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TRAFFIC CALMING

In This Issue...

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Traffic Calming Overview

Traffic calming is the use of physical measures to address speeding and high-volume cut-through traffic. Speeding and cut-through traffic can create an atmosphere in which non-motorists are intimidated, or even endangered, by motor vehicle traffic. By addressing high speeds and cut-through volumes, traffic calming can improve both the real and perceived safety for pedestrians and bicyclists, and improve the quality of life.

In areas where there is potential conflict between pedestrians and motor vehicles, reducing vehicle speeds could have a significant impact on the number of crashes and the severity of crashes. When vehicle speeds are slower, drivers have more time to react to potential conflicts and avoid them. If a crash does occur, the chance of survival typically increases with decreasing speeds; especially for crashes involving pedestrians and bicyclists.

Four Major Traffic Calming Technique Categories

- Horizontal deflection
- Vertical deflection
- Physical obstructions
- Signing and pavement markings

Generally, traffic calming measures are not appropriate on higher speed and higher volume streets such as arterial roadways since the purpose of these roadways is traffic mobility. Traffic calming measures may be appropriate on the following roadway types:

- Local residential streets
- Collector streets with predominantly residential land uses
- Arterial roads within downtown districts or commercial areas (with posted speeds of 40 mph or less)

Additionally, traffic calming measures can be effective within an entry control facility (ECF) area to reduce the velocity of threat vehicles (i.e., motorists intending to gain unauthorized access) and non-threat vehicles; although not all traffic devices are proven effective at speed reduction of threat vehicles.

Traffic calming techniques can be grouped into four major areas: horizontal deflection, vertical deflection, physical obstructions, and signing and pavement markings. This bulletin will discuss how the most common traffic calming measures within these categories can be used for three primary purposes: ECF threat vehicle calming, ECF non-threat vehicle calming, and non-ECF traffic calming. In addition to the recommended traffic calming measures, non-compliant traffic calming measures often found on military installations will be discussed along with compliant measures that can be used in their place.

Reducing Speeds at ECFs

The control of vehicle speeds at ECFs is a common concern. To control the speed of a threat vehicle, the geometry must limit the maximum attainable speed. To control the speed of average motorists (i.e., non-threat vehicles), traffic calming can be considered; but there are differences in applying the techniques to ECF areas. These differences are noted throughout this bulletin. Though the use of traffic calming strategies may seem appropriate at select ECFs, an engineering assessment is recommended.

Three Reasons to Reduce Speeds in an ECF Area:

- Increase safety of guards and motorists
- Provide a clearer distinction between threats and speeders
- Physically control the maximum threat speed

ECF Threat Containment

An ECF is the first line of defense from a threat intending to gain unauthorized access to an installation. As such, it is designed to provide adequate time for a guard to respond to a threat, adequate safety time (for a signalized scheme), and time for barriers to deploy for threat containment. The threat containment time required in the design of the response zone (which is dependent on the AVB Safety Scheme utilized) does not change. It is the threat vehicle speed, and thereby the distance traveled, that can be changed. **As it relates to traffic calming techniques, only horizontal deflection, and physical obstructions have the capability to limit the maximum attainable speed.**

ECF Threat Detection

The ability to detect a potential threat is a vital part of ECF security. In conjunction with overspeed detection systems, certain traffic calming techniques can aid guards in gauging the intentions of a motorist to determine if they are a potential threat or not. For example, a typical motorist slows down to 15-20 mph at a speed hump and is limited to 25-30 mph between speed humps. If a vehicle traverses the first speed hump and continues at a high rate of speed and/or accelerates over subsequent speed humps, then it is likely that they intend to access the installation without authorization. Speed humps can allow guards to make a more informed decision ahead of time and respond accordingly. In terms of limiting the maximum attainable speed of a threat vehicle, however, the speed humps will have no effect. Research has shown that vertical deflection that does not exceed regular driver comfort is not a deterrent to threat vehicle maximum attainable speed but is effective as a means of detecting high speed approaches.

Traffic Calming Techniques

The following table summarizes traffic calming techniques according to their category (i.e., horizontal deflection, vertical deflection, physical obstruction, signing and pavement markings), and illustrates their effect on reducing volumes and speeds; as well as their effect on increasing emergency response time and estimated cost to construct. Note that costs are considered typical, do not consider the possible need to replace poor drainage or pavement, and have not been adjusted by location. To adjust cost by location, refer to the adjustment factors in the *Cost DoD Area Cost Factors* document found on the Army Corps of Engineers website: https://www.usace.army.mil/Cost-Engineering/Area-Cost-Factors/.

Legend Key for Summary Tables					
Significant Effect	●	Moderate Effect	◑	Minimal or No Effect	○

Horizontal Deflection

Horizontal deflection refers to two types of traffic calming measures. The first type hinders the driver's ability to drive in a straight line by creating a horizontal shift in the roadway. The shift forces drivers to slow their vehicle to safely navigate the roadway. The second type of horizontal deflection measure is designed to narrow the width of the travel lane. Doing so reduces the usable surface of the roadway causing drivers to slow their vehicle to maintain an acceptable comfort level.

Bulb-out/Curb Extension - Areas of expanded curbing that extend across a parking lane, resulting in a narrower travel lane.

Chicane - Series of three bulb-outs, staggered at mid-block locations on alternating sides of the street.

Gateway - Entrance treatment, typically using physical and textural changes, which provides identity to an area.

On-Street Parking - Provisions for on-street parking, which gives the perception of a reduced travel way width.

Raised Median Island/Pedestrian Refuge - Narrow islands, at mid-block or intersections, located between travel lanes with breaks in landscaping and curbing for pedestrians. These can often be constructed in the width otherwise used for a two-way left-turn lane when one is present. ADA-accessible curb ramps and sidewalks must be provided.

Roundabout - Raised island in the center of an intersection that requires vehicles to travel counterclockwise around the circle (in countries where vehicles travel on the right-hand side of the road).

Technique	Example	Volume Reduction	Non-Threat Speed Reduction	Threat Speed Reduction	Threat Detection	Emergency Response	Estimated Cost
Bulb-out / Curb Extension*	 Source: FHWA	○	◑	◑	○	◑	$8,000 to $11,000
Chicane*		◑	◑	●	◑	◑	$7,000 to $15,000

Technique	Example	Volume Reduction	Non-Threat Speed Reduction	Threat Speed Reduction	Threat Detection	Emergency Response	Estimated Cost
Gateway	 Source: https://www.beta-inc.com/project/canton-street-neighborhood-traffic-calming/	●	●	○	○	●	$5,000 to $22,000
On-street Parking**	 Source: FHWA	○	●	○	○	●	Varies
Raised Median Island / Pedestrian Refuge*	 Source: www.pedbikeinfo.org	○	●	●	○	○	$5,000 to $16,000
Roundabout*	 Source: Omni-Means, Ltd.	●	●	◉	●	◉	$200,000 to $500,000

*** Threat speed reduction possible with the use of 8-inch curbing or passive barrier.**

**** Not applicable at ECF areas where parking should only be permitted in designated parking areas.**

Vertical Deflection

Vertical deflection refers to traffic calming measures that create a change in the height of the roadway. When designed properly, vehicles must slow down over these measures to avoid driver and passenger discomfort.

Speed Humps - Raised humps in the roadway, typically 3-inches high and 12- to 22-feet long.

Raised Crosswalk - Marked pedestrian crossing elevated 3- to 6-inches above street grade at intersections or mid-block. Raised crosswalks can have similar effects as speed humps but allow for pedestrian crossings. The reduction in speeds can have a benefit to pedestrian crossings that would not otherwise occur.

Raised Intersection - Intersections, including crosswalks, raised 3- to 6-inches above street grade.

Transverse Rumble Strips – These strips are a series of grooves within the pavement spanning the width of a travel lane that are used to alert drivers of an unexpected change in the roadway such as the need to change lanes, slow down or stop, or changes in the roadway alignment.

