INVESTIGATING SPEED MANAGEMENT TECHNIQUES

by

PB99-157927

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Report 1770-S
Project Number 0-1770
Research Project Title: Investigating Speed Management Techniques

Sponsored by the
Texas Department of Transportation
In Cooperation with
U.S. Department of Transportation
Federal Highway Administration

September 1998
Revised: March 1999

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REPRODUCED BY: NTIS
U.S. Department of Commerce
National Technical Information Service
Springfield, Virginia 22161

Technical Report Documentation Page

1. Report No. FHWA/TX-99/1770-S	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle INVESTIGATING SPEED MANAGEMENT TECHNIQUES		5. Report Date September 1998 Revised: March 1999 6. Performing Organization Code
7. Author(s) Angelia H. Parham and Kay Fitzpatrick		8. Performing Organization Report No. Report 1770-S
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135		10. Work Unit No. (TRAIS) 11. Contract or Grant No. Project No. 0-1770
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Transfer Office P.O. Box 5080 Austin, Texas 78763-5080		13. Type of Report and Period Covered Project Summary: September 1997 - August 1998 14. Sponsoring Agency Code

15. Supplementary Notes

Research performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.
Research Project Title: Investigating Speed Management Techniques

16. Abstract

Speeding and speed control are often considered critical issues on residential and collector streets. Activities to reduce speed and volume on residential streets have recently been gathered under the term traffic calming. Speed management goes beyond traffic calming by examining higher speed facilities, such as arterials, in addition to residential and collector streets. Integrating speed management techniques on residential, collector, and arterial streets can encourage traffic to use major roadways rather than residential streets and can address need on an areawide basis rather than for an isolated roadway or intersection. The *Handbook of Speed Management Techniques* was developed to identify speed management techniques used throughout the country and to give practitioners basic information regarding their use. The *Handbook* includes descriptions, photographs, experiences of agencies that have used the techniques, and lessons learned.

17. Key Words Speed Management, Traffic Calming, Devices		18. Distribution Statement No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 36	22. Price

Form DOT F 1700.7 (8-72)

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ACKNOWLEDGMENTS

The project team recognizes Imelda Barrett, project director; Robert Kovar, project advisor; and technical panel members Chris Hehr, James Kratz, Gus Lopez, and Doug Woodall for their time in providing direction and comments for this study. This study was performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.

The authors would also like to recognize the following persons for helping with documentation of techniques and report preparation efforts: Dale Picha, Shirley Kalinec, Pat Beck, Maria Medrano, Jon Collins, Lizette Laguna, Molly Marshall, and David Noyce.

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IMPLEMENTATION RECOMMENDATIONS

The *Handbook of Speed Management Techniques* was developed to identify speed management techniques used throughout the country and to give practitioners basic information regarding their use. The *Handbook* will be available after review and approval by TxDOT for local and state agencies as well as private practitioners.

TxDOT has several in-place mechanisms for promoting the availability of the *Handbook,* including the annual Transportation Conference. Additionally, the researchers are committed to informing others of the research through presentations at local and national meetings and papers written for publication.

INTRODUCTION

Speeding and speed control are often considered critical issues on residential and collector streets. In addition, speeding complaints are a continuing problem for traffic engineers and police departments. Indeed, speeding is a serious threat to the motoring public. In 1993, 53,343 drivers were involved in fatal automobile crashes in the United States. Of these drivers, 11,019 (20.7 percent) were reported to have been speeding. In the same year, 15.6 percent of Texas drivers involved in auto crashes were reported to have been speeding.[1]

The idea of controlling speed evolved from the assumption that reducing speed also reduces accidents, and indeed, speed is related to accident occurrence in three ways. First, speed influences the amount of time needed to respond to a problem in the roadway and to either stop or avoid the problem. Second, the difference in speed between vehicles on the roadway, or between vehicles and roadside objects such as pedestrians, parked cars, or obstructions, directly influences the probability of accidents. Third, greater speed influences the severity of injuries and property damage in accidents.[2]

Residential streets provide access, while collector streets distribute local traffic between neighborhoods and arterial street systems. Low operating speeds are desired to accommodate pedestrians, bicyclists, and local access. Excessive speed, however, is a frequent residential complaint.[3] In some cases, a majority of the vehicles speed, while in other cases, only a few drivers speed. The negative reaction to speeding evolves from concern over safety and high noise levels. Vehicles driven at high speeds are seen as a threat to the peace, safety, and quality of life within a neighborhood.[4]

On arterial streets, the primary function of the road is to carry traffic. However, speed management is also needed on arterials due to concerns about pedestrian and cyclist safety, excessive speeds in residential areas, and pedestrian accessibility and parking availability in retail areas.[5] The goal of speed management on arterials is safety related: maintaining mobility and capacity while increasing safety.

