Speed Management Toolbox for Rural, Urban, and Suburban Facilities

Countermeasures for Speed Management on Rural Curves

SEQUENTIAL DYNAMIC CHEVRONS

Sequential dynamic chevrons (SDCs), also referred to as a sequential dynamic curve warning system (SDCWS), consist of a series of solar-powered, LED-enhanced chevrons that are installed throughout a curve in the same manner as regular chevrons (Figure 1). The system is set up so that the chevrons flash sequentially through the curve to warn drivers to slow down.

Image source: Omar Smadi, Institute for Transportation

Figure 1. Sequential dynamic curve warning system

The system can be set to flash continuously, but in most cases the system uses radar or other sensors to measure vehicle speeds and only activates when an approaching vehicle is traveling over a set speed threshold.

In this regard, SDCs are a category of speed feedback sign and only target drivers who are speeding rather than all drivers who pass the sign. By interacting with individual drivers, the system may lead to better compliance because the message appears to be personalized.

Considerations for Implementation

Sequential dynamic chevrons are located off the roadway itself and therefore do not physically interfere with road users, as shown in Table 1.

Table 1. Implementation considerations for different road users

User Group	Considerations
	No obvious concerns
	No obvious concerns
	No obvious concerns
	No obvious concerns
	No obvious concerns
	No obvious concerns
	No obvious concerns
	No obvious concerns

Since sequential dynamic chevrons do not directly impede traffic, they can be used along any type of roadway, as shown in Table 2. However, it may be challenging to position the radar (or other speed measuring sensor) for more than one lane of traffic.

Table 2. Implementation considerations for different roadway types

Roadway Type	Considerations
Urban	Appropriate in most situations
Suburban collector	Appropriate in most situations
Suburban arterial	Appropriate in most situations
School zone	Appropriate in most situations
High to low speed transition	Appropriate in most situations
Rural high-speed arterial	Appropriate in most situations
Rural curve	Appropriate in most situations
Rural village	Appropriate in most situations
Rural unpaved	Appropriate in most situations

Other considerations for the use of SDCs include the following:

- Devices must be calibrated and maintained to ensure that they are positioned correctly to record speeds and that speeds are accurate.
- SDCs are most appropriate when used as a replacement for typical static chevron signs rather than as a new installation.

Effectiveness

Crash Reduction

Crash reduction factors (CRFs) for SDCs are summarized in Table 3.

Table 3. Crash reduction factors for SDCs

Iowa DOT Planning-Level Guidance or Iowa-Specific Studies	National Studies
SDCs on rural two-lane curves (Hallmark et al. 2017; includes sites in Iowa and other states): • CRF = 44 for non-intersection crashes; all severities • CRF = 60 for non-intersection crashes; KABC	• No national studies available

Speed Reduction

Only one study was available that assessed the effectiveness of SDCs in reducing speed. The study was a national demonstration project that included Iowa sites (Smadi et al. 2015). The speed reduction impacts are shown in Table 4.

Table 4. Speed reduction impacts of SDCs

Street Type	Mean (mph)			85th Percentile (mph)			10+ mph Over Speed Limit (%)			Sample Size	Source
	Low	Avg	High	Low	Avg	High	Low	Avg	High		
SDC ON RURAL TWO-LANE CURVE											
Short-term	-2.8	-1.7	-0.7	-3.0	-1.7	0.0	-89.1%	-10.5%	0.0%	12	Smadi et al. 2015
Long-term	-3.1	-1.3	0.2	-3.0	-1.4	0.0	-76.6%	-11.0%	38.4%	35	

Examples of Applications

SDCs have not been widely deployed in Iowa. However, Iowa sites such as the one shown in Figure 2 were included in a national demonstration project (Smadi et al. 2015).

Image source: Smadi et al. 2015

Figure 2. Sequential dynamic chevrons along Highway 144 in Iowa

Advantages

The main advantages of SDCs include the following:

- Do not affect vehicle operation
- Do not impact emergency vehicles
- Do not impact drainage
- May be implemented immediately
- Alert driver of an upcoming curve
- May be particularly advantageous in reduced visibility conditions (e.g., rain, fog, snow)

Disadvantages

The main disadvantages of SDCs include the following:

- Require regular maintenance and a power source
- Need to remain free of vegetation around signs
- Cost much more than a single feedback sign

Resources

Additional resources for the implementation of SDCs include the following:

- Pennsylvania has tested SDCs and documented their experience and lessons learned (PennDOT n.d.).
- An Institute for Transportation (InTrans) project for the Federal Highway Administration (FHWA) evaluated SDCs in multiple states, resulting in a report that provides information on siting and installation (Smadi et al. 2013).

Disclaimer

The information in this toolbox is intended to show examples of countermeasures that have been shown to be effective or that have been evaluated and show promise. Formal guidance may not be available in the MUTCD, and some countermeasures may require experimental approval. Descriptions, images, best practices, case studies, etc., are examples of use and should not be considered to constitute standards or policies.

References

Hallmark, S. 2017. *Evaluation of Sequential Dynamic Chevrons on Rural Two-Lane Highways*. Report No. FHWA-TBD. Federal Highway Administration, Washington, DC.

PennDOT. n.d. Sequential Dynamic Lighting Curve Warning Systems. Pennsylvania Department of Transportation. https://www.pa.gov/agencies/penndot/about-penndot/advisory-committees-boards-and-commissions/state-transportation-innovation-council/innovations/lighting-curves.

Smadi, O., N. Hawkins, S. Knickerbocker, and S. Hallmark. 2015. *Evaluation of the Sequential Dynamic Curve Warning System*. FHWA-15-CAI-012-B. Federal Highway Administration, Washington, DC.

Smadi, O., N. Hawkins, S. Hallmark, and S. Knickerbocker. 2013. *Evaluation of the TAPCO Sequential Dynamic Curve Warning System*. FHWA-HIF-13-040. Federal Highway Administration, Washington, DC. https://www.intrans.iastate.edu/research/completed/evaluation-of-the-sequential-dynamic-curve-warning-system.