Technique	Example	Volume Reduction	Non-Threat Vehicle Speed Reduction	Threat Vehicle Speed Reduction	Threat Detection	Emergency Response	Estimated Cost
Speed Humps	 Source: FHWA	◐	●	○	◐	●	$2,000 to $4,000
Raised Crosswalk	 Source: FHWA	◐	●	○	◐	●	$2,000 to $11,000
Raised Intersection	 Source: www.nacto.org	○	◐	○	◐	●	$16,000 to $66,000

Technique	Example	Volume Reduction	Non-Threat Vehicle Speed Reduction	Threat Vehicle Speed Reduction	Threat Detection	Emergency Response	Estimated Cost
Transverse Rumble Strips	 Source: Florida Department of Transportation	○	●	○	●	○	$0.11 to $1.27 per linear foot

Physical Obstruction

Physical obstruction refers to measures that prevent specific vehicle movements, thereby discouraging or eliminating cut-through traffic. The overall traffic volume reduction depends upon the nature of the traffic calming measure and the number of movements obstructed.

Semi-Diverter - Directional closure created by physically blocking half the street.

Diagonal Diverter - Physical barrier placed diagonally across a four-leg intersection to create two unconnected roadways.

Right-In/Right-Out Island - Use of raised islands to prevent left turns and through movements, to and from side streets, at intersections with major streets.

Raised Median Through Intersection - Median barrier through an intersection that discourages through traffic in a residential area by restricting movements.

Street Closure - The use of a cul-de-sac to close a roadway by extending a physical barrier across the entire width, obstructing all traffic movements.

Technique	Example	Volume Reduction	Non-Threat Vehicle Speed Reduction	Threat Vehicle Speed Reduction	Threat Detection	Emergency Response	Estimated Cost
Semi-diverter*	 Source: FHWA	●	◐	◐	○	◐	$1,000 to $22,000
Diagonal Diverter*	 Source: FHWA	●	◐	◐	○	◐	$8,000 to $22,000
Right-In / Right-Out Island	 Source: Google Earth	◐	○	○	○	◐	$4,000 to $8,000

Technique	Example	Volume Reduction	Non-Threat Vehicle Speed Reduction	Threat Vehicle Speed Reduction	Threat Detection	Emergency Response	Estimated Cost
Raised Median Through Intersection	 Source: FHWA	●	○	◐	○	●	$2,000 to $22,000
Street Closure	 Source: FHWA	●	◐	◐	○	●	$2,000 to $27,000

*** Threat speed reduction possible with the use of 8-inch curbing or passive barrier.**

Signing and Pavement Markings

Signing and pavement markings can be used as traffic calming measures that regulate traffic movements in lieu of physical changes to the roadway. In certain applications, these measures may produce the same effect as the physical traffic calming measures. However, police enforcement is often required to ensure motorist compliance.

Speed Limit Signing - Proper placement of speed limit signing can serve as a reminder for roadway users to drive at an appropriate speed. Most states have statutory speed limits which can be enforced in the absence of posted speed limit signs. These statutory speeds vary by state; examples include: 25 mph in urban business districts, 35 mph in residential districts, 70 mph on rural freeways, or 55 mph on all other roadways. Therefore, residential streets must include speed limit signing if a speed limit other than the statutory speed limit is to be enforced. However, a speed study must be conducted to establish the speed limits. Note that even if the desired speed is the statutory speed limit, posting speed limits can still have traffic calming benefits.

Driver Speed Limit Feedback (Changeable Message) Signing – A speed limit sign with a screen that displays a vehicle's current speed approaching the sign using radar detection. The screen usually indicates that the speed limit has been exceeded by flashing the speed or displaying another message. A 2016 report by the Federal Highway Administration (FHWA) has shown that the feedback signs "are reasonably effective in reducing both vehicle speeds and crashes". The color of the changeable message legend should be a yellow legend on a black background or the reverse of these colors.

Roadway Narrowing with Edge Lines - A low-cost way of reducing speeds is to narrow the roadway lane using edge lines and center lines. Several jurisdictions across the country have installed this type of pavement marking application to create 10-foot wide lanes. This pavement marking application is appropriate on local streets and low-volume minor collectors but should not be used on major collectors or arterial streets.

Transverse Markings - Double-thick thermoplastic transverse pavement markings have been successful in slowing traffic in diverse areas such as school zones, hospitals, approaches to severe curves, and stop signs.

Technique	Example	Volume Reduction	Non-Threat Vehicle Speed Reduction	Threat Vehicle Speed Reduction	Threat Detection	Emergency Response	Estimated Cost
Speed Limit Signing	 R2-1  R2-5iP, R2-1, R2-5P	○	●	○	○	○	$300 to $500 per sign

Technique	Example	Volume Reduction	Non-Threat Vehicle Speed Reduction	Threat Vehicle Speed Reduction	Threat Detection	Emergency Response	Estimated Cost
Driver Speed Limit Feedback (Changeable Message) Signing	 Source:Unknown	○	●	○	○	○	$5,000 to $11,000
Roadway Narrowing with Edge Lines	 Source: FHWA	○	●	○	○	○	$0.32 per linear foot
Transverse Markings	 Source: FHWA	○	●	○	○	○	$2.20 per linear foot

Common Traffic Calming Devices (on Military Installations)

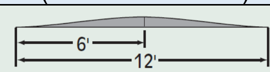
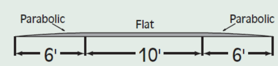
This section discusses six devices that can that can be used to address speeding commonly found on military installations.

- Speed Humps
- Chicanes
- Roundabouts
- Raised Crosswalks
- Driver Speed Limit Feedback Signs
- Transverse Rumble Strips

Speed Humps

Speed humps are a vertical traffic calming device used to reduced vehicle speeds on low volume, low speed roadways. They are typically 12- to 22-feet long and 3- to 4-inches high with the two main types being the Watts Profile and the Seminole Profile (also referred to as a speed table). It is important to note the distinction between speed humps and speed bumps. Speed bumps are the much shorter design and can be traversed at high speeds. Speed bumps are prohibited on Army installations by regulations (AR 420) but are also strongly discouraged on any military roadway with the exception of low volume roadways such as an alley. The summary table in figure 1 below describes the two types of speed humps and speed bumps.

Figure 1 Speed Bumps vs. Speed Humps

Type of Device	SPEED BUMP	SPEED HUMP (WATTS PROFILE)	SPEED HUMP (SEMINOLE PROFILE)
			
Size	• 1- to 3-feet long • 3- to 6-inches high	• 12-feet long • 3- to 4-inches high	• 22-feet long • 3- to 4-inches high • Also called speed tables
Application	• NOT RECOMMENDED • Prohibited on Army installations	• Recommended only for local/residential streets having less than 3,500 vehicles per day, and a speed limit of 30 mph or less • Not recommended for major emergency service routes	• Appropriate for streets with ADT volumes of up to 6,500 vehicles per day • Many jurisdictions also permit the use of Seminole speed humps on emergency response routes
Design Speeds	• At low speeds, the driver and vehicle occupants experience discomfort • At high speeds, some vehicles can traverse speed bumps easily since the vehicle's suspension quickly absorbs the impact	• Designed to slow vehicles to 15-20 mph at each hump and 25-30 mph in between properly spaced humps • Smoother to traverse when traveling at lower speeds than at higher speeds	• Because of its gentler profile, the Seminole speed hump has a design speed of 25-30 mph at the hump, and approximately 35 mph in between humps • Smoother to traverse at lower speeds than at higher speeds
Speed Reduction	• Dependent upon vehicle type and speed	• Reduces vehicle speeds by about 8 mph in the vicinity of bumps	• Reduces vehicle speeds by about 6.5 mph • Studies show that vehicle speeds at the hump and in between the hump are not significantly difference
Volume Reduction	• Unknown	• Volumes are reduced, on average, by about 18%	• Volumes are reduced, on average, by about 12%
Note: Army Regulation 420-1 Section 7-16 states: "Hazardous features such as transverse ridges, speed bumps, or dips on pavement surfaces will not be installation or maintained as a means of controlling or reducing the speed of traffic." This regulation applies to speed bumps on Army installations. Speed humps can still be used			

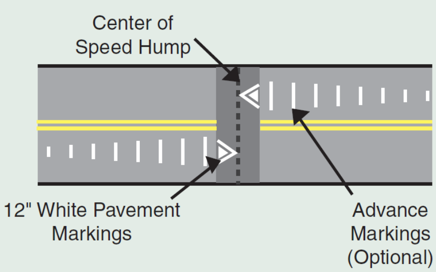
When installing speed humps, it is important to ensure the proper signing and pavement markings are used to delineate them. Other important factors include speed hump spacing, proximity to intersections, and roadway geometry, bicycles and drainage, emergency vehicles, and noise as shown in figure 2 below.