The issue of reducing speed, especially in residential areas, is currently one of the most popular topics in the areas of traffic and transportation. The use of traffic calming techniques is becoming widespread; in fact, traffic calming is one of the Institute of Transportation Engineers' (ITE) topics for 1998. ITE and the Transportation Research Board (TRB) have taken active roles in supporting residential traffic calming programs by city agencies. They have also established a network of professionals and committees to assess the state-of-the-practice of traffic calming in the United States and to sponsor technical sessions and papers at professional society meetings.

Traffic calming uses geometric changes or design to influence travel speed, and perhaps, to cause drivers to select another route for travel. It is intended to restore local streets to their primary function, providing a more livable environment for residents. In most cases, problems on local streets are caused by through traffic, speeding, and/or noise. Traffic calming is site-specific; therefore, specific conditions must be considered in selecting appropriate traffic calming devices and measures.

Speed management goes beyond traffic calming by also examining higher speed facilities, including collectors and arterials. Many typical traffic calming techniques used in residential areas to control volume and speed would be difficult to implement on these roadways; however, other techniques need only modifications or a different approach to be effective. Mobility, rather than access, characterizes arterials; therefore, speed management techniques may need to focus on reducing the speed of the fastest vehicles only or on providing a consistent, predictable speed to improve safety while satisfying its mobility role. Although this area has not had the same amount of attention as traffic calming on residential streets, managing speed on higher speed roadways can be an effective part of a neighborhood traffic management plan. Integrating speed management techniques on local, collector, and arterial streets can encourage traffic to use major roadways rather than residential streets, and can address area-wide needs rather than just focusing on an isolated roadway or intersection. A need exists to identify treatments that would maintain mobility but decrease speed variance on collector and arterial facilities.

Many transportation professionals are concerned about the potential liability resulting from new devices on a road. These concerns are best addressed by designing devices to accepted standards, adequately signing devices, and regularly maintaining them. Additionally, transportation

organizations are responding to the need for design standards. ITE recently developed a "Recommended Practice" for the design of speed humps and is currently completing a *National Traffic Calming Report - State-of-the-Art*.[4,6] The Transportation Association of Canada is currently developing standards for traffic calming devices.[7]

The goals of the Texas Department of Transportation (TxDOT) project are to identify speed management techniques used throughout the country and to develop a handbook documenting these techniques.[8] This project provides one of the first comprehensive studies to document speed management on collector and arterial roadways in addition to providing information about techniques used on residential streets. This document gives practitioners basic information regarding the use of speed management techniques.

The *Handbook of Speed Management Techniques* includes descriptions of the techniques, photographs of the techniques, experiences of agencies that have used the techniques, and lessons learned. The four chapters of the *Handbook* discuss speed management techniques as follows:

1. Roadway Design Techniques
2. Road Surface Techniques
3. Traffic Control Techniques
4. Enforcement Techniques

Roadway design techniques include physical measures designed to alter the driver's path. Road surface techniques change the surface of the roadway by adding vertical elements such as speed humps, by narrowing the roadway, or by attracting the driver's attention by using pavement markings. Traffic control techniques, such as signs and beacons, alert drivers of allowable speeds or warn them of an approaching hazard or other traffic control device, such as a traffic signal. Enforcement techniques remind drivers of speed limits and the speed they are traveling through either speed displays or additional enforcement. They may be used to issue warning letters or citations to those traveling over the speed limit.

The techniques described in the *Handbook* are illustrated in Figure 1.

