPEED DISPLAY



Sign Displays by Measured Vehicle Speed Condition:

Sign Display 1
Blank – Measured vehicle speed is below the set threshold #1 or no vehicle present.

Sign Display 2
YOUR SPEED XX – Measured vehicle speed equal to or greater than speed threshold #1 but less than speed threshold #2.

Sign Display 3
SPEED LIMIT XX – Measured vehicle speed equal to or greater than speed threshold #2.

CURVE DISPLAY

Sign Displays by Measured Vehicle Speed Condition:

Sign Display 1
Blank – Measured vehicle speed is below the set threshold or no vehicle present.

Sign Display 2
"W" Series Warning Sign with "SLOW DOWN" text along with alternating lights top to bottom - Measured vehicle speed equal to or greater than the set speed threshold.

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Low Cost Strategies

- Selected 2 other low cost strategies
  - Reflectorized treatments on existing chevron posts
    - 4 sites
  - On-pavement curve markings
    - 2 sites

Evaluation

- Collected speed and volume data
  - Before, 1-month, 12-month, 24-mon for DSFS
  - Before, 1-month, 12-month as some sites for low cost
  - Used pneumatic road tubes
    - 0.5 miles upstream of PC
    - At PC
    - At center of curve

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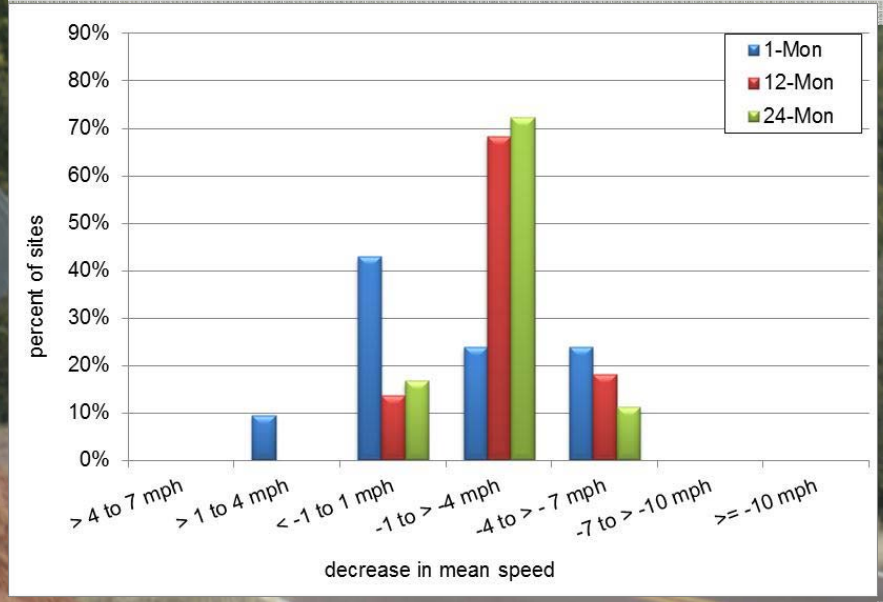
Results for DSFS at PC

