VARIABLE SPEED LIMITS

Description

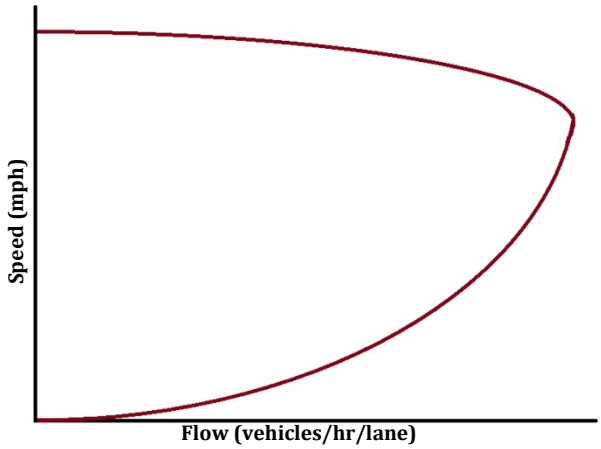
Variable speed limits are enacted by signs that can be changed to alert drivers when traffic congestion is imminent. Sensors along the roadway detect when congestion or weather conditions exceed specified thresholds and automatically reduce the speed limit (in 5 mph increments) to slow traffic and postpone the onset of congestion. The system's goal is to slow traffic uniformly in a way that allows smooth traffic flow and avoids stop-and-go conditions. Depending upon the objectives set for the system, speed limits can be regulatory or advisory. Dynamic message signs (DMS) can also be deployed in conjunction with this system to give drivers travel-time information or explanations

Cost:	●●○○○
Time:	**Moderate**
Impact:	**Corridor**
Who:	**State**
Hurdles:	**Public Support, Legal Authority, Operations**

Agencies use an expert system to monitor data coming from roadway sensors and automatically adjust speed limits when congestion thresholds are exceeded and stop-and-go traffic is imminent. The speed limit is lowered to obtain a consistent and homogenous traffic flow at a speed that is sustainable with the traffic volume. This will delay the onset of stop-and-go conditions and reduce the number of rear-end collisions at the back end of the queue. Variable speed limits are also referred to as speed harmonization and dynamic speed limits. Two common purposes for deploying variable speed limits are for weather-related conditions and congestion management:

- *Weather-Related Variable Speed Limits* are used on roads where fog, ice, rain, or other factors often influence safety. When weather conditions deteriorate to the point that hazardous conditions are impending, the operating agency reduces the speed limit to one that helps minimize the likelihood of collisions.
- *Congestion-Related Variable Speed Limits* are used when traffic volumes are building and congestion is likely. When volumes and/or speed exceed a predetermined threshold, the operational strategy is deployed. The intent is to handle more traffic volume at a slower, but not stop-and-go, speed.

In both cases, the speed limit decrease is intended to alert drivers of conditions downstream. Ideally, the speed limit and message alerts are automated and do not require intervention from any operator. The speed limits change in increments of 5 or 10 mph to progressively decelerate the flow of traffic. The speed can be either mandatory or advisory, depending on the goals of the agency. Variable speed limits are commonly used with automated queue detection and warning, and lane control signs. It is also regularly used in combination with temporary shoulder use.



The diagram above shows the graphic relationship between traffic flow and speed. The purpose of using the variable speed limit technique is to slow traffic based on the flow before the characteristics pass the optimal point on the curve. Doing so can prevent the sudden decrease in speed and stop-and-go conditions commonly seen on congested roadways.

Target Market

- Freeways or roads experiencing frequent congestion.
- Areas susceptible to adverse weather.

How Will This Help?

Variable speed limits can improve safety by helping to reduce primary and secondary crashes during adverse weather conditions and congestion. By implementing more uniform driver behavior and uniform speeds, drivers are less likely to drive erratically, reducing the likelihood of crashes. Furthermore, the reduced speeds help reduce the severity of incidents that might occur.

Variable speed limits can help delay the onset of congestion. With more uniform speeds and decreased headways, traffic flows more smoothly and efficiently, which can improve trip travel time reliability.

Environmental benefits with variable speed limits can include decreased emissions, decreased noise, and decreased fuel consumption.