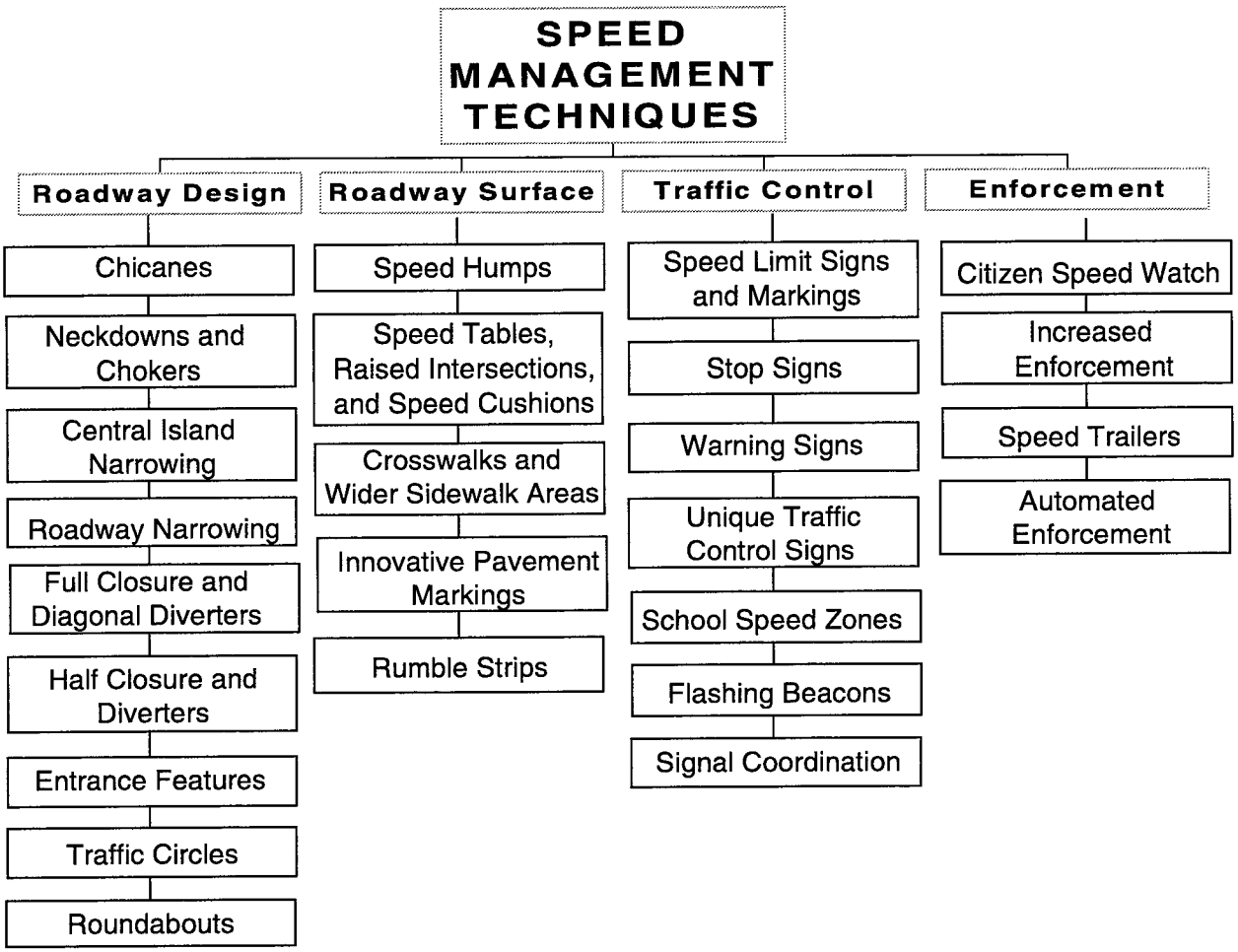

Figure 1. Speed Management Techniques (8).

RESEARCH APPROACH

The research approach included the following:

- reviewing the literature;
- processing a written mailout survey;
- conducting follow-up telephone interviews;
- performing on-site visits;
- summarizing experiences; and
- developing the *Handbook* and related reports.

These tasks are summarized below with additional details on the findings contained in the following sections.

LITERATURE REVIEW

A literature review was conducted to identify the current state-of-the-practice for various speed management techniques. The literature review included techniques used on residential streets in addition to those used on collector and arterial facilities. Researchers used this information to define the speed management techniques available, to determine how they are being used, and to focus on areas that warranted additional study. For example, the literature search provided very little information on citizen speed watch programs, but the written survey results showed that citizen speed watch programs have been, or are being, used successfully by many agencies and citizen groups.