Figure 2 Considerations for Speed Hump Applications

SIGNING

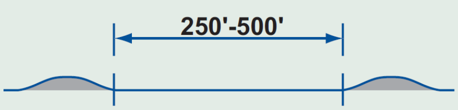
- The SPEED HUMP (W17-1) sign should be used to give warning of a vertical deflection in the roadway that is designed to limit the speed of traffic. If used, the SPEED HUMP sign should be supplemented by an Advisory Speed plaque (W13-1). If a series of speed humps exists in close proximity, an Advisory Speed plaque may be eliminated on all but the first SPEED HUMP sign in the series for either direction.

PAVEMENT MARKINGS



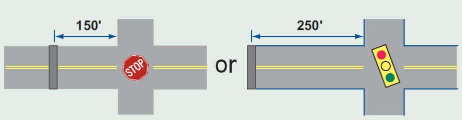
- Speed hump markings consist of 12-inch white markings as illustrated. Two other allowable configurations exist as shown in the MUTCD (Section 3B.25). Advanced speed hump markings, which shall be white, may be used in advance of a speed hump where added visibility is desired or where deflection is not expected.

NUMBER AND SPACING



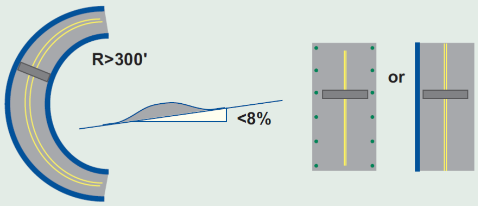
- A single hump will act as point speed control. To reduce speeds along an extended section of street, a series of humps is usually needed. Humps should be placed 250 to 500 feet apart. One study shows that placing speed humps at intervals of 275 feet resulted in 85th-percentile speeds of 25 mph; intervals of 550 feet resulted in 85th-percentile speeds of 30 mph.

PROXIMITY TO INTERSECTIONS



- Normally, humps should not be placed within 150 feet of an unsignalized intersection, or 250 feet of a signalized intersection.

Figure 2 Considerations for Speed Hump Applications (continued)

GEOMETRIC ISSUES 	• Curves—Speed humps should only be used on curves if the radius is greater than 300 feet. • Grade—Humps should be installed on streets with a grade less than 8 percent. • Curbing—Humps should only be installed on streets with curbing unless obstructions such as signing or flexible delineator posts prevent drivers from driving around a hump.
BICYCLES AND DRAINAGE 	• Ideally, speed humps should extend across the roadway from curb to curb. Bicyclists generally prefer this design, and it prevents motorists from driving with one wheel in the gutter. However, if drainage cannot be accommodated in the preferred design, the hump can be altered to allow drainage around the hump and to the nearest inlet.
EMERGENCY VEHICLES 	• Watts humps delay emergency vehicles anywhere from 1 to 10 seconds, with most delays in the range of 3 to 7 seconds. • Seminole humps delay emergency vehicles by approximately 1 second.
NOISE 	• Although speed humps may create noise from vehicles passing over them, the overall noise levels on the street may be reduced because of reduced vehicle speeds.

Speed Hump Applications at ECFs

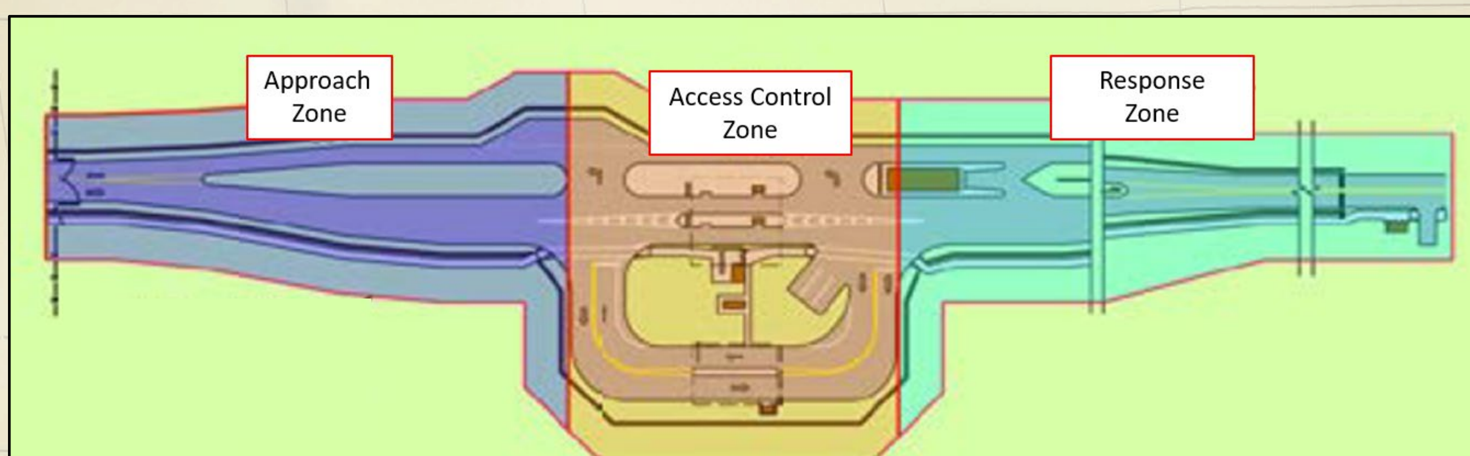
While speed humps are commonly found in residential areas and other low volume roadways, they can also be used at ECFs. Although SDDCTEA has done extensive testing that shows speed humps do not have a significant impact on threat vehicles (i.e., they do not affect the placement of active vehicle barriers), they can be useful for gauging the intent of a motorist and reducing the speeds of non-threat vehicles both in the inbound and outbound directions prior to the ID checkpoint.

Some guidelines for implementing speed humps at ECFs are shown below. Note that the guidelines assume that there are no major geometric measures already in place (i.e., chicanes, roundabouts, etc.) to reduce vehicle speeds. In these cases, speed humps are not recommended since the geometry should already reduce vehicle speeds and the addition of speed hump would have negative impacts on operations.

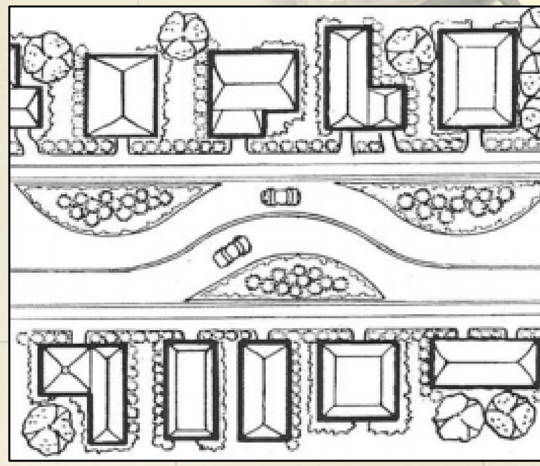
ECF Zone*	Guidelines
Approach Zone – Installation boundary to a point just before the ID checkpoint.	• In most cases, a single speed hump is appropriate. • Place at least 150 feet from the ID checkpoint. • For approach zones greater than 400 feet, an additional set of speed humps can be installed to keep vehicle speeds below 25 mph throughout the zone. • Speed humps should not be placed in the outbound direction since they can meter traffic into the adjacent intersection external to the ECF.
Access Control Zone – A point just before and after the ID checkpoint.	• Speed humps should not be placed in the inbound direction as it can only cause inefficiencies in operation at the ID checkpoint. • In most cases, a single speed hump is appropriate for the outbound direction just before the ID checkpoint to reduce the speed of vehicles as they pass the ID check area.
Response Zone – A point just after the ID checkpoint to the active vehicle barriers.	• Speed humps are not recommended in the response zone for the inbound direction since they would have no effect on response time or the safety of the ECF personnel. • Speed humps can be placed in the response zone for the outbound direction to reduce vehicle speeds as they approach the ID check area.