Implementation Examples

Sydney, Australia, implemented a fog warning system that includes advisory speeds. During fog, the advisory speed limit is continuously adjusted to the speed of the preceding vehicle (but no higher than the speed limit).[1]

In Denmark, studies found that a DMS indication of slippery road, fog, and other hazardous road conditions reduced the traffic mean speed by 0.6 to 1.2 mph (one to two km/h). When the variable speed limit sign showed a speed limit of 50 mph (80 km/h) instead of 62 mph (100 km/h), the mean speed was reduced by 2.1 mph (3.4 km/h). In adverse road conditions, such as black ice, the speed limit was lowered from 75 mph (120 km/h) to 62 mph (100 km/h) mean speed dropped by 3.2 mph (5.1 km/h). The variable speed limit signs also reduced speed variance.[2]

The Netherlands also deploy variable speed limits for weather conditions. Visibility sensors are used to measure the level of fog and when visibility drops to 459 or 230 ft (140 or 70 m), the speed limit is dropped to 50 or 37 mph [80 or 60 km/h], respectively. After implementation of the variable speed limit during fog conditions, drivers reduced their speed by 5.0–6.2 mph (8–10 km/h).[3]

For congestion-related deployments, the United Kingdom has seen a decrease in emissions by two to eight percent, a noise reduction around 0.7 decibels, 20 percent fewer property-damage-only crashes, and 10 percent fewer injury crashes.[4,5] Implementation has also resulted in an improvement in travel time reliability, a smoother flow, more even distribution of volume to travel lanes, and a calmer driving experience. Facilities in Germany with variable speed limits had travel times reduced by 5 to 15 percent, the number of crashes decreased by 30 percent, and a five percent increase in the maximum volume handled by the road.[6,1] In Denmark, the implementation of variable speed limits resulted in speeds decreasing by less than five km/h and reduced speed variance. A survey showed that

46 percent of Danish travelers felt safer after the implementation.[7]

The Netherlands are examining speed limits through the project *Dynamic Speed Limits*. The project was developed "to gain more insight into the impact of variable, tailor-made speed limits."[8] A pamphlet on dynamic speed limits provides the following discussion on the benefits:

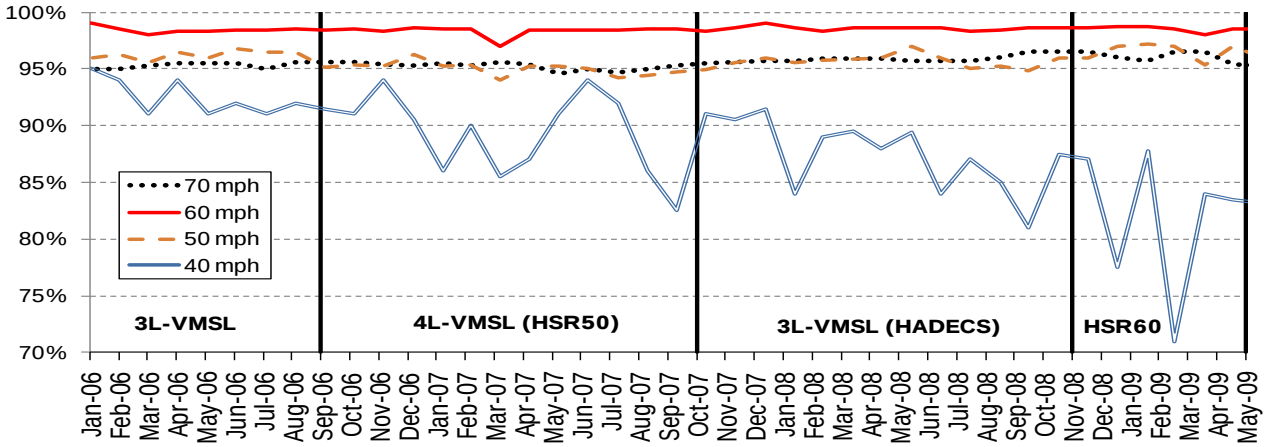
> "Adjusting speed limits to unexpected and varying situations such as weather conditions, congestion, or an incident can improve traffic flow. It will also enhance the safety and improve local air quality. By applying a flexible and wide range of speed limits (50 to 120 km/h [31 to 75 mph]) operators can influence the actual situation on the road. Thus road users can drive faster if possible and slow down if necessary."

