ROADWAY COUNTERMEASURES

ACCESS MANAGEMENT

DESCRIPTION

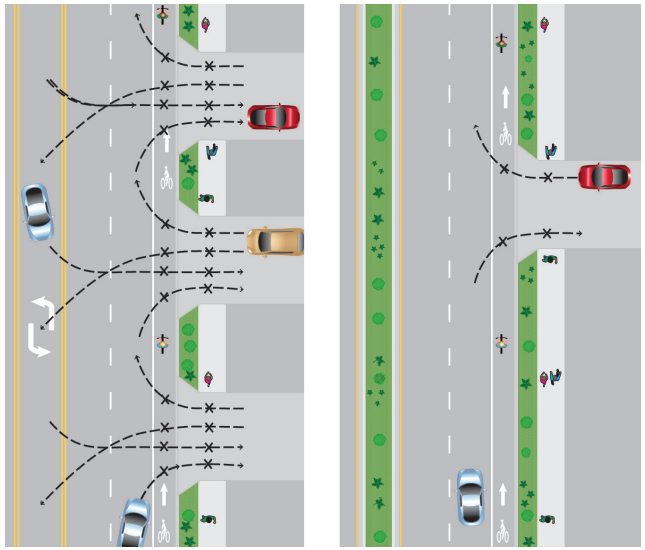
Most conflicts between users occur at intersections and driveways. The presence of many driveways in addition to the necessary intersections creates many conflicts between vehicles entering or leaving a street and bicyclists and pedestrians riding or walking along the street.

KEY DESIGN FEATURES

> When possible, new driveways should be minimized and old driveways should be eliminated or consolidated
> Raised medians should be placed to limit left turns into and out of driveways

BENEFITS

> Number of conflict points is reduced
> Pedestrian crossing opportunities are enhanced with a raised median
> Universal access for pedestrians is easier, since the sidewalk is less frequently interrupted by driveway slopes
> Result in more space available for higher and better uses
> Improved traffic flow may reduce the need for road widening



APPLICATIONS

> New development
> Redevelopment
> Where driveways make sidewalk inaccessible based on ADA guidelines

BUS LANES

DESCRIPTION

Bus lanes are dedicated lanes for buses only.

KEY DESIGN FEATURES

> "Bus Lane" pavement markings with a solid white stripe
> Bus lane signs with instructions as to the days and times that apply
> "Bikes OK" text on the signs

BENEFITS

> Reduce side-swipe, rear-end and left-turn crashes (as with road diets)
> Reduce speeding
> Reduce aggressive acceleration
> Reduce hard braking events
> Speed up buses
> Improve entry and exit from bus stops

APPLICATIONS

> Along bus routes with frequent service
> Along bus routes where buses are slowed by traffic

CENTERLINE RUMBLE STRIPS/EDGE LINE RUMBLE STRIPS

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

Center or edge line rumble strips are longitudinal safety features installed at or near the center line of a paved roadway. They are made of a series of milled or raised elements intended to alert inattentive drivers (through vibration and sound) that their vehicles have left the travel lane. In most cases, the center or edge line pavement marking is placed over the rumble strip.

KEY DESIGN FEATURES

- Rumble strips could be milled-in, raised, rolled-in, and formed
- Typically, only milled rumble strips are used in center line applications
- Considerations to be given for road joints and crowns
- Lateral width is six inches to 12 inches Longitudinal milling pattern is five inches groove + or – one inch; depth should be no greater than 5/16-inch + or - 1/16-inch

BENEFITS

- Effective for roads with head-on and opposite direction sideswipe crashes
- Aid in navigation during inclement weather

APPLICATIONS

- Consider corridor-wide or system-wide applications rather than spot applications in areas with where speeds are above 50 mph and lane plus shoulder width are above 14 feet
- Consider all road users particularly bicyclists, motorcycles, and truck drivers

CONVERT TO ALL-WAY STOP CONTROL

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

All-way stop control is suitable only at intersections with moderate and relatively balanced volume levels on the intersection approaches. Under other conditions, the use of all-way stop control may create unnecessary delays and aggressive driver behavior (e.g., deliberate ignoring of the stop control).

