

Updated Guidelines for the Design and Application of Speed Humps

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Abstract

Speed humps have gained acceptance as a traffic calming device by North American and international jurisdictions. However, design and application varies widely between jurisdictions, and speed humps often meet resistance from residents and road users. In 1997, the Institute of Transportation Engineers (ITE) published a Recommended Practice for the design and application of speed humps. The recommended practice is now being updated to provide state-of-the-practice guidelines for speed humps and speed tables.

To update the ITE speed humps recommended practice, the experiences of agencies implementing speed humps were obtained through an extensive literature review. The literature review was supplemented with an online survey targeting North American and international jurisdictions.

This paper provides an overview of the recommended framework for an agency to follow to implement speed humps or speed tables in their jurisdiction. This framework is based on the experience documented by dozens of agencies. The framework includes:

- Develop and follow a formal public consultation process;
- Determine the needs of the street or neighborhood;
- Construct and maintain speed humps; and
- Monitor and evaluate speed hump effectiveness.

1. INTRODUCTION

Speed humps are one tool available in the traffic calming toolbox, and have gained acceptance by North American and international jurisdictions since their development in the early 1970s by the Transport and Road Research Laboratory (TRRL) in Great Britain. However, design and application varies widely between jurisdictions, and speed humps often meet resistance from residents and road users.

In 1997, the Institute of Transportation Engineers (ITE) published a Recommended Practice for the design and application of speed humps. Research has been conducted and lessons have been learned through experience regarding the design and implementation of speed humps since the publication of this guideline.

As a result, ITE initiated an update to the Recommended Practice to provide state-of-the-practice guidelines for the design and application of speed humps. State-of-the-practice guidelines were obtained through an extensive literature review on relevant published material. The knowledge base gained from the literature review was supplemented through an on-line survey of jurisdictions implementing speed humps. The on-line survey was designed to capture

information to fill the knowledge gap from the literature review. Jurisdictions in the United States, Canada, and internationally provided their experiences; close to 300 responses to the survey were received.

Guidance was also provided by an ITE Technical Advisory Committee (TAC) whose members have extensive experience in speed hump design and implementation. The update is currently under review, and is expected to be published later this year.

This paper provides an overview of the recommended framework for an agency to follow to implement speed humps or speed tables in their jurisdiction. This framework is based on the experience documented by dozens of agencies. The framework includes:

- Develop and follow a formal public consultation process;
- Determine the needs of the street or neighborhood;
- Construct and maintain speed humps; and
- Monitor and evaluate effectiveness.

Other common speed control measures currently used by various agencies are documented in ITE's "Traffic Calming: State of the Practice". (Ewing 1999)

1.1 Speed humps vs. speed bumps

A speed hump is a raised area in the roadway pavement surface extending transversely across the travel way. Speed humps are sometimes referred to as "pavement undulations" or "sleeping policemen". Most agencies implement speed humps with a height of 3 to 3.5 inches (76 to 90 mm) and a travel length of 12 to 14 feet (3.7 to 4.3 m). Speed humps are generally used on residential local streets.

A speed bump is also a raised pavement area across a roadway. Speed bumps are typically found on private roadways and parking lots and do not tend to exhibit consistent design parameters from one installation to another. Speed bumps generally have a height of 3 to 6 inches (76 to 152 mm) with a travel length of 1 to 3 feet (0.3 to 1 m).

From an operational standpoint, speed humps and bumps have critically different impacts on vehicles. Within typical residential operational speed ranges, vehicles slow to about 20 mph (32 km/h) on streets with properly spaced speed humps. A speed bump, on the other hand, causes significant driver discomfort at typical residential operational speed ranges and generally results in vehicles slowing to 5 mph or less at each bump.

Speed bumps of varying design have been routinely installed on private roadways and parking lots without the benefit of proper engineering study regarding their design and placement. Speed humps, on the other hand, have evolved from extensive research and testing and have been designed to achieve a specific result on vehicle operations without imposing unreasonable or unacceptable safety risks.

1.2 Speed tables

Speed tables are essentially flat-topped speed humps, and may have a textured material on the flat section with asphalt or concrete for the approaches. Speed tables are sometimes referred to as “trapezoidal humps” or “speed platforms”. If marked as a pedestrian crossing, speed tables may also be referred to as “raised crosswalks” or “raised crossings”.