WRITTEN SURVEYS AND TELEPHONE INTERVIEWS

Surveys were mailed or faxed to 400 agencies to identify locations where speed management techniques have been considered or implemented. Issues addressed by the survey included:

- public involvement;
- criteria for approval by residents or businesses;
- cost sharing procedures;

- maintenance responsibilities; and
- locations where speed management techniques have been installed.

The survey focused on obtaining information about techniques used on higher speed facilities and indicated limited use of techniques on these facilities. One hundred and fifty-three survey responses were received. Telephone interviews were conducted to obtain more information about particular techniques and specific sites where these techniques have been installed.

SITE VISITS AND ON-SITE INTERVIEWS

Locations for on-site visits were selected based on information obtained through the literature review, the written survey, the telephone interviews, and by personal interviews when members of the research team were in the area for another project. The site visits were used to clarify and expand areas of limited information, to identify useful information about specific techniques and sites, and to identify candidate sites for future research. Photographs taken at the sites are included in the *Handbook.*

Both in-state and out-of-state visits were made to record a broad spectrum of technique types currently in use. Sites visited in Texas included Austin, San Antonio, College Station, Bryan, Carrollton, Plano, Garland, Arlington, and several towns in the Atlanta District. Out-of-state visits included various sites within the states of California, Oregon, Washington, Georgia, Maryland, Virginia, and Wisconsin, as well as the Canadian cities of Toronto, Ontario, and Vancouver, British Columbia.

EVALUATION OF EXPERIENCES

The information obtained through the written surveys, telephone interviews, and on-site visits were summarized by technique. Experiences for each technique include descriptions of the techniques, characteristics of the techniques, notes on their effectiveness or ineffectiveness, maintenance requirements, and advantages and disadvantages. Discussions include both successes and problems with various techniques.

HANDBOOK DEVELOPMENT

The *Handbook of Speed Management Techniques* was developed as a user-friendly document to give practitioners a general overview of speed management techniques. The *Handbook* includes techniques used on local collector and arterial streets. The four chapters in the *Handbook* include descriptions and photographs of the techniques, experiences of agencies that have used the techniques, and lessons learned.

FINDINGS

Speed management includes both residential areas (typically gathered under the term traffic calming) and higher speed facilities such as collectors and arterials (freeway speeds were not included in this project). Managing speed on arterials can be an effective part of a neighborhood traffic management plan: integrating speed management techniques on local, collector, and arterial streets can encourage traffic to use major roadways rather than residential streets and can address area-wide needs rather than focusing on an isolated roadway or intersection. Table 1 indicates the techniques suitable for collectors and arterials as well as those appropriate for residential streets.

Table 1. Technique Use by Street Type.

Technique	Appropriate on Local Residential Streets	Appropriate on Collectors and Arterials
ROADWAY DESIGN TECHNIQUES		
Chicanes	✔	
Neckdowns/chokers	✔	✔
Central Narrowing Islands	✔	✔
Roadway Narrowing Techniques	✔	
Full Closures	✔	
Half Closures	✔	
Entrance Features	✔	✔
Traffic Circles	✔	
Roundabouts		✔
ROADWAY SURFACE TECHNIQUES		
Speed Humps	✔	
Speed Tables, Raised Intersections, Speed Cushions	✔	
Crosswalks Wider Sidewalk Areas	✔	✔
Bicycle Mobility Techniques	✔	✔

Table 1. Technique Use by Street Type (continued).

Technique	Appropriate on Local Residential Streets	Appropriate on Collectors and Arterials
Innovative Pavement Markings	✔	✔
Rumble Strips		✔
TRAFFIC CONTROL TECHNIQUES		
Speed Limit Signs and Pavement Markings	✔	✔
Stop Signs	✔	✔
Warning Signs	✔	✔
School Speed Zones	✔	✔
Flashing Beacons		✔
Signal Coordination		✔
Unique Traffic Control Sign	✔	✔
ENFORCEMENT TECHNIQUES		
Citizen Speed Watch Programs	✔	✔
Increased Enforcement (Conventional)	✔	✔
Speed Trailers	✔	✔
Automated Enforcement	✔	✔

Table 2 summarizes the speed management techniques investigated in this project. This table further develops information contained in Table 1 and gives the advantages and disadvantages of each.

Table 2. Summary of Speed Management Techniques.