KEY DESIGN FEATURES

> Based on an engineering study that considers approach volumes (including pedestrians and bicyclists) as well as traffic patterns and sight distances
> Use supplemental plaques such as "ALL WAY" Sign

BENEFITS

> All-way stop control can reduce right-angle and turning crashes at unsignalized intersections
> Can reduce through and turning speeds, and minimize the safety effect of any sight distance restrictions that may be present

APPLICATIONS

> Locations with a need to control left-turn conflicts
> Locations with a need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes
> Locations with limited sight visibility for cross-traffic
> Locations where an all-way stop could improve traffic operational characteristics of the intersection
> Locations with high or severe crash history that could be mitigated by converting to an all-way stop control

FLASHING BEACONS AS WARNING TO AN INTERSECTION (SIGNALIZED AND NON-SIGNALIZED)

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

Flashing beacons can be used at both signalized or stop-controlled intersections. For signalized intersections, they provide advance warning of an upcoming signalized intersection especially in locations with sight distance restrictions (curves, hills, etc). For unsignalized intersections, flashing beacons reinforce the awareness of the STOP control.

KEY DESIGN FEATURES

- Flashing beacons can be designed in such a way that they flash all the time or only when a sensor detects a vehicle approaching the intersection (an actuated beacon)
- Beacons can be installed either overhead, or mounted directly onto a STOP sign (or on a pedestal for signalized intersections)
- Some actuated overhead beacons are supplemented with a sign that indicates, "Vehicles Entering When Flashing"
- Need to be placed far enough in advance of the intersection for motorists to react

BENEFITS

- Enhance the visibility and awareness of intersections
- Have the potential to reduce the number of crashes associated with drivers' lack of awareness

APPLICATIONS

- At signalized intersections with crashes that are a result of drivers being unaware of the intersection or are unable to see the traffic control device or back of the queue in time to react and comply
- At unsignalized intersections flashing beacons can help mitigate patterns of right-angle crashes related to stop sign violation. This is especially true in rural areas where there may be long stretches between intersections as well as locations where night-time visibility of intersections is an issue.

GUARDRAILS AND IMPACT ATTENUATORS

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

Guardrails redirect errant vehicles away from embankment slopes or fixed objects and dissipate the energy.

Impact attenuators are typically used to shield rigid roadside objects such as concrete barrier ends, steel guardrail ends and bridge pillars from oncoming automobiles. Attenuators bring an errant vehicle to a more-controlled stop or redirect the vehicle away from a rigid object.

KEY DESIGN FEATURES

> The guardrail itself, the posts, the soil that the posts are driven in, the connection of the guardrail to the posts, the end terminal, and the anchoring system at the end terminal impact the performance of the guardrail
> Attenuators should only be installed where it is impractical for the objects to be removed. Consideration should be given to ongoing maintenance

BENEFITS

> Guardrails and Impact attenuators are effective at absorbing impact energy and increasing occupant safety
> They tend to draw attention to the fixed object, which helps drivers steer clear of the fixed objects

APPLICATIONS

> On embankment slopes
> To protect fixed objects

HIGH-FRICTION SURFACE TREATMENTS

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

High friction surface treatments (HFST) are pavement treatments that mitigate the reduction in pavement friction during wet conditions or due to vehicle speeds or roadway geometrics. HFST involve the application of very high-quality aggregate to the pavement using a polymer binder to restore and/or maintain pavement friction at existing or potentially high crash areas.