* Refer to figure 3 for an illustration of the ECF zones.

Figure 3 ECF Zones



Chicanes



A chicane is a serpentine curve used to reduce vehicle speeds and typically provides horizontal deflection by using buildouts or introducing curvature along the roadway. SDDCTEA does not recommend using in-roadway bollards or barriers to create a chicane on a tangent section of roadway. A chicane is most appropriate on two-lane, two-way streets or one-lane, one-way local streets. A chicane can allow for landscaping improvements in the areas not taken up with pavement. However, it is important to use low-lying shrubs and vegetation so that sight lines are not obstructed; this applies to any objects placed in these areas. It is also crucial to utilize retroreflective pavement markings to properly delineate the chicane during nighttime conditions.

Chicane Applications at ECFs

For a chicane to be effective at limiting the maximum attainable speed of a threat vehicle in an ECF area, 8-inch curbing or passive barriers must be used. SDDCTEA studies have shown that vehicles traveling more than 25-mph will become disabled when striking 8-inch curbing; however, a vehicle can traverse the curbing at very low speeds. This is acceptable since the function of the 8-inch curb is to mitigate the high speeds of a high-speed threat vehicle.

Eight-inch curbing with a foundation can be used to outline the roadway edge and restrict the path of a threat vehicle. To create a chicane on an existing tangent section of roadway, 8-inch curbing can be placed within the roadway and doweled in the pavement. It must be noted that the **8-inch curbing does not function as a passive barrier.** A compliant passive barrier system must still be provided for the ECF perimeter. If there are concerns about drainage or plowing snow with the high curbing, a chicane without curbing can be supplemented by strategically placed passive barrier segments.

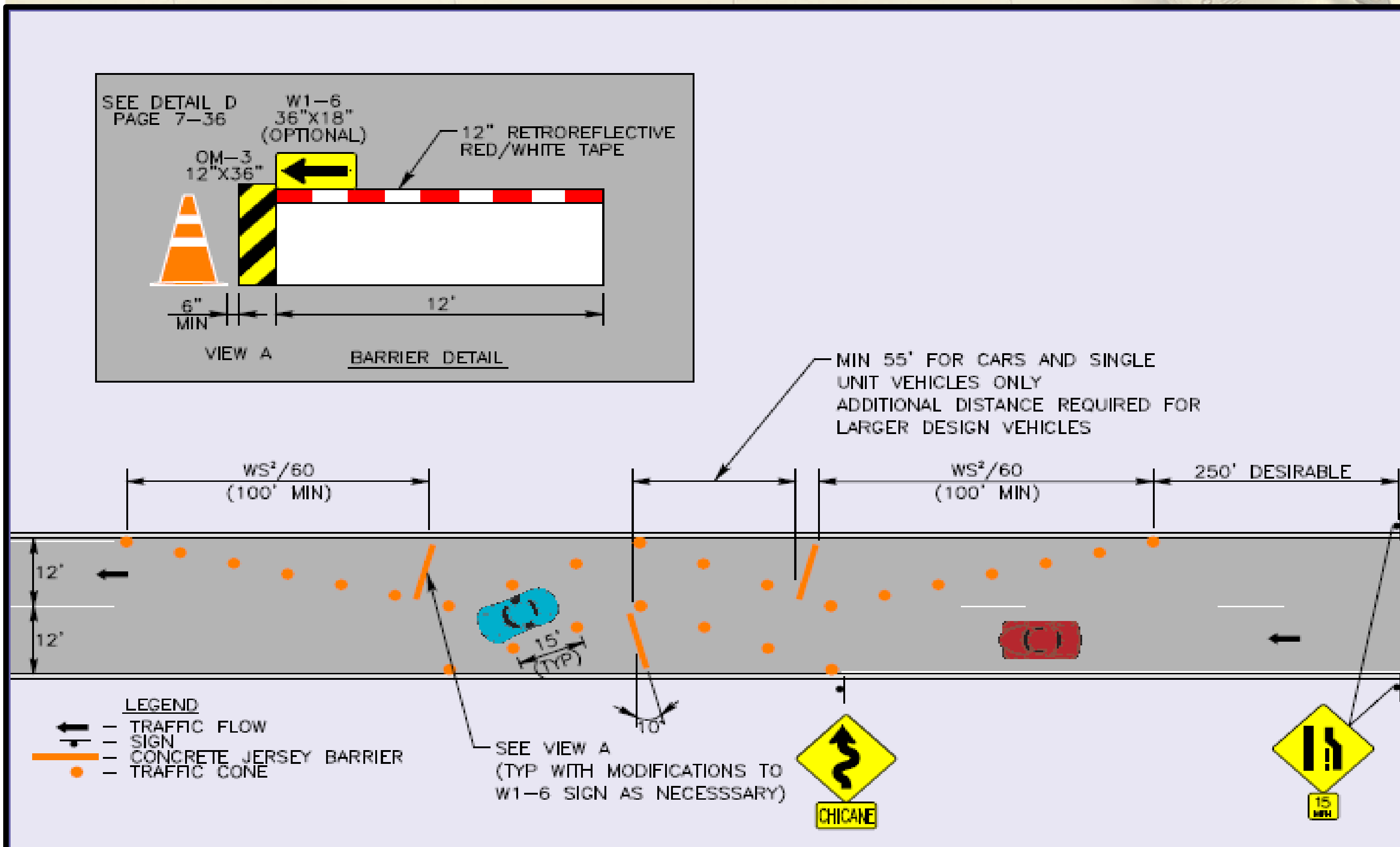
In-roadway bollards or barriers have been deployed at numerous military installations in order to provide security benefits by limiting vehicular speeds and movements. SDDCTEA does not endorse the use of in-roadway bollard or barrier systems and encourages other design options to address security concerns (e.g., installing 8-inch curbing doweled into the pavement). However, installations often see it as the only temporary means of controlling traffic before a permanent fix can be installed. In addition to this bulletin, SDDCTEA's Pamphlet 55-15 offers guidance on the suitability, layout, spacing, and delineation of barrier placements to promote traffic safety.

In-Roadway Barriers (Not Recommended)

In-Roadway Bollards (Not Recommended)

If existing systems are in use and must remain in use, they shall be delineated as shown in the following figures.