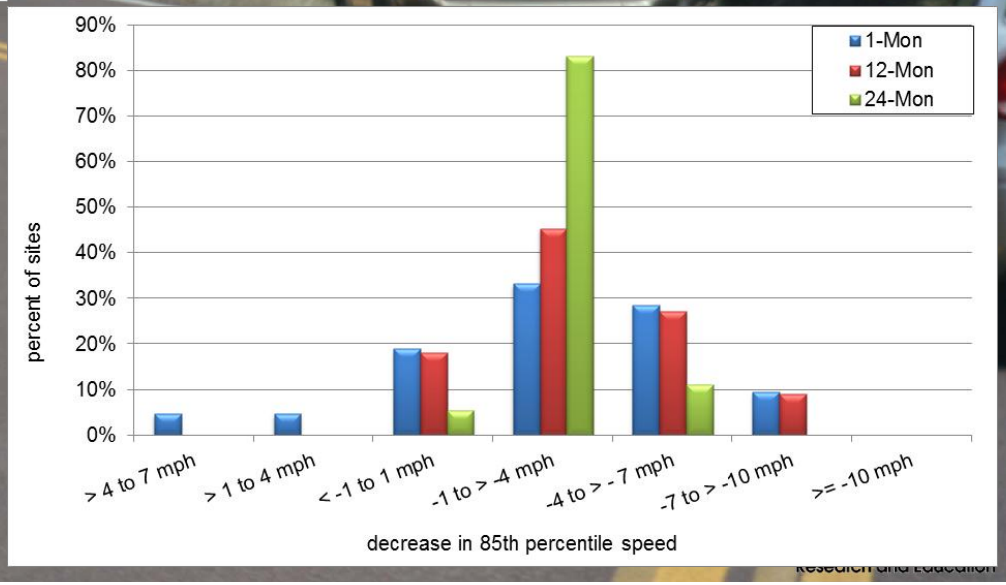


Mean Speed at PC

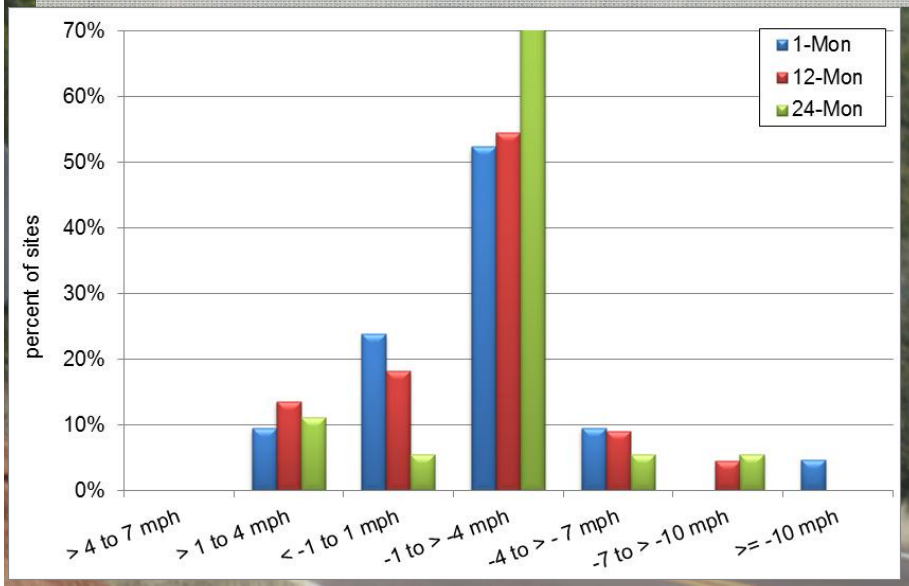
- Majority of sites had 1 to < 4 mph decrease
- Up to 23% had decreases 4 to < 7 mph

85th Percentile Speed at PC

- Majority of sites had 1 to < 4 mph decrease
- Up to 28% had decreases 4 to < 7 mph
- Around 10% had decrease ≥ 7 mph