KEY DESIGN FEATURES

- HFST can be applied by machine or with hand tools, but the road surface must be durable with few to no cracks and crumbling
- While the initial costs are usually higher than conventional pavement, the long-lasting durability of and their limited use in critical locations makes HFST a low-cost option over its life cycle

BENEFITS

- The higher pavement friction helps motorists maintain better control in both dry and wet driving conditions

APPLICATIONS

- Locations where drivers may brake excessively such as steep hills, curves, loop ramps, intersections, and areas with short stopping or weaving distances

IMPROVE SIGNAL HARDWARE

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

Signal hardware countermeasures include a variety of signal treatments such as adding yellow retroflective borders to signal backplates, upgrading to 12-inch lenses, adding additional heads, converting signals from pedestal mounted to mast arms, supplemental pole-mounted signals on the near approach, as well as using visors and louvers among others.

KEY DESIGN FEATURES

- Typically do not require significant labor material or design costs
- Backplate retroflective tapes are available with adhesive backing which enables retrofitting of existing backplates
- Weight considerations are necessary when adding signals to existing mast arms or new longer reach structures
- Adhere to MUTCD guidelines when upgrading or retrofitting

BENEFITS

- Retroflective borders enhance traffic signal visibility, conspicuity, and orientation; especially for both older and color-vision deficient drivers
- During periods of power outages when the signals would otherwise be dark, retroflective borders provide a visible cue for motorists
- Larger lenses and signals for each approach lane provide for better visibility
- Overhead signal displays provide better line-of-sights for motorists in mixed traffic
- Louvers block the view of the signal from another approach to avoid the confusion

APPLICATIONS

- Signalized intersections with visibility constraints due to natural conditions or presence of trucks that can block lines of sight
- Intersections with a skewed approach angle can benefits from installation of louvers

TRAFFIC SIGNALS

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

Traffic signals are used to assign right-of-way to the various modes, including pedestrians, bicycles, and vehicles. Signals promote the orderly movement of traffic and prevent excessive delay to traffic.

KEY DESIGN FEATURES

- Consideration to signalize an intersection should only be given after less restrictive forms of traffic control have been utilized as the installation of a traffic signal often leads to an increased frequency of crashes (rear-end) on major roadways and introduces congestion
- The CA MUTCD lists nine warrants for the placement of traffic signals

BENEFITS

- Traffic signals can be used to prevent the most severe type crashes (right-angle, left-turn)
- Provide for orderly movement of traffic.
- Increase traffic capacity of the intersection
- Reduce the frequency of certain types of crashes (e.g. right-angle crashes)
- Provide for continuous or nearly continuous movement of traffic along a given route
- Interrupt heavy traffic to permit other traffic, vehicular or pedestrian, to cross

APPLICATIONS

- At unsignalized junctions meeting signal warrants or where sound engineering judgment justifies signalization for safety and access management considerations as well as the spacing of signals on arterial roadways
- At pedestrian crossings where traffic volumes, number of travel lanes and/or speed make it unsafe to cross without a signal
- At locations where a trail crosses a street or road and where traffic volumes, number of travel lanes and/or speed make it unsafe to cross without a signal

INSTALL/UPGRADE LARGER OR ADDITIONAL STOP SIGNS OR OTHER SIGNS

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

Installing larger (30-inch compared to the standard 24-inch) or additional stop signs are low-cost treatment enhancements that increase the visibility of stop signs and can improve driver compliance.

KEY DESIGN FEATURES

> Larger (30-inch) stop signs with "Stop Ahead" advance traffic control sign and added pavement markings can help delineate traffic at the intersections

BENEFITS

> Help reduce the number and severity of crashes

APPLICATIONS

> Approaches to unsignalized intersections with patterns of rear-end, right-angle, or turning crashes related to lack of driver awareness of the presence of the intersection

LEADING PEDESTRIAN INTERVAL

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

Under a leading pedestrian interval, the "Walk" signal comes on before motorists receive a green signal.