The evaluation of permanent speed reduction found excellent compliance (approximately one percent violators) due to enforcement. Reductions in emissions and noise level were also identified. Residents along the sections also expressed appreciation with the change. The evaluation for variable speed limits in the Netherlands is currently ongoing and they are investigating how to use data from traffic monitoring equipment to assist in detecting shockwaves and then to manage upstream speeds to limit the impact of the shockwave. A system called Specialist (for SPEed ControllIng ALgorIthm using Shockwave Theory) is being developed. Weather forecasts (for example, a major rainstorm) are also considered when setting the variable speed limits.[9]

In England, the Managed Motorways concept was implemented on the M42. Compliance with the variable mandatory speed limit is shown in the figure below.[10] The graph starts with data from January 2006 and ends with data from May 2009. In late 2007 to early 2009, the mandatory speed limit would be set at 50 mph when hard shoulder running was permitted. During this time period compliance was not as good as when the mandatory speed limit was set to 60 mph during hard should running (started in early 2009). Drivers did not see the reason for the lower speed and responded by driving at the higher speeds. This behavior is also shown in the decline in compliance when the mandatory speed limit was set to 40 mph.

Application Techniques and Principles

General criteria for variable speed limits include considerable peak hour congestion on a freeway facility, right-of-way available for overhead support structures (for signs and arrow boards), and DMS at regular intervals, and at significant incidents related to queuing or merging.



England: Compliance with Mandatory Speed Limits[10]

For more information, please refer to: http://mobility.tamu.edu/mip/strategies.php.

Additionally, the implementing agency needs to be willing to automate the deployment of the strategy and have aggressive operating expectations and communication connections to the traffic management center (TMC) to support deployment.

The following are key factors that should be considered to help facilitate successful deployment:

- The success of variable speed limits are closely linked to the extent to which drivers comply with the signing, so it is important that agencies communicate with the public and inform them of new measures and regulations as they are put in place.
- Variable speed limits should be implemented in response to an actual situation. If users do not believe the system is legitimate, compliance rates will be low. Therefore, if the reason for the new speed limit is not apparent, it should be explained through appropriate signing.
- Speed limit signs have to be visible to all vehicles; therefore, the signs are to be placed on gantries over every lane of traffic. DMS should be placed regularly to either give explanation for the lower speed limits or warn about extraordinary events.

Issues

This strategy has been successful in Europe but is new to the U.S. Public acceptance and understanding of the system is crucial to its success. Drivers must be able to understand why the speed limit is being reduced and that the reason is legitimate. Whether the new speed limit is advisory or mandatory must also be clearly understood by all drivers. Furthermore, the automated implementation of the dynamic speed display without operator intervention ensures that changes are implemented prior to the onset of stop-and-go traffic. Also, the speed limit signs have to be visible to all vehicles.

Who Is Responsible?

The local TxDOT office bears the responsibility of developing and maintaining variable speed limits. This agency should determine the viability of and need for the strategy along with the availability of right-of-way required for sign installation at regular intervals for adequate visibility. It should also provide the adequate infrastructure for the TMC and deployment support for other devices.

Project Timeframe

The length of variable speed limit projects differ based on the available infrastructure and planning in place at the time this technique starts. The systems should have adequate connections to the local traffic center and other supporting infrastructure and policies should be in place. Furthermore, since some additional signage will be required, a typical variable speed limit deployment may take between one and two years to initiate.

Seattle, Washington

Cost

The cost of installing variable speed limits within a corridor varies considerably depending on the existing infrastructure and the selection and spacing of overhead gantries, DMS, and other related signage.

Data Needs

Variable speed limit deployments require standard traffic information to evaluate the need and to deploy the strategy. Data regarding traffic volumes, travel speeds, climate and weather conditions for the area, and incident presence and location are essential to determine the need for deployment.

Variable Speed Limit Best Practice

- Type of Location: Freeways.
- Agency Practices: Strong program support from administrators and policy makers.
- Frequency of Reanalysis: Annual or when substantial changes in traffic demand or in capacity due to nearby construction.
- Supporting Policies or Actions Needed: Possible changes to ordinances and laws.
- Complementary Strategies: Temporary shoulder use, queue warning.

For More Information

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