Most agencies implement speed tables with a height of 3 to 3.5 inches (76 to 90 mm) and a travel length of 22 feet (6.7 m). Speed tables generally consist of 10 foot (3.1 m) plateau with 6 foot (1.8 m) approaches on either side that can be straight, parabolic or sinusoidal in profile. The longer lengths of speed tables provide a gentler ride than speed humps and generally result in vehicle operating speeds ranging from 25 to 30 mph (40 to 48 km/h) on streets depending on the spacing between speed tables. Speed tables are generally used on residential collectors, emergency routes or transit routes.

The City of Portland, OR has designed “split” speed tables for designated emergency routes. Split speed tables are also 22 feet (6.7 m) long and extend from curb to centerline on opposite sides of the street. Split speed tables are separated by a longitudinal gap that allows fire trucks to weave around the split speed humps in slalom-like fashion. The Portland Department of Transportation is currently testing this alternative speed table design. Split speed tables are not included in this paper.

2. PUBLIC CONSULTATION PROCESS

Traffic calming activities are carried out to reduce traffic speeds and volumes. Based on the experience of most agencies, it is critical to obtain the support of a substantial majority of all residents in a neighborhood targeted for traffic calming measures, including speed humps, prior to implementation. Therefore, it is important for agencies to develop a working relationship with communities and have well defined administrative procedures in place.

Based on a survey of agencies in North America and around the world, the large majority of agencies (77%) have a formal public consultation process for implementing speed humps.

It is recommended that each agency, prior to installing speed humps, develop a formal process for speed humps. Five key elements are recommended:

1. Appropriate legislation (policies, ordinances and regulations);
2. Request procedure;
3. Evaluation of requests;
4. Consultation (with the public and other agencies); and
5. Removal procedure.

2.1 Appropriate legislation

Statutory authority, constitutionality, and tort liability are the legal issues surrounding speed hump installation that jurisdictions should take into consideration. A jurisdiction must have the legal authority to implement speed humps on a given class of roadways, while respecting the

constitutional rights of affected landowners and road users, and minimizing the risks to road users. (Ewing 1999)

Before initiating a speed hump installation program, it is recommended that appropriate policies, regulations, and/or ordinances are developed to govern elements such as the community involvement process, hump design and location criteria, cost sharing relationships, installation and maintenance requirements, and evaluation/modification procedures. It is also important to clearly define the project area, that is, the area expected to be affected by speed hump implementation. For example, any property located within 250 feet (76 m) from the first and last speed humps is considered by the City of Beaverton (OR) to be part of the project area.

It is important that jurisdictions review state and municipal ordinances and regulations to ascertain if existing legislation could affect the implementation of speed humps. Existing legislation may have to be modified, or new legislation developed, before proceeding with speed hump installation (TAC 1998).

2.2 Request procedure

Speed hump installation may be requested by a single resident, though additional support from the community is generally needed at a later stage in the process for the project to remain eligible. The request procedure should clearly outline the expectations of all potentially impacted parties and the timing of their participation in the various stages of the process. The following components are recommended for inclusion into a speed hump request procedure:

- Develop a request or petition form which residents can use to request speed humps in their neighborhood. Many agencies have petition forms available on the internet, which residents can download, collect signatures, and return to the appropriate department;
- Identify the department that will be responsible for receiving speed humps requests and coordinating the overall process;
- Screen all requests received to determine eligibility. Common eligibility criteria include the 85th percentile speed, the posted speed limit, and the average daily traffic. Some agencies also require support from a certain number or percentage of affected residents in order for a request to be eligible; and
- If a request meets all eligibility requirements, obtain wider community support before proceeding to the evaluation stage. Define the project area for the speed hump request in order to determine who to include in the process. Speed hump projects typically extend between higher-order streets.

The eligibility criteria will vary depending on the needs of each jurisdiction. Therefore, it is recommended that each implementing agency develop a customized speed hump request procedure with input from other relevant agencies (e.g., emergency services, transit agencies). Before proceeding to evaluation of a request, the eligibility criteria should be met.

2.3 Evaluation of requests

To evaluate the merit of installing speed humps, it is recommended that eligible requests be ranked to determine priority levels. Some agencies use a points system to evaluate and rank projects with points allocated based on certain elements, such as:

- Speed;
- Traffic volumes;
- Collisions (e.g., speed-related);
- Proximity to schools or other land uses where high numbers of children could be present, such as parks or playgrounds;
- Lack of sidewalks; and
- Designated bicycle routes.