KEY DESIGN FEATURES

> The duration should be at least three to six seconds and should be timed to allow pedestrians to cross at least one lane of traffic, or where there is a large turning radius, to travel far enough into the intersection to establish their position before turning motorists receive a green light
> Restrict right turns on red where needed
> Audio signals

BENEFITS

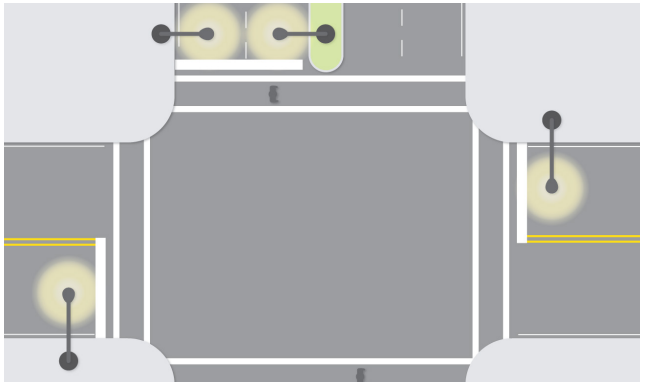
> Allows pedestrians to increase their changes of being seen
> Allows pedestrians more time to cross wide streets
> Allows pedestrians into an intersection where right-turning vehicles frequently block their path

APPLICATIONS

> Where pedestrians have difficulty entering signalized intersections to cross due to heavy turning traffic
> Where pedestrians have difficulty being seen in signalized intersections
> Where pedestrians have difficulty crossing wide streets within the allotted time

LIGHTING

HSIP SAFETY COUNTERMEASURE



DESCRIPTION

Intersection lighting illuminates the entire intersection well enough that approaching motorists can see all legs of the intersections sufficiently to avoid conflicts with other intersection users.

KEY DESIGN FEATURES

- Wider streets and streets with higher classifications have higher light level requirements
- There are many issues related to spacing, poles, number of luminaires, etc
- It is important to select the appropriate lighting fixture for each application, fixtures very greatly in style and function
- Light before pedestrian crossings to avoid back lighting pedestrians
- Refer to street light design standards to determine the lighting standards and select the appropriate make, wattage, lighting distribution, and mounting details

BENEFITS

- Improves visibility for motorists
- Improves personal safety for pedestrians
- Improves visibility of pedestrians and bicyclists
- Improves pedestrian comfort in commercial areas

APPLICATIONS

- At all intersections, except in rural areas
- At intersections in rural areas with a crash history, or a typology similar to where crashes have occurred
- At mid-block crossings
- At bus stops
- At pedestrian, vehicle and bike conflict and shared use areas
- School zones

LED-FLASHING STOP SIGN

DESCRIPTION

LED-Flashing Stop Signs heightens motorists' awareness and increases compliance.

KEY DESIGN FEATURES

- LED units may be used individually within the face of a sign and in the border of a sign
- LEDs units shall be red to go with stop signs; if flashed, all LED units shall flash simultaneously at a rate of between 50-60 times per minute
- LEDs visible during daytime and nighttime
- Commonly solar-powered and requires low power usage
- May be set to flash throughout the day or be vehicle- or pedestrian-activated

BENEFITS

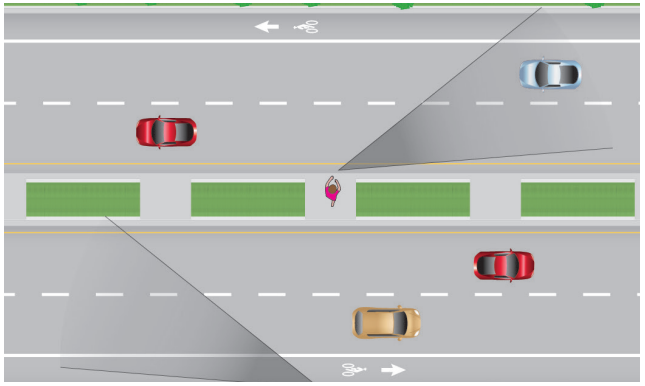
- Increase motorists compliance with stop signs
- Enhance visibility and recognition of regulatory and warning signs to drivers, especially under low-light or low-visibility conditions

APPLICATIONS

- Apply at stop sign locations with sight visibility limitations (i.e. dusk/dawn glare) and documented problems of drivers failing to stop
- LED flashing stop signs are covered in the FHWA MUTCD under Section 2A.08

MEDIANS

HSIP SAFETY COUNTERMEASURE



DESCRIPTION

Raised medians are the most important, safest, and most adaptable engineering tool for improving many street crossings. A median is a continuous raised area separating opposite flows of traffic.