Figure 4 Traffic Control Plan for Jersey Barrier System and Bollard System



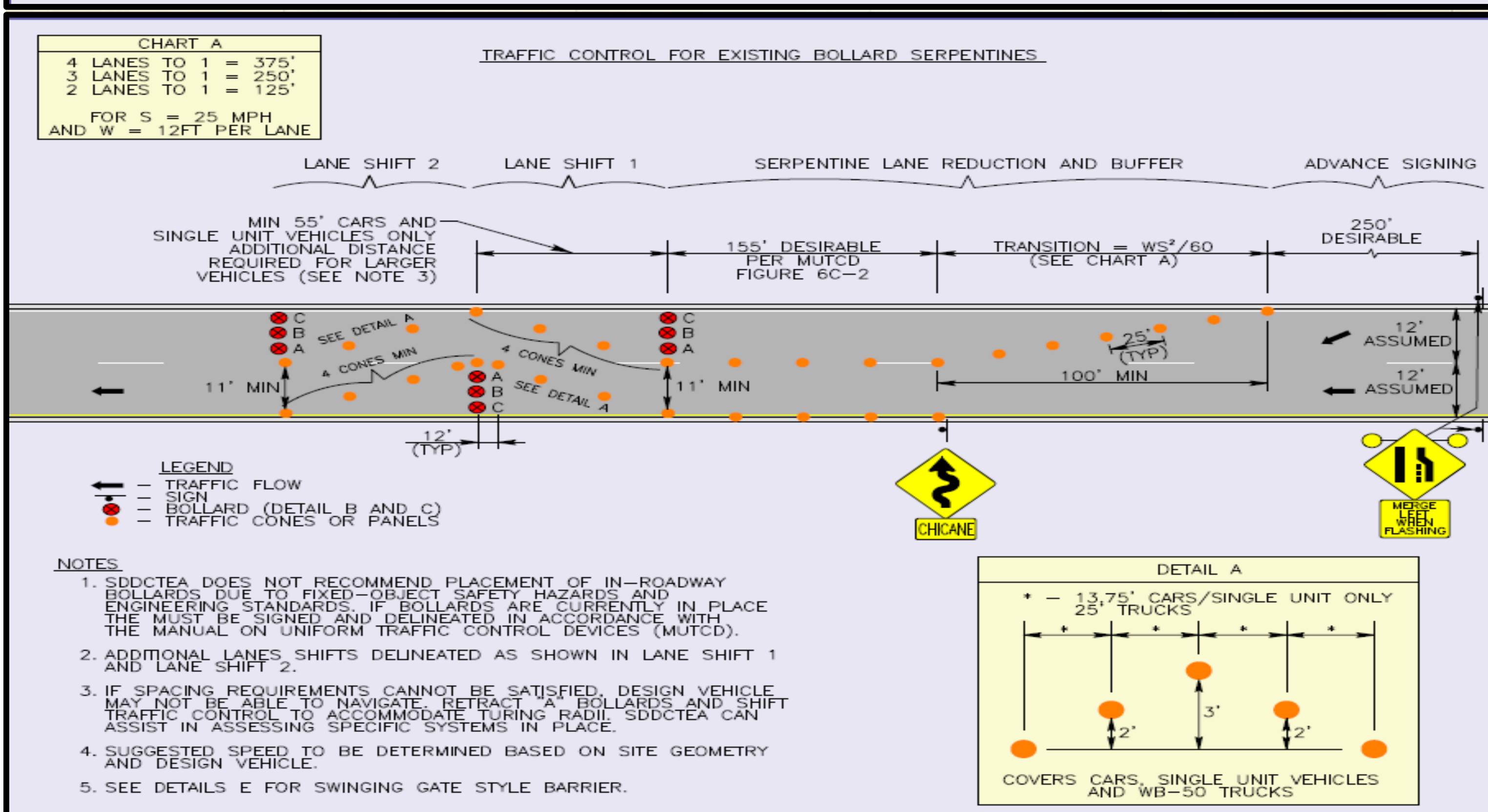
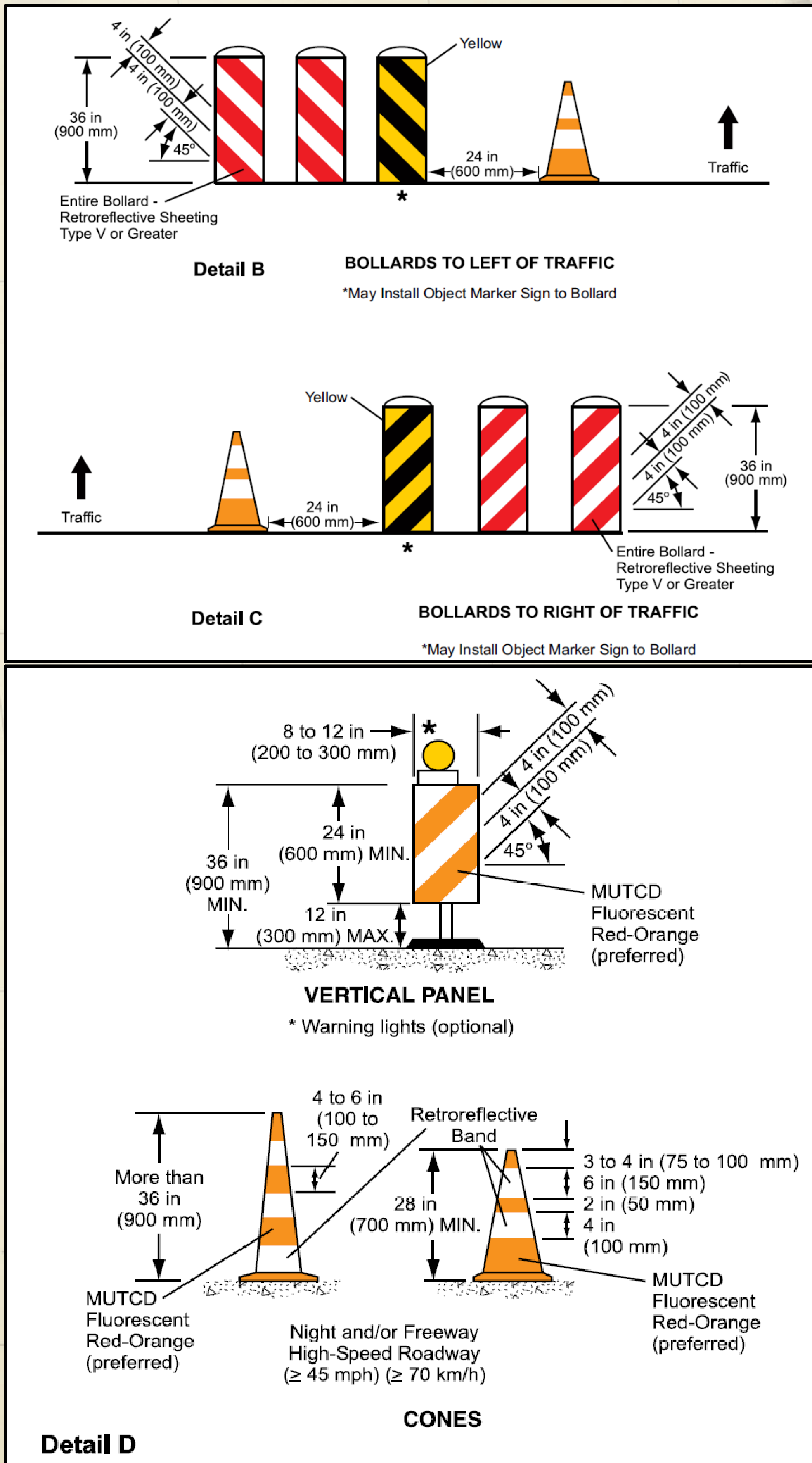


Figure 5 Details for Bollard Serpentine System



Roundabouts

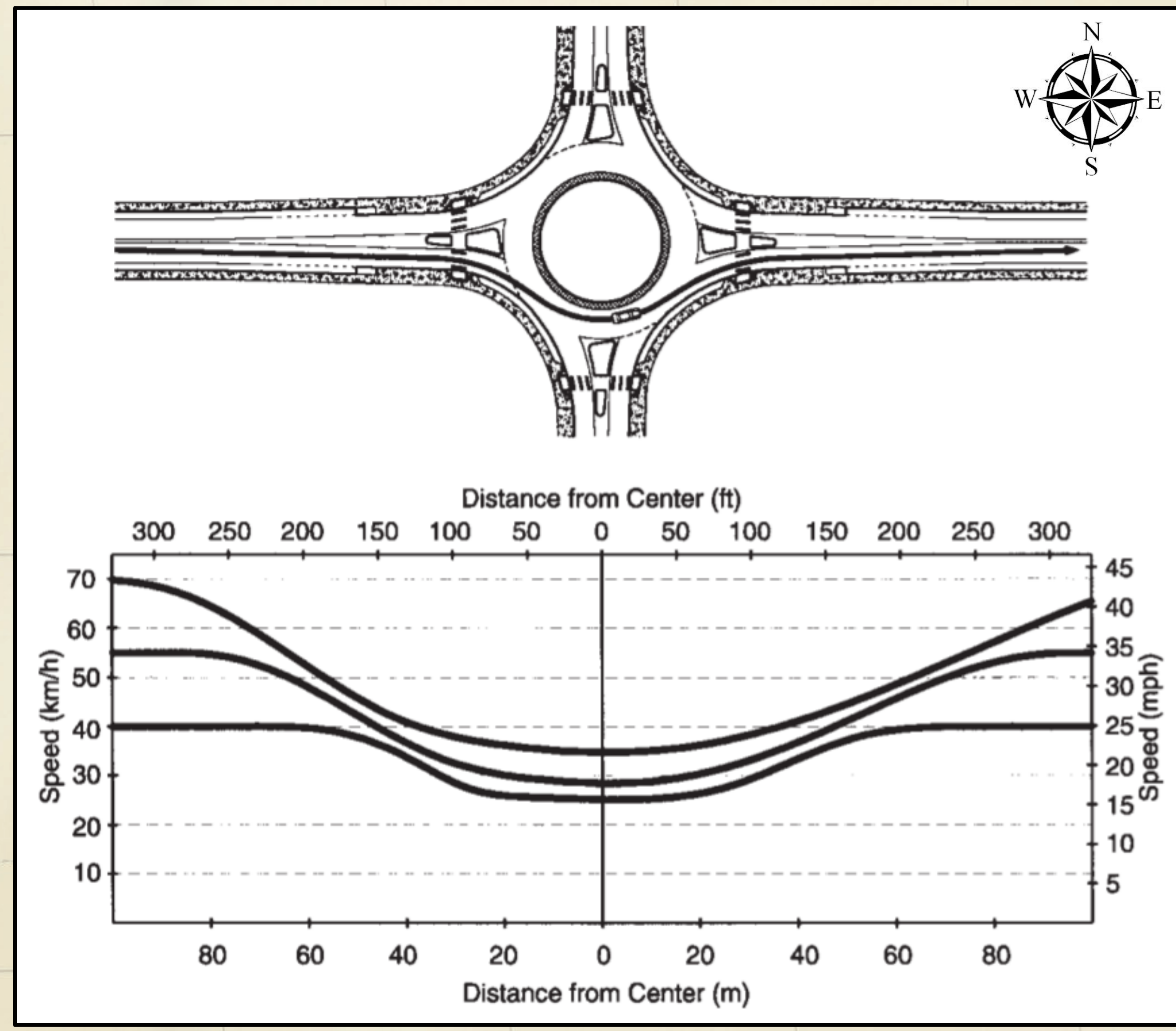
A roundabout is a channelized intersection at which all traffic moves counterclockwise around a central traffic island. They can be used to reduce vehicle conflicts at intersections with balanced approach volumes that satisfy multiway stop warrants or traffic signal warrants when either of these improvements are not desired. They can be aesthetically pleasing but are costly to construct but may provide an acceptable benefit-to-cost ratio due to the minimal costs to maintain as compared to maintain and operate a signalized intersection.