During evaluation, traffic conditions in the neighborhood should be observed and data collected, such as daily traffic volume and operating speed. The data collection required will be determined by the evaluation criteria developed for the jurisdiction.

As part of the evaluation of requests, consideration should be given to the objectives of the installation (e.g., reduced speed, reduced infiltration or cut-through traffic). The objectives of the installation will guide the monitoring and evaluation of speed humps after implementation. Collection of data is a key part of the evaluation of speed humps both before and after implementation.

For those projects which receive the highest ranking, a preliminary design plan can be developed to show the potential locations of speed humps prior to initiating public and agency consultation.

2.4 Public and agency consultation

Consultation of proposed speed hump installations should include:

- Property owners, residents, and business owners. Special consultation should be considered with those residents or landowners directly adjacent to proposed hump locations;
- Emergency services (police, fire, ambulance, etc.); and
- Other groups such as school districts, nearby hospitals or emergency medical centers, transit operators, road maintenance workers, snow plow operators, and waste collection agencies.

At least one public meeting is recommended to have an open discussion of speed humps. Notification of the meeting should be provided well in advance, and the meeting should be held as close as possible to the study area. However, a single method of public involvement may not be suitable for every situation. More complex or controversial requests will require greater public education and involvement throughout the process.

At the public meeting, the scope and timing of the project can be discussed and the preliminary design plan should be presented for comments from all parties. Comment sheets could be distributed at the meeting, and collected at the end of the meeting. A deadline for resident comments after the meeting should be established. All comments received should be considered

fully in the decision-making process to arrive at the final design plan.

Most agencies perform another survey at this stage, and require a higher level of support from the public to continue with the implementation of speed humps. In order to gauge support, a mail-out questionnaire or survey can be conducted. Some agencies require the support of at least 67 percent of all residents before speed humps are installed. This ensures that a substantial majority of the affected people agrees with the project and there is a general acceptance of the final design plan.

2.5 Removal procedure

Most agencies require speed hump removal requests to be supported by a majority of residents, although poor traffic operations, emergency services or transit agencies may also initiate the removal procedure. Monitoring and evaluation of speed hump installations will assist in the determination of any unexpected problems that may have been created.

The removal procedure will vary depending on the needs of each jurisdiction. Therefore, it is recommended that each implementing agency develop a customized speed hump removal procedure with input from other relevant agencies (e.g., emergency services, transit agencies).

3. DETERMINE NEEDS OF THE STREET OR NEIGHBOURHOOD

Speed humps should be implemented only to address documented safety or traffic issues supported by a traffic engineering review. It is recommended that an engineering review be conducted to identify, quantify, and document the existing traffic issues on the street and in the neighbourhood. Issues could include speeding, cut-through traffic, or safety. It is important to review existing conditions and determine if there is a measurable problem, rather than a perceived problem (TAC 1998). Documented issues can then be used to support the implementation of speed humps, and to measure their effectiveness if implemented (Ewing 1999).

Installing speed humps in a community can be met by resistance from residents, thus community support and involvement are important for increasing awareness of speed humps and creating an atmosphere of acceptance and ownership (TAC 1998). By explaining the full context, setting residents' expectations appropriately, and discussing the potential benefits and disbenefits of speed humps and other traffic calming treatments, consensus on the most appropriate treatment for the neighbourhood is more likely achievable.

3.1 Roadway characteristics

In the United States and Canada, speed humps are generally installed on roadways functionally classified as local streets and neighbourhood or residential collector streets as defined in AASHTO's "A Policy on Geometric Design of Highways and Streets" (AASHTO 2004, pg 12; TAC 1998).

Many agencies install speed humps on roads with an urban cross-section (i.e., curb and gutter). Streets where speed humps are applied may or may not have sidewalks or bicycle facilities (such as on or off road trails). The surrounding land use for streets where speed humps are applied is generally residential in nature, and may include schools, parks or community centers.

Speed humps can be used on one-way or two-way streets (TAC 1998). Speed humps are not recommended on streets with more than two travel lanes. In addition, the pavement should have good surface and drainage qualities. The location of individual speed humps will depend on the presence of on-street parking, driveways, intersections, and other roadway features. Figure 1 shows a speed hump installed on a street with parking and bicycle lanes in the City of Portland, OR.