Medians are a FHWA Proven Safety Countermeasure.

KEY DESIGN FEATURES

> Raised median with center area for landscaping
> Provide frequent breaks in median to assist crossing pedestrians
> Minimum of six-feet wide, but usually as wide as center-turn lane

BENEFITS

> Separate traffic flows
> Slow traffic
> Break crossings into shorter segments
> Provide space for landscaping and beautification
> Make street feel narrower
> Allow pedestrians to cross during a gap in one direction of traffic at a time

APPLICATIONS

> Raised medians and crossing islands are commonly used between intersections when blocks are long (500 feet or more in downtowns) and in the following situations:
> Speeds are higher than desired
> Streets are wide
> Traffic volumes are high
> Sight distances are poor
> Raised islands have nearly universal applications and should be placed where there is a need for people to cross the street
> To slow traffic

NEIGHBORHOOD TRAFFIC CIRCLES

DESCRIPTION

Neighborhood traffic circles, sometimes called "mini-circles", are small circles that are retrofitted into local street intersections to control vehicle speeds within a neighborhood. Typically, a tree and/or landscaping are located within the central island to provide increased visibility of the roundabout and enhance the intersection.

KEY DESIGN FEATURES

- The design of neighborhood traffic circles is primarily confined to selecting a central island size to achieve the appropriate design speed of around 15 to 20 mph
- Neighborhood traffic circles should generally have similar features as roundabouts, including yield-on-entry and painted or mountable splitter islands
- Can replace stop-controlled intersections in residential areas

BENEFITS

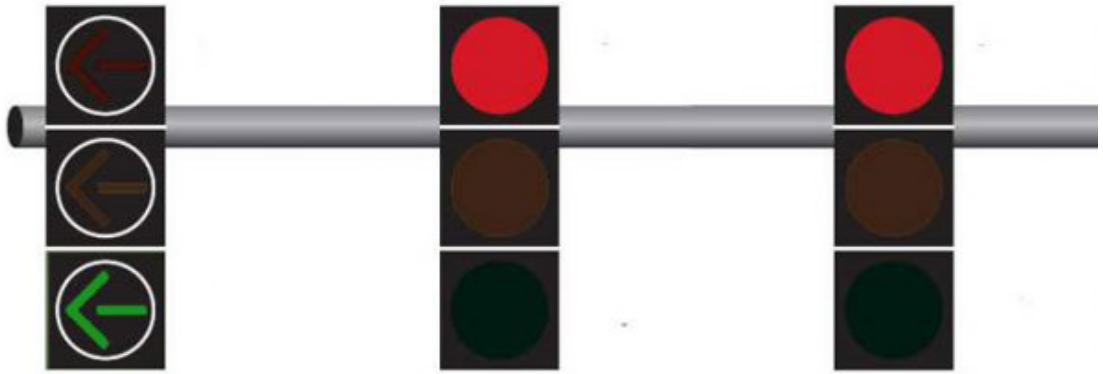
- Create continuous, slow vehicle speeds
- Better for bicyclists than stop-controls
- Improve traffic flow
- Allow space for landscaping and beautification, as well as stormwater recapture
- Reduce crashes

APPLICATIONS

- Neighborhood traffic circles should be used on low-volume, neighborhood streets
- Larger vehicles can turn left in front of the central island if necessary
- Curb radius should be tight; may impede some large vehicles from turning
- Landscaped circles often require agreements from adjacent residents and maintenance

PROTECTED LEFT-TURN PHASE

HSIP SAFETY COUNTERMEASURE



DESCRIPTION

Protected left-turn phases provide a separate signal phase for left-turn movements.