ROADWAY DESIGN TECHNIQUES		
TECHNIQUE/Description	**Key Advantages**	**Key Disadvantages**
CHICANES are devices that alter the linear progression of a vehicle so that the driver must change paths to avoid the device.	• Can reduce speeds at the chicane or on the entire street length if installed in series • Can reduce cut-through volumes	• May require high initial costs • Are restrictive for emergency and service vehicles • May create potential crash obstacles for drivers
NECKDOWNS/CHOKERS are constrictions of the roadway to reduce the width of the traveled path. **CENTRAL NARROWING ISLANDS** are used in the center of the roadway to provide refuge to pedestrians during the crossing maneuver.	• Can shorten the crossing time for pedestrians • Central island narrowings create a refuge so pedestrians can cross half the street at a time. • Both can make pedestrian crossings more visible to drivers • Neither slow emergency vehicles	• Both may require some parking removal • Both may give pedestrians a false sense of security • Both create potential crash obstacles for drivers
ROADWAY NARROWING TECHNIQUES narrow the roadway for a continuous length using geometric features, pavement markings, or landscaping.	• Provide continuous, visual channelization • Can be inexpensive to install • Can be quickly implemented • Do not affect emergency response times	• Require regular maintenance • Increase cost of roadway resurfacing • May be expensive to install, depending upon technique
FULL CLOSURES completely close the roadway to through traffic at one end or at a midblock location using diverters, cul-de-sacs, or signing.	• Reduce traffic volume and number of conflict points • Can still allow bicycle and pedestrian access	• Restrict emergency vehicle and transit access • May increase trip length • Can be unsightly

Table 2. Summary of Speed Management Techniques (continued).

ROADWAY DESIGN TECHNIQUES (continued)		
TECHNIQUE/Description	**Key Advantages**	**Key Disadvantages**
HALF CLOSURES limit access to or from a roadway through the use of semi-diverters, median barriers, exclusion lanes, or forced-turn barriers.	• Reduce through traffic • Can provide for bicyclists and pedestrians • Can be attractive if landscaped	• May increase emergency response time • Do not provide 100 percent compliance • May add landscape maintenance
ENTRANCE FEATURES use textured pavements, curb extensions, raised crosswalks, landscaping, or entrance signs to create a sense of neighborhood or community.	• Provide an indication of a change of environment • Help to create a sense of identity • Create additional areas for landscaping and monuments	• Are not uniform from one location to another • May add additional landscape maintenance costs
TRAFFIC CIRCLES are small circular islands placed in the center of existing local intersections.	• Reduce vehicle speeds • Improve safety conditions • Can be visually attractive when landscaped and maintained	• Add a potential hazard to the middle of the roadway • Can increase emergency vehicle response times • Can impede unfamiliar drivers, especially when making a left turn
ROUNDABOUTS are raised islands that create a circular one-way flow of traffic.	• Can noticeably reduce speeds • Reduce the number of conflict points at the intersection • Can increase capacity • Provide an orderly and continuous flow of traffic • Are effective at multi-leg intersections	• May be restrictive for some larger emergency and service vehicles unless mountable • Require pedestrians and bicyclists to adjust to less traditional crossing patterns • May have reduced aesthetic value due to safety signage

Table 2. Summary of Speed Management Techniques (continued).

ROADWAY SURFACE TECHNIQUES		
TECHNIQUE/Description	**Key Advantages**	**Key Disadvantages**
SPEED HUMPS are raised areas in the roadway pavement perpendicular to the traffic flow.	• Reduce speed • Are inexpensive to install • Do not affect intersection operations	• Can increase emergency vehicle response times • May shift traffic to parallel streets
SPEED TABLES are elevated plateaus in the roadway with descending ramps on each side. **RAISED INTERSECTIONS** elevate the entire intersection above the normal roadway surface. **SPEED CUSHIONS** are smaller raised areas within a traffic lane.	• Reduce speed • Draw attention to intersection and pedestrian areas • Can be used on higher or lower volume streets • Can be aesthetically pleasing	• May be expensive to construct and maintain • May affect emergency vehicle response times • Require additional signage and driver education
CROSSWALKS are portions of roadways designated for pedestrian use in crossing the street. **WIDER SIDEWALK AREAS** provide additional pedestrian space and streetscaping space off of the roadway.	• Crosswalks indicate the preferred crossing location to pedestrians • Higher visibility crosswalks provide more visibility to drivers than standard crosswalks • Wider sidewalks provide additional space for pedestrians and street furniture • Wider sidewalks can improve the aesthetics of the area	• Higher visibility crosswalks may provide a false sense of security to pedestrians • Higher visibility crosswalks require consideration of the effect of the materials on vehicle tires paths and the slipperiness of the surface where wet weather or snow conditions exist • Both may require increased construction and maintenance costs
BICYCLE MOBILITY TECHNIQUES include shared lanes, bike lanes, bike paths, or bicycle routes.	• Encourage non-motorized travel • Better define where bicyclists are expected	• Could create additional conflicts between vehicles and bicycles