Results for DSFS at Center of Curve

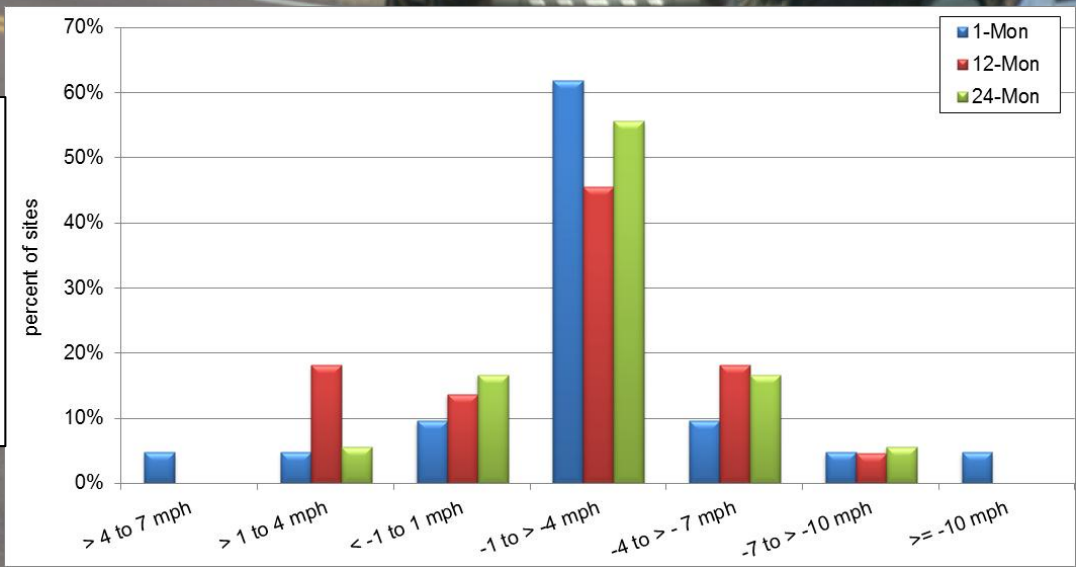


Mean Speed at CC

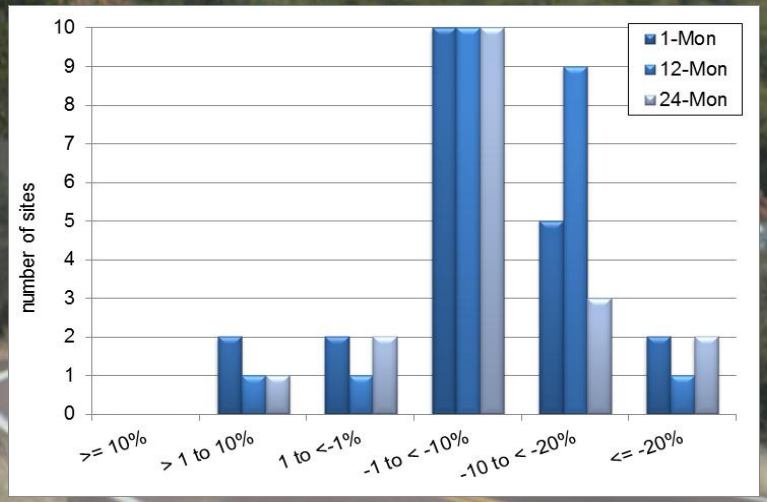
- Majority of sites had 1 to < 4 mph decrease
- Up to 10% had decreases 4 to < 7 mph
- Around 5% had decreases ≥ 7 mph

85th Percentile Speed at CC

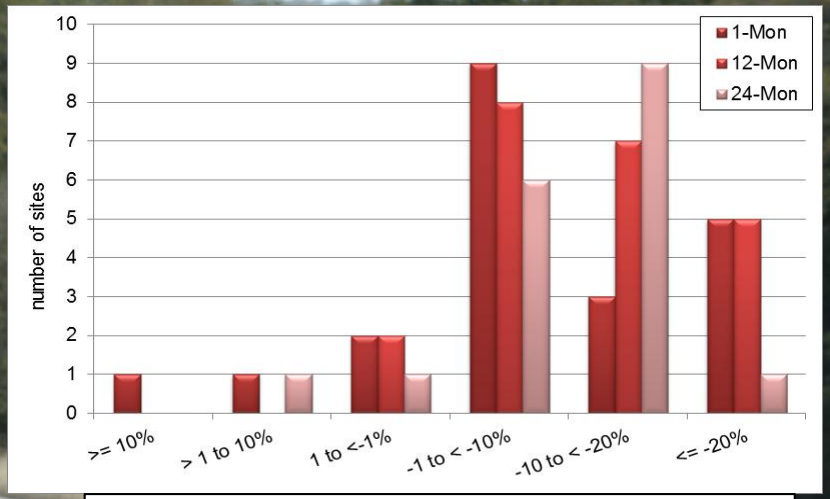
- Majority of sites had 1 to < 4 mph decrease
- Up to 18% had decreases 4 to < 7 mph
- Around 5% had decrease ≥ 7 mph