KEY DESIGN FEATURES

> The circular red for the protected must not be seen by the through traffic; as such use a "LEFT-TURN SIGNAL" or a visibility-limited (using hoods, shields, louvers, positioning, or design) circular red signal to provide additional information not given in the actual signal indication to the driver by specifying the control device for different intersection movements
> Adhere to MUTCD guidelines
> Consider signal retiming after conversion
> Exclusive left-turn lanes minimize disruption of through traffic and decrease rear-end crash potential

BENEFITS

> Vehicles making left-turn movements encounter potential conflicts from several sources including opposing through traffic, through traffic in the same direction, and crossing vehicular and pedestrian traffic. Protected (and sometimes protected/permissive) phases reduce left-turn crashes particularly left-turn/head-on crashes by eliminating these conflicts.
> Reduces conflicts with pedestrians crossing parallel to vehicle traffic
> Provides safer turns for bicyclists

APPLICATIONS

> An exclusive left-turn lane is needed
> Signalized intersections with left-turn/head-on crashes
> Signalized intersections with significant pedestrian traffic

REMOVABLE PYLONS/DELINEATORS

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

Removable pylons, also known as flexible delineators, are intended not so much to obstruct traffic as to guide it. They alert motorists to changing road conditions and are especially useful in areas where side-swipe types of crashes are likely to occur.

Removable pylons can be used on wide streets where painted buffers have been used to delineate non-standard roadway shoulders. They are used to reduce the crossing distance for pedestrians and provide a physical buffer from vehicular traffic.

KEY DESIGN FEATURES

> High degree of visibility as they rise vertically from the road surface and reflective at night
> Typically used to alert motorists of changing road conditions

BENEFITS

> Provide a physical buffer from the travel lanes to increase comfort for pedestrians and bicyclists
> Narrow the streets to slow driver speeds

APPLICATIONS

> May be used to create temporary curb extensions
> May also be used delineate protected bike lanes
  - *Three-foot minimum buffer width preferred per FHWA or 18 inches per NACTO*
  - *10-foot to 40-foot spacing desired by FHWA*

ROAD DIETS

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

Road diets require restriping streets to reduce the number of travel lanes. Typically, streets are reduced from four lanes to two, or from six lanes to four.

KEY DESIGN FEATURES

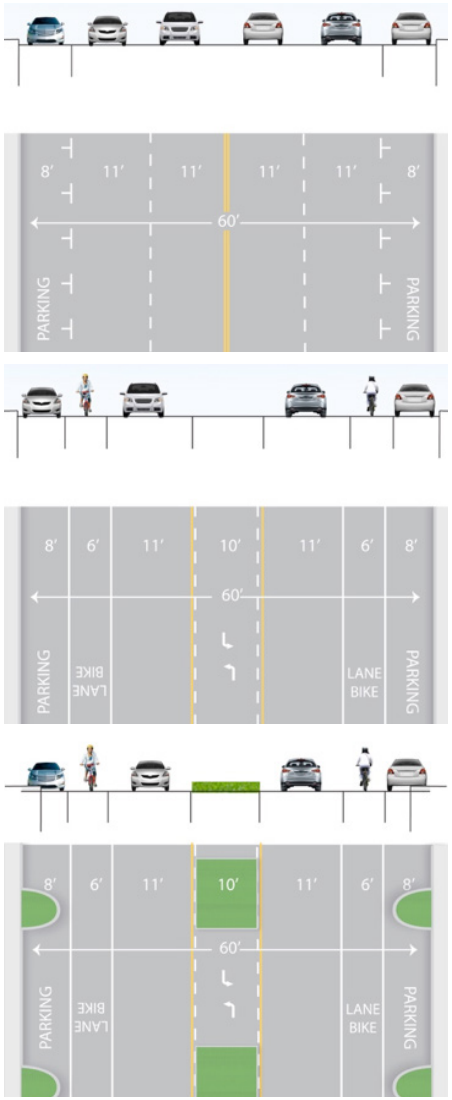
> Reducing the number of lanes, usually by adding a center-turn lane, and/or bicycle lanes

BENEFITS