Speed humps are generally not recommended for use on bus routes or emergency vehicle routes (Ernish et al. 1998), or on streets that provide access to hospitals and emergency medical services. Speed tables may be more appropriate, and could be applied after consultation with representatives of the emergency services. The use of alternative traffic calming measures may also be considered for use on bus or emergency vehicle routes.



Figure 1: Speed hump on residential street with parking and bicycle lanes in Portland, Oregon

Photo by: Scott Batson (City of Portland, Oregon)

3.2 Traffic characteristics

Traffic operation elements include traffic speeds, traffic volumes and mix (including cut-through traffic), emergency vehicle access, transit routes, vehicle and cargo damage, and environmental impacts. The decision to install speed humps includes consideration of the posted speed limit and the operating speed of traffic. Speed humps are usually recommended only on streets where the

speed limit is 30 mph (50 km/h) or less. Speed humps are generally not considered appropriate where the 85th percentile speed is 45 mph (70 km/h) or more.

Spacing and location of the speed humps and the length of the road segment where the hump is installed affects operating speeds. The research available suggests that speed humps should be no more than 500 feet (152 m) apart where the desired 85th percentile operating speed is between 25 and 30 mph (40 and 48 km/h). Short road segments may require only a single speed hump even where two could be installed as acceleration opportunities are limited on a short segment.

The final locations of the humps are dependent on site specific considerations, making the determination of actual spacing and final location a complex task. After the general spacing and layout of the speed humps have been established, the final location of each hump is determined by considering vertical alignment, horizontal alignment, intersections, driveways, street lighting, on-street parking, pedestrian crossings, installation angle, and drainage and utilities.

Several studies have shown that speed humps reduce vehicle speed as measured by the 85th percentile speed, the percentage of drivers traveling over the speed limit, and the percentage of drivers traveling 10 mph or more over the speed limit.

The installation of speed humps should also consider traffic volumes in terms of the total volume of traffic, the presence of cut-through traffic, and the traffic mix. Each street requires individual assessment prior to implementation. An area-wide approach is needed to avoid simply diverting traffic from roads with speed humps to parallel untreated roads, but the extent of the diversion problem is unclear at present.

Speed humps have been shown to reduce traffic volumes. The combined results for speed humps and speed tables investigated in the City of Portland (OR) showed an average traffic reduction of 28 percent.

3.3 Pedestrians and bicyclists

The consideration of all road users, especially pedestrians and bicyclists, is another key component of the engineering review conducted prior to the installation of speed humps. Speed humps and speed tables are two traffic calming techniques that can be used to facilitate pedestrian and bicyclist movement and improve the safety of these road users (Zegeer 1998).

Speed tables can serve as raised marked crosswalks when they extend from curb to curb (Figure 2) and provide a flat surface suitable for pedestrians to use. Speed tables can facilitate pedestrian flow while providing vehicle speed control at the crosswalk location (Ewing 1999, Ernish et al. 1998). Parabolic or circular speed humps are too rounded or sloped for pedestrians to safely use.

Where a speed table is used as a raised pedestrian crosswalk, crosswalk design elements can be incorporated. Design element considerations include the following:

- The markings must be visible to motorists, especially at night. Inlay tape and thermoplastic are generally recommended for crosswalk pavement markings on speed tables (PBIC 2006)

- Granite and cobblestones finishes are not recommended because, although aesthetically pleasing, the surface may become slippery when wet, and may be difficult to cross for pedestrians who are visually impaired or using wheelchairs (PBIC 2006).



Figure 2: Raised pedestrian crosswalks can control vehicle speeds on local streets at pedestrian crossings

Photo by: Dan Burden

In general, bicyclists do not require extensive special provision (TAC 1998). Bicyclists may, however, be concerned that the vertical deflection of the speed hump will be uncomfortable and inconvenient and that abrupt slopes could even throw a bicyclist from their bicycle (PBIC 2006). Additional elements that could be considered to accommodate bicyclists include (DeRobertis and Wachtel 1996):

- Using a tapered edge before the curb to reduce the likelihood of pedal impact on hump. If this gap is too wide, it may promote gutter running by motor vehicles;
- Using speed humps that are less than 4” high;
- Providing adequate warning signs and markings;
- Ensuring that speed humps are far enough from intersections so bicyclists do not have to negotiate humps while turning; and
- Ensuring that speed humps are not installed on streets with vertical grade greater than 5 percent.