. Two key characteristics of any roundabout include:

- Entering traffic must yield to circulating traffic.
- Each approach has a splitter island designed to slow traffic and to ensure that all vehicles travel in the proper direction around the central island.

Roundabouts come in different sizes depending on the traffic volume, available footprint, and design vehicle. The geometry coupled with the yield condition at each approach can have a significant reduction in travel speeds. Figure 6 shows the speeds (25, 35, and 45 mph) of typical vehicles approaching and negotiating a roundabout in the eastbound direction. Deceleration begins before this time, with circulating drivers operating at approximately the same speed (i.e., between 15 mph and 25 mph) in the roundabout.

Figure 6 Sample Theoretical Speed Profile at Roundabouts

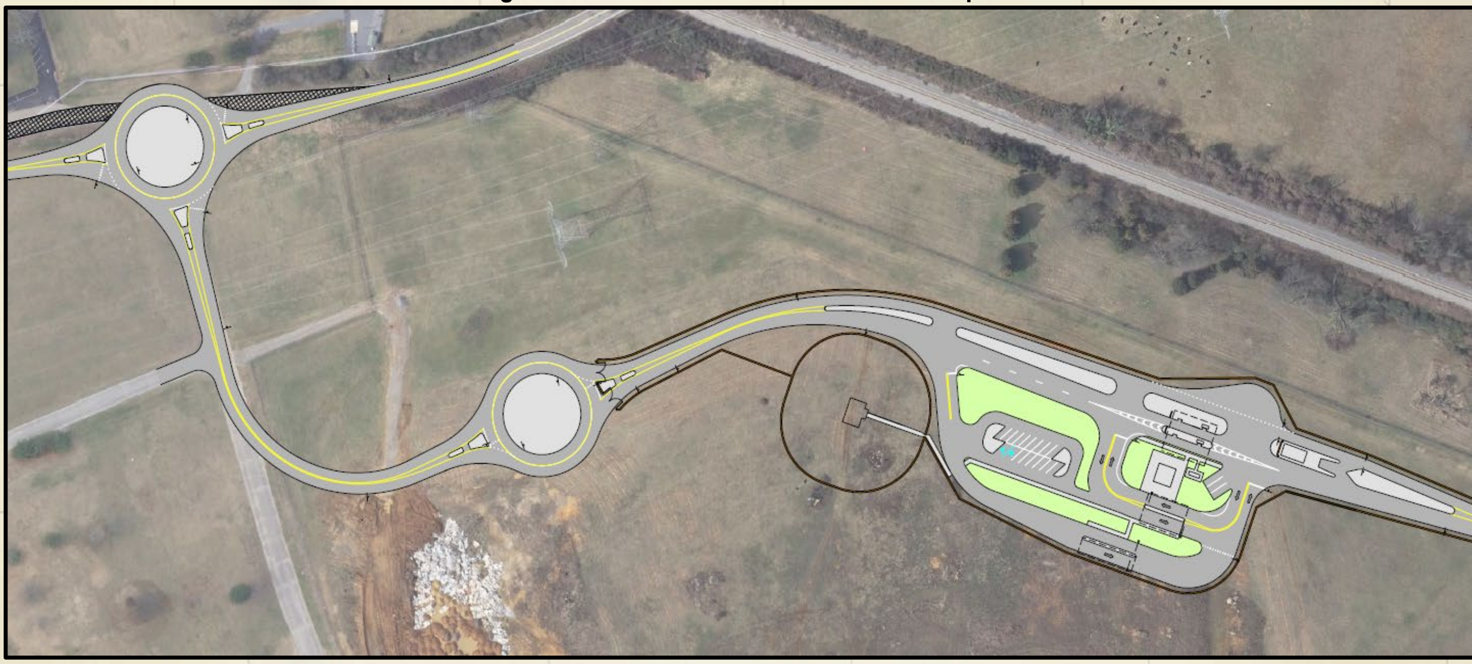


Source: Roundabouts: An Informational Guide, FHWA

Roundabout Applications at ECFs

While roundabouts are typically used at intersecting roadways, they can also be used on a tangent section of roadway to introduce roadway curvature and thereby reduce speeds. Figure 7 shows an example of two roundabouts used in an ECF design: one at the intersection external to an ECF and the other used in the approach zone of the ECF. Since a turnaround prior to the ID check is required by UFC 4-022-01, the roundabout can fulfill this requirement if designed for rejecting a commercial vehicle (AASHTO Wheel Base (WB)-67). Like the chicane, roundabouts have the potential to reduce the speed of a threat vehicle if curbing is utilized around the central traffic island.

Figure 7 Roundabout at ECF Example



Raised Crosswalks

Raised crosswalks are elevated crosswalks that bring added attention to mid-block pedestrian crossings. They are also effective at reducing vehicle speeds and have the same functionality as a speed table in terms of speed reduction. Often these devices are combined with bulb-outs to enhance pedestrian crossings. A raised crosswalk is typically between 3 and 6 inches above street level. It is common for a raised crosswalk to be level with the street curb. This height increases the visibility of a pedestrian in a crosswalk to a motorist. It also improves the line of sight for a pedestrian toward an oncoming vehicle.