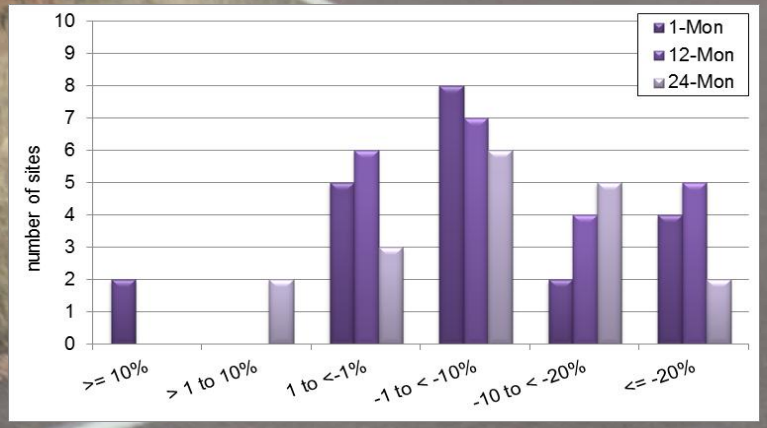
Results for DSFS at PC



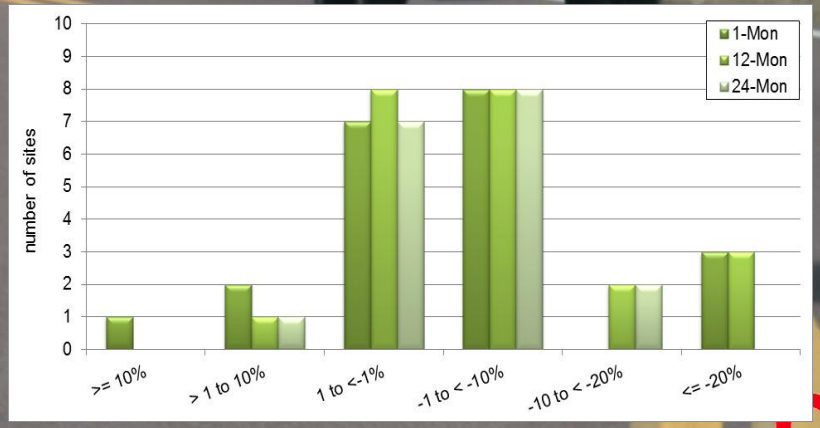
> 5 mph over advisory or posted



> 10 mph over advisory or posted



> 15 mph over advisory or posted



> 20 mph over advisory or posted

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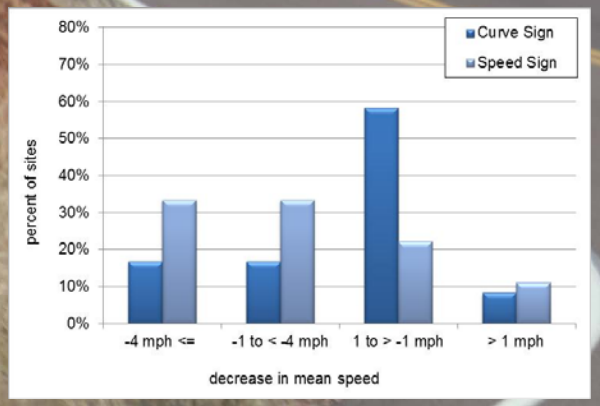
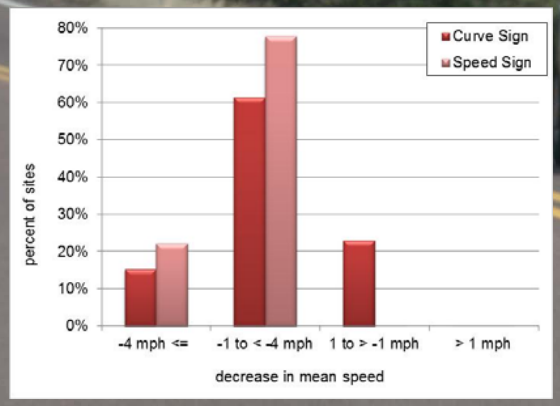
Comparison by Sign Type

- Speed sign appeared to be slightly more effective (i.e. more sites in general had higher reductions
- However, Wilcoxon Signed Rank test indicated no statistical difference

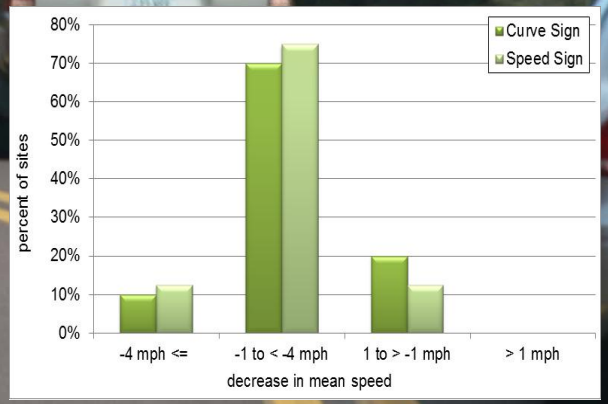
Change in Mean Speed at Center of Curve



1 month



12 month



24month

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Crash Modification Factors for DSFS