Table 2. Summary of Speed Management Techniques (continued).

ROADWAY SURFACE TECHNIQUES (continued)		
TECHNIQUE/Description	**Key Advantages**	**Key Disadvantages**
INNOVATIVE PAVEMENT MARKINGS are used to create the illusion of narrowed or narrowing lanes, to add a parking lane, or to develop on-street parking, particularly on collector and arterial streets.	• May serve to reduce traffic speeds and crashes by warning or alerting drivers to an upcoming situation and by causing drivers to perceive that they are traveling too fast • Even if the innovative pavement markings do not reduce vehicle speeds, they may still alert drivers to a heightened sense of awareness in which they are better prepared to avoid a crash	• More research is needed to verify the use of these patterns • Expensive to maintain the complex patterns
RUMBLE STRIPS are pavement undulations across the driving lane causing a vehicle to rumble or vibrate when crossing them.	• May reduce speeds • Create driver awareness to increase safety • Are inexpensive to install	• May require high maintenance (depending upon the type installed) • May adversely impact bicyclists • Are noisy and may not be appropriate for neighborhood areas

Table 2. Summary of Speed Management Techniques (continued).

TRAFFIC CONTROL TECHNIQUES		
TECHNIQUE/Description	**Key Advantages**	**Key Disadvantages**
SPEED LIMIT SIGNS display the speed limit established by law or by regulation. **PAVEMENT MARKINGS** may be used to reinforce the message.	• Signs are well recognized and understood • Pavement markings reinforce speed limit signs • Both are inexpensive to install • Signs can reduce speeds with regular enforcement	• Signs have significant non-compliance rates • Pavement markings are proven not to be effective • Pavement markings may cause concern regarding conspicuity and legibility
STOP SIGNS are used to assign the right of way at intersections with *significant* traffic volume or accident frequencies. Numerous studies have indicated that Stop signs are not effective at reducing speed or volume in residential areas.	• Are well recognized and understood • Provide positive public perception of reduced speeds and volumes if installed • Are inexpensive to install • Are easy to install • Can improve safety at previously uncontrolled intersections	• Can breed disrespect and non-compliance if used excessively • May cause poor public perception if agency rejects installation request • Have warrants for installation that may be difficult to meet • Are not effective in reducing speed or volume
WARNING SIGNS are used to warn drivers of existing or potentially hazardous conditions on or adjacent to a highway or street.	• Are easily recognizable • Alert drivers of approaching hazards or unique conditions • Can be supplemented with advisory speeds or flashing beacons to provide drivers with additional guidance	• Can cause disrespect for signs if used unnecessarily
UNIQUE TRAFFIC CONTROL SIGNS include regulatory, informational, warning, and guide signs. Such signs are typically designed for a unique situation believed to warrant special attention.	• May be successful in informing drivers of a unique situation	• May not conform to standards in the MUTCD • Are not easily recognized

Table 2. Summary of Speed Management Techniques (continued).

TRAFFIC CONTROL TECHNIQUES (continued)		
TECHNIQUE/Description	**Key Advantages**	**Key Disadvantages**
SCHOOL SPEED ZONES use warning signs, crosswalks, other pavement markings, flashing beacons, and/or traffic signals to alert drivers of the school zone and to inform them of the beginning and ending of the reduced speed area.	• Alert drivers of possible pedestrian presence • Use uniform colors and symbols for easy recognition • Reduce speed limits for specified hours only	• Can be costly to implement • Can be costly to enforce • May cause confusion if non-uniform devices or enforcement procedures are used
FLASHING BEACONS are used to attract drivers' attention and to inform them of right-of-way conditions or potential roadway hazards.	• Are effective in drawing attention to hazards • May be a low-cost solution • Require low maintenance	• Effect may diminish over time if there is a high number of repeat users • May become overused
TRAFFIC SIGNAL COORDINATION allows a platoon of vehicles to progress through a series of intersections at a specified speed.	• Can reduce number of stops • Can reduce delay • Can encourage a preferred speed • Can send vehicles through intersections in platoons, reducing time headways • Can stop fewer vehicles • Can conserve fuel and minimize air pollution	• May be difficult to include all intersections within a corridor • May be difficult to optimize both directions