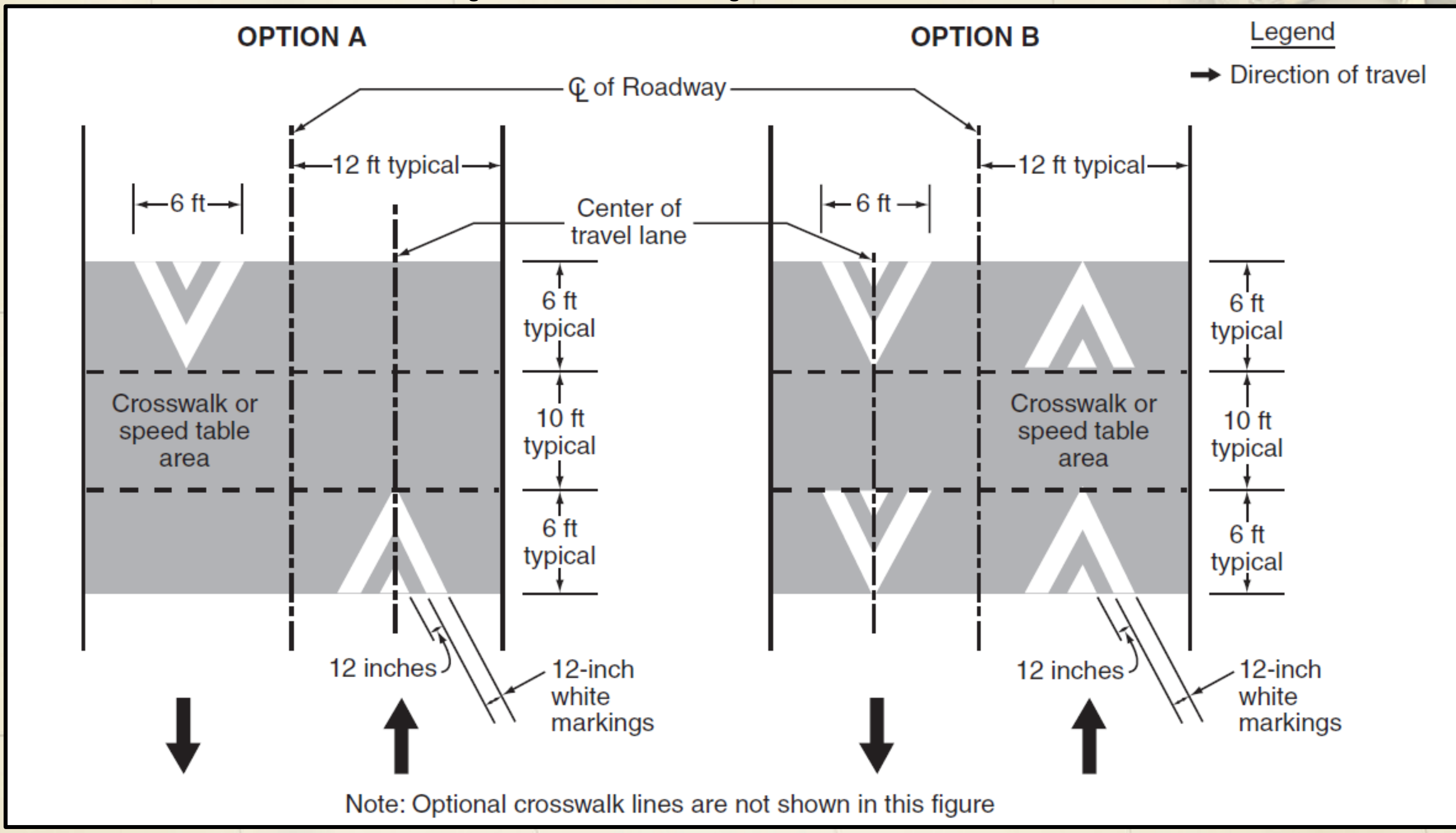
There are two distinct raised crosswalk designs. Both use a modified version of the common 22-foot speed table:

- The most common type is constructed flush against the roadside curb.
- The other type is constructed on an open section (requiring a curb ramp on the raised crosswalk) or separate from the curb (requiring a curb ramp on both the curb and the raised crosswalk).

Raised crosswalks are appropriate for local streets and minor collectors with volume less than 10,000 vehicles per day. When determining the placement of raised crosswalks and whether a crossing is warranted, consult SDDCTEA's Crosswalk Guidelines found here: https://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pamphlets/SDDCTEA_Pamphlet_55-17%20Addendum.pdf.

The pavement markings should follow the standards in the 2009 MUTCD as shown in figure 8.

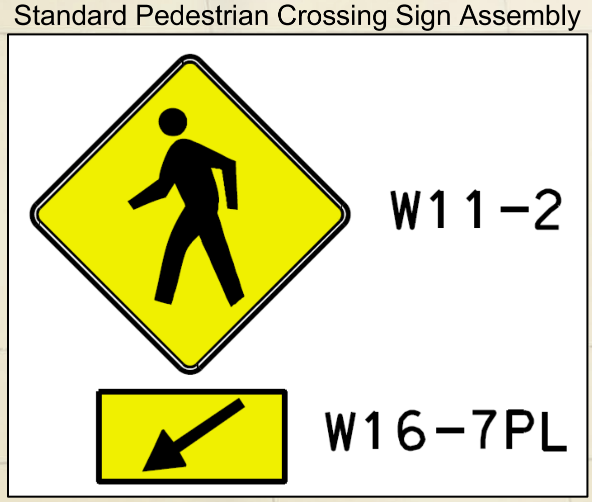
Figure 8 Standard Markings for Raised Crosswalks



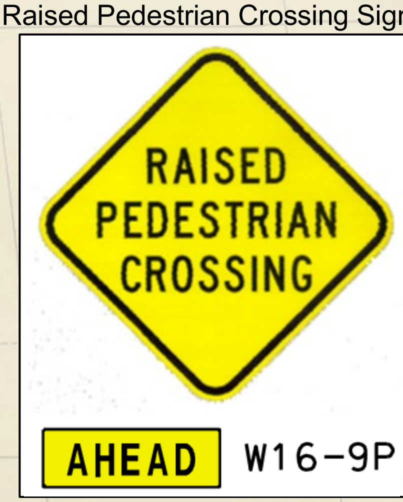
Source: 2009 MUTCD

There is no standard signage for a raised crosswalk in the 2009 MUTCD. However, if the raised crosswalk is located at an uncontrolled location (no stop/yield sign or signals) a Pedestrian Crossing sign (W11-2) and Downward Diagonal Arrow plaque (W16-7P) should be provided at the location of the raised pedestrian crosswalk. It is recommended that a Raised Pedestrian Crossing Warning Sign with an AHEAD plaque (W16-9P) be used in advance of each raised pedestrian crossing. For illustrations of the signs to use for a rasied crosswalk, refer to the drawings below.

Standard Pedestrian Crossing Sign Assembly



Modified Raised Pedestrian Crossing Sign Assembly



Driver Speed Limit Feedback Signs

Source: Unknown

The posted speed limit is the numerical speed limit noted on regulatory signs placed along the roadway to which it applies. The basic reason to have a posted speed limit is to encourage speed uniformity and to provide a means to prosecute the few drivers that travel at excessive speeds and jeopardize the safety of others. It is important to ensure that speed limit signs are posted in the proper locations to make motorists more aware of the speed limit. Driver speed limit feedback (changeable message) signs are one method of increasing awareness of the speed limit.

These signs are used to reduce vehicle speeds, and therefore crashes and crash severity, by giving drivers who are traveling over the posted or advisory speed a targeted message such as “YOUR SPEED XX” or “SLOW DOWN.” They include a speed-measuring device, which consists of loop detectors or radar, and a message sign that displays feedback to those drivers who exceed a predetermined speed threshold. The feedback can include displaying the driver’s actual speed, showing a message such as SLOW DOWN, or activating some warning device, such as beacons. According to FHWA’s *Engineering Speed Management Countermeasures: A Desktop Reference of Potential Effectiveness in Reducing Speed*, driver speed limit feedback signs have been shown to reduce average speeds by 1 to 6 mph. The color of the changeable message legend should be a yellow legend on a black background or the reverse of these colors.

Before implementing driver feedback signs, installation stakeholders should first ensure that the speed limit signs are correctly posted and are enforceable to encourage compliance. The speed limits should be set to the statutory speed limits found in the state code that the installation resides in. Where statutory limits do not fit specific road, traffic, or land uses conditions, most road authorities have the power to establish speed zones to reflect the safe maximum reasonable speed; a process commonly known as speed zoning. Refer to SDDCTEA’s bulletin on Speed Limits for more information about specific state statutory speed limits and speed laws. If driver compliance with the posted speed limits remains an issue, driver feedback speed limit signs can be installed.

Transverse Rumble Strips


Source: Texas Department of Transportation

Rumble strips are a series of either bumps or depressions in the pavement. They are intended to alert drivers of a special situation, such as a speed reduction or stop ahead condition. They are typically 1/2 to 1 1/2 inches high or deep, 3- to 4-inches wide and placed 90 degrees to traffic flow.