4. CONSTRUCT AND MAINTAIN SPEED HUMPS

Speed humps and speed tables are most often constructed on existing roadways (i.e., retrofit); however, speed humps and speed tables may be constructed on new roadways or during resurfacing projects.

It is recommended that jurisdictions planning to implement speed humps or speed tables develop standard construction procedures. Following these procedures will ensure more uniform speed humps and speed tables are constructed throughout the jurisdiction. The procedures should be used by both municipal staff and private contractors engaged to work on municipal roads.

The construction procedures should contain detailed working drawings showing development of the desired profile and allowable tolerances for speed hump height. Material specifications and construction guidelines can also be included.

Agencies have reported that parabolic or sinusoidal cross-sections are more difficult to construct than circular speed humps or speed tables with straight approaches. However, many agencies have successfully constructed parabolic and sinusoidal cross-sections within acceptable tolerances. This success is often related to the use of a speed hump profile template which is used to verify that the speed hump dimensions and profile are accurate within reasonable tolerances. Figure 3 shows the use of a speed hump profile template in Beaverton, OR to construct a parabolic speed hump. If the profile is incorrect, the effect of the speed hump will likely change, which might result in unanticipated or reduced effectiveness.



Figure 3: Use of speed hump profile template in Beaverton, OR

Photo by: Jabra Khasho (City of Beaverton, Oregon)

Care should be taken in the initial installation and monitoring of speed humps to minimize the risk of edge raveling and profile deformation exceeding established tolerances. It is important to maintain the appropriate design relationship between the hump or table and the street so the device continues to perform its intended purpose within allowable tolerances. From the experiences of several agencies, speed humps constructed of asphalt concrete tend to deform over time in the direction of traffic flow, while rubberized speed humps may develop ruts along

the wheel paths or curl up along the edges. Ambient temperature during construction as well as sufficiency of the bond between the new asphalt and the existing street also play a role in the durability an asphalt hump.

If maintenance activities, such as utility work or pavement resurfacing, result in speed hump pavement markings being reduced or eliminated, they should be promptly replaced or supplemented with temporary signs providing the same warning to motorists.

Experience has shown that speed humps and speed tables are generally not damaged by snow plowing activities. Snow removal crews in Montgomery County (GA) reported minimal impact or cost associated with speed humps (Wainwright 1998). The City of Edmonton (AB) experienced some damage to parabolic speed humps from snow plows; however, in most cases there was no damage since snow plow operators do not plow down to the pavement on local streets where speed humps are located. For jurisdictions which experience substantial snowfall, it is recommended that snow plow operators be informed of all streets with speed humps before the winter season starts.

5. MONITOR AND EVALUATE EFFECTIVENESS

Speed hump installations affect residents and road users; traffic speeds, volumes and travel time; roadway safety, noise levels and emissions. It is important to monitor and evaluate the effect of each speed hump or speed table installation project. Minimum monitoring and evaluation includes data collection and analysis of vehicle operating speed and traffic volume changes including traffic diversion. More extensive evaluation may include gathering feedback from residents and road users.

The type, number, and extent of studies performed to evaluate speed humps may vary based upon the particular circumstances and objectives of each installation. However, some review could be performed after each installation to determine if the desired results were achieved, or if unexpected problems were created. If the installation of speed humps resulted in undesirable safety or traffic operations issues, consideration can be given to mitigation efforts including possible removal of the humps.

Monitoring and evaluation may include several aspects of the speed hump installation, including impacts on residents, traffic operations and safety, and on the environment.

6. CONCLUSIONS AND RECOMMENDATIONS

Speed humps and speed tables are two of several geometric design techniques that may be used to control vehicular traffic speeds along a roadway. Positive results in terms of reduced operating speeds and reduced traffic volumes have been documented after speed hump installation.

The experiences of various agencies currently implementing speed humps across North America are documented in the updated ITE Recommended Practice along with findings from published research work. The ITE Recommended Practice also provides details on the design of speed humps and speed tables.

This paper provides an overview of the recommended framework for an agency to follow to implement speed humps or speed tables in their jurisdiction. This framework is based on the experience documented by dozens of agencies. General considerations for the implementation of speed humps as a traffic calming measure were discussed along with the importance of community involvement.

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