Table 2. Summary of Speed Management Techniques (continued).

ENFORCEMENT TECHNIQUES		
TECHNIQUE/Description	**Key Advantages**	**Key Disadvantages**
CITIZEN SPEED WATCH PROGRAMS are public awareness programs involving residents, agency staff, and motorists.	• Are an effective public relations and educational tool • Make neighbors feel that they are part of the solution for speeding problems • Long-term effects are possible due to resident interaction	• Are very labor intensive • Are not an enforcement tool
INCREASED ENFORCEMENT (CONVENTIONAL) increases the use of conventional enforcement to reduce speeds in target areas.	• Reduces speed during enforcement period • Increases driver awareness of speeding • Makes response quick and effective	• Requires regular long-term enforcement to gain long-term benefits • Is costly for law enforcement agencies
SPEED TRAILERS are mobile roadside devices that use a radar device to detect the speed of approaching vehicles. The devices display the speed limit and the speed of approaching vehicles.	• Educate the public of posted and excessive speeds • Are a good educational and public relations tool • Are easily moved from one location to another	• Do not appear effective in reducing speeds after the trailer is removed • Have limited use unless used in combination with enforcement • Have limited use on multi-lane roadways
AUTOMATED ENFORCEMENT uses a radar device, processing unit, and camera to record vehicle speeds and photograph those exceeding the speed limit.	• Can detect and record information about a large number of speeders • Can provide enforcement in areas where roadway geometry makes it difficult for police officers • Targets speeders objectively	• Allows impaired or unsafe drivers to remain on the road because no traffic stop is made • May be a less effective learning tool than if the violator were stopped and given a citation immediately • Doesn't allow an officer to give discretion for an emergency situation

RECOMMENDATIONS

Brief descriptions of additional research efforts to benefit those who are considering treatments to manage speeds on residential, collector, or arterial facilities follow.

APPROPRIATE SIGNS AND MARKINGS FOR DEVICES

Currently, several sign and marking treatments are available for the different devices. For example, speed humps have been shown on signs as "humps," "bumps," "speed humps," a graphic representation of the device, and others. Several different striping treatments also are being used for speed humps throughout the country, e.g., chevron @ pattern, "shark teeth," and colored asphalt. Sign and marking treatments for other devices, such as traffic circles, roundabouts, speed tables, and raised intersections, are also being developed in different cities. A consistent approach is needed for signs and markings that is readily understood by motorists and conforms to the colors, shapes, sizes, and placement philosophy as specified in the *MUTCD*.

OPTIMAL SPACING BETWEEN SPEED TABLES, HUMPS, AND OTHER DEVICES

A single device will generally only affect speeds at its location, for example a Stop sign. One concern is that motorists will greatly accelerate before or just after the device to "make up for lost time." Proper spacing of devices will limit the acceleration between the devices. Initial research has been made into the proper spacing for speed humps. In general, 500 ft is given as the optimal spacing. This value needs to be confirmed, and the value for other devices, such as speed tables, needs to be investigated.

EFFECTS ON SPEED VARIANCE (RATHER THAN 85TH PERCENTILE SPEED) OF DIFFERENT DEVICES

While certain devices have minimal effect on the measured 85th percentile speed, these devices may influence the fastest vehicles. Research is needed to determine which devices have the greatest effect on those traveling at the highest speeds.

EFFECTS OF TRAFFIC CALMING DEVICES ON NOISE LEVELS

Some traffic calming devices are criticized because of the additional noise generated from the vehicle driving over the devices, such as at humps or rumble strips. Also, additional noise is generated when vehicles are decelerating to or accelerating from the treatment. Research is needed to determine the level of the additional noise and how it compares with the noise generated by other users of the roadway.