Rumble strips produce both an audible rumble and a vibration that creates an awareness of a condition for which a driver must react. They are used most frequently on shoulders of high-speed roadways to alert drivers that they are not driving in the travel lanes of a road. They are also commonly installed transversely to alert drivers in rural or high-speed areas of an unexpected stop-ahead condition.

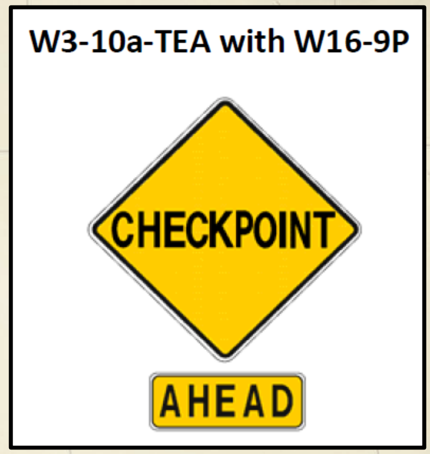
Some research has been conducted on transverse rumble strips. The Minnesota Department of Transportation conducted a series of three studies that evaluated the strips on approaches to stop-controlled intersections; this would be most applicable for ECFs since motorists must come to a stop.

In all three studies, drivers reduced speed earlier and to a greater extent at intersections with rumble strips. The three studies provide compelling evidence that in-lane rumble strips promote safer stopping behavior on approaches to stop-controlled intersections. Stopping behavior is safer when rumble strips are installed because drivers slow down earlier on the approach and thus they have more time to respond to an unexpected event (e.g., a slippery road surface).

The Texas Department of Transportation and FHWA conducted a similar study at rural intersections. In order to gauge the effectiveness of in-lane rumble strips on driver speeds, rumble strips were installed on 14 approaches to rural intersections. An analysis of the speed data revealed a small and statistically significant decrease, generally 1 to 2 mph in mean and 85th percentile speeds on the approaches. The largest difference in mean speeds occurred between two sets of rumble strips.

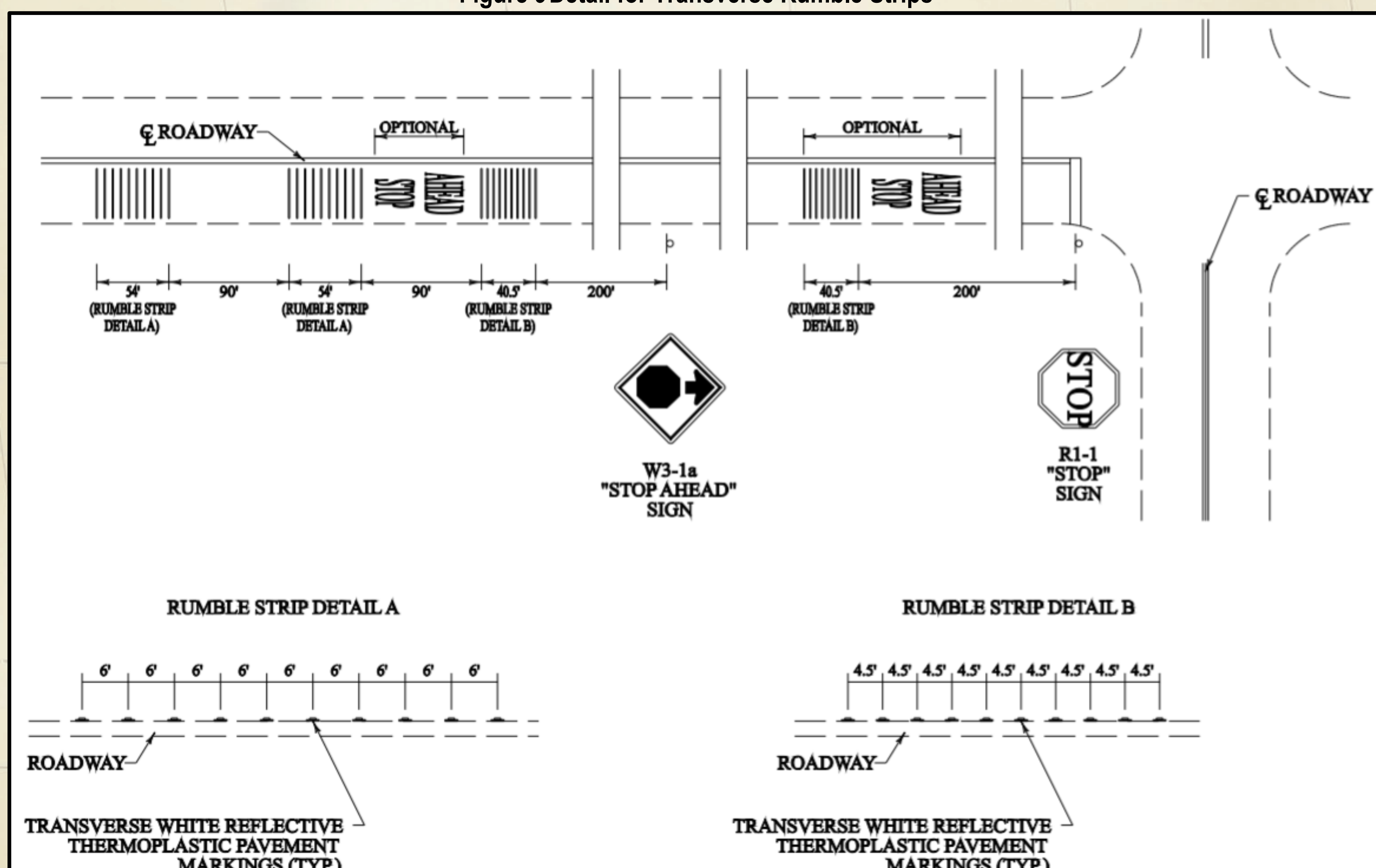
Transverse Rumble Strips Design Guidelines

Several state departments of transportation (DOTs) have developed design guidelines for transverse rumble strips. Below are some examples of details developed by Minnesota DOT and Maryland DOT. Initially, Minnesota used a full-lane width pattern. The pattern was changed to a wheel path pattern so that motorists who are aware of the rumble strips (i.e., local drivers) and bicyclists could avoid the pattern. An approach to a stop-controlled intersection can have up to five sets of strips, but a minimum of three sets are recommended.



The design guidelines are intended for use at stop-controlled intersections. For ECFs, the same design guidelines can be used; but the CHECKPOINT (W3-10A-TEA) sign with AHEAD (W16-9P) plaque should substitute the STOP AHEAD sign. The two common rumble strip styles are the milled style and the rolled or formed style; both are appropriate for ECFs. Rumble strips applied to the surface are for temporary situations such as work zones and are not approved for ECFs. When considering the placement of rumble strips, ensure that they are placed far enough advance of the ID checkpoint so the sound created does not interfere with the guard's ability to communicate. Additionally, they should not be placed in a ECF that is adjacent to residential areas where the noise can disturb residents.

Figure 9 Detail for Transverse Rumble Strips



Traffic Calming Considerations

A multitude of traffic calming techniques are provided in this bulletin and sometimes it can be unclear which are most appropriate (if at all) for any given location on a military installation. Traffic calming measures should typically be considered only after:

- Education and enforcement efforts have failed to produce the desired results.
- Existing traffic conditions have been thoroughly analyzed.
- The necessary approvals have been received by installation authorities and/or by the local DOT if the roadway is not owned by the installation.

SDDCTEA recommends that a qualified engineer should gather the appropriate traffic data, analyze the data, and identify what (if any) traffic calming techniques are appropriate. In cases where a horizontal deflection traffic calming device such as a chicane or roundabout is used to mitigate the speed of a high-speed threat vehicle in an ECF area, a qualified engineer must conduct an analysis according to the requirements and guidelines in UFC 4-022-01 to ensure threat containment design specifications are met.

An evaluation should also be conducted to determine whether the traffic calming implementation was a success in addressing the problem or issue that prompted the development. Speed and volume are likely to be the primary metrics used to assess the effects of the measure. The data will help the stakeholders and community learn from the project and make decisions for implementation at similar locations. The evaluation could also lead to refinement of the plan – including the removal, relocation, or redesign of a measure.

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