- Crash data for up to 4 years before and up to 3 years after
- Compared crashes by quarter
  - Allowed for removal of quarter for install and times when sign was not functioning
  - Account for seasonal differences
- Used Full Bayes model

Crash Type	Direction Type	Observed crashes	Estimated crashes	CMF (SE)	95% CI
Total	both	52.1	54.6	0.95 (0.01)	0.93, 0.97
Total	one	32.5	34.8	0.93 (0.02)	0.89, 0.97
Single-vehicle	both	38.6	40.7	0.95 (0.01)	0.93, 0.97
Single-vehicle	one	22.3	23.4	0.95 (0.02)	0.91, 0.99


COMMENTS/QUESTIONS
(or a Low Cost Treatment Discussion)
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Results for Low Cost

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On-Pavement Curve Signing

- Applied on 2 rural curves
- thermoplastic

Description of test sites

Site	AADT (vpd)	Posted Speed Limit	Curve Advisory Speed
DMC 99	780	55	none
CR L20	1,880	55	35

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On-Pavement Curve Signing

- DMC 99 site:
  - change in mean and 85th percentile speeds showed mixed results
  - Also mixed results for high end speeders
    - percentage of vehicles traveling 5 or 10 or more mph over the posted speed limit increased by up to 10 percent at the north PC but decreased significantly at the center of the curve and at the south PC.
- CR L20 site
  - mean and 85th percentile speeds decreased by **up to 2 mph**
  - **moderate decreases** in the percentage of vehicles exceeding the advisory speed by 5, 10, 15, or 20 or more mph resulted for the north and south PC (up to 7 percent)
  - **significant decreases** occurred at the center of the curve for all thresholds (up to 16 percent).

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Additional Delineation

- 4 sites
- Added reflective sheeting to existing chevron post

Description of test sites

Site	AADT (vpd)	Posted Speed Limit	Curve Advisory Speed
US 52	2,280	50	40
CR Y52	1,710	55	40
221st Street	2,410	55	50
IA 141	830	55	35

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Additional Delineation

- CR Y52
  - 2 mph decreases in mean and 85th percentile speeds
  - up to 10 percent in the percentage of vehicles traveling 5 or 10 or more mph over the advisory speed
  - Significant decreases in the percent of vehicles traveling 15 or 20 or more mph over the advisory speed.
- 221st Street
  - decreases up to 2 mph in mean and 85th percentile speeds
  - significant decreases resulted for vehicles traveling 5, 10, 15, or 20 mph or more over the advisory speed
- IA 141:
  - Decreases up to 1.9 mph resulted in mean and 85th percentile speeds
  - percentage of vehicles traveling a certain threshold over the advisory speed increased for the daytime period but decreased at night in most cases
- US 52:
  - mean and 85th percentile speeds were relatively constant from the before to 1 month after period.
  - moderate decreases in the percent of vehicles traveling 5, 10, 15, or 20 or more mph over the advisory speed (up to 6 percent) occurred for the daytime period
  - Up to 13% increase in percentage of vehicles traveling 5 or 10 more mph over the advisory speed for nighttime
  - Up to 6% decrease for vehicles traveling 15 or 20 mph over

Toolbox of Strategies

Table 1. Outline for countermeasure information in this toolbox

Subsection	Summarizes
Description	Countermeasure
Application	How the countermeasure has been applied, where the countermeasure is most effective, and so forth
Effectiveness	Studies showing whether the countermeasure is effective, information about crash reductions, and speed changes, with the assumption that speed change can be used as a crash surrogate
Advantages	Countermeasure advantages, such as low cost
Disadvantages	Main countermeasure disadvantages, such as long-term maintenance

Toolbox of Strategies

- Advance curve warning and advisory speed signs
- Chevrons and oversized chevrons
- Widening/paved shoulders
- Reflective barrier treatment
- High friction treatment
- Raised pavement markers
- Edge lines and wide edge lines
- Transverse pavement markings
- Vertical delineation
- Rumble strips and rumble stripes
- On-pavement curve signing
- Flashing beacons
- Dynamic curve warning systems
- Pavement inset lights


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