EFFECT OF DIFFERENT TREATMENTS ON SPEED OR VOLUME REDUCTION

Some initial work has been done on evaluating the effects of traffic calming devices on speed or volume reduction; however, more is needed. Recent efforts have focused on the effects of speed humps on reducing speed and volume, and although more data have been requested, preliminary conclusions have been reached. Devices that show promise in affecting speed, especially on collectors and arterials, are discussed below.

Roadway Narrowing

To narrow the roadway, paint the edgewise several feet from the pavement edge. While this narrows the lane which could result in reduced speed, the addition of markings on the roadway may better define the travel path, which could result in increased speed. More research is needed to determine the effect on speed from narrowing a roadway with striping. The study should consider whether narrowing is accompanied by the addition of a parking or bike lane, both of which could have a major effect on travel speed.

Initially reducing the number of lanes on a facility appears counter productive for traffic engineering. Similar to the debate about using more narrow lanes/roads in neighborhoods, the reduction of the number of lanes on a facility is growing in acceptance. While wider lanes/roads and more lanes are generally associated with a safer and more effective facility, the opposite may be true under certain conditions. Research is needed to determine when fewer lanes or more narrow lanes would provide better service for the area. Issues to consider include the anticipated operating speed on the facility, characteristics of the traffic flow, such as sufficient gaps for vehicle and pedestrian crossing maneuvers, and the quality of life concerns for the surrounding area.

Roundabouts

Roundabouts are becoming more popular in the United States as a means to serve intersecting traffic movements safely and efficiently. Roundabouts also have a speed control benefit needed in some areas, such as near subdivisions. Studies conducted for Maryland and Florida DOTs have shown that roundabouts have fewer accidents and lower delays than most conventional intersections, regardless of their control type. Within this decade, several roundabouts have been constructed in Florida, Maryland, and Colorado with great success. These roundabouts have several characteristics that differentiate them from the configurations built in earlier years, some of which were built in Texas. For example, the successful "modern roundabouts" have splitter islands on the approach legs; are defined for specified design vehicles; have all vehicles circulate counterclockwise; and entering traffic yields to the traffic circulating within the roundabout. Research is needed to determine the applicability of modern roundabouts for Texas. In addition, investigating the design characteristics of existing roundabouts in Texas and comparing these configurations with the successful modern roundabouts in other states could provide insight into the future use of modern roundabouts within the state of Texas. Issues that need to be addressed include the following:

- design speed;
- sight distance;
- radius of central island;
- circulatory roadway width and cross slope;
- splitter island size and orientation; and
- bicycle and pedestrian accommodations.

Also, guidelines are needed to identify traffic demand and control conditions suitable for roundabout applications. These guidelines would consider roundabout capacity, travel modes, right-of-way requirements, adjacent intersection impacts, and speed limits. The use of guidelines will ensure cost-effective and consistent application within the state of Texas.

Rumble Strips

The use of rumble strips in Texas has been limited to a few isolated locations. Additional information on their effectiveness, especially for use on rural roadways approaching a signalized intersection, a sharp horizontal curve, or a small town, could provide the support needed for additional use of the technique elsewhere. Another issue for consideration is how the rumble strips affect braking for motorcycles.

Citizen Speed Watch Programs

Speed watch programs have generally shown only limited success in reducing speeds. They could be labor intensive if the city provides personnel to monitor speeds. In other cases they may have limited use due to citizens' concerns about confronting motorists or neighbors and the need to recruit volunteers during the busiest traffic volume periods. The benefits of a citizen watch program could extend beyond the influence of reduced speeds, however. For example, the program could cause increased interaction between neighbors that could result in lower crime rates. These other benefits, along with the effects on speed, should be compiled to make an appropriate assessment about the value of a citizen watch program.

Innovative Pavement Markings

Only limited information is available on the effects of transverse pavement markings on speeds, and most of the information is from Europe and Japan. Tests need to be conducted in the U.S. to determine the effects of pavement markings on drivers. These tests should include markings of the converging chevron pattern, transverse bars, and the speed limit on the pavement.

Signal Coordination

Additional information about the benefits of signal coordination as related to speed management (i.e., desired speed for a given percent of the traffic flow instead of reduction in delay) is needed. This information may already be available; however, some review of the data and reorganization of the information is needed so it can be better assessed as a speed management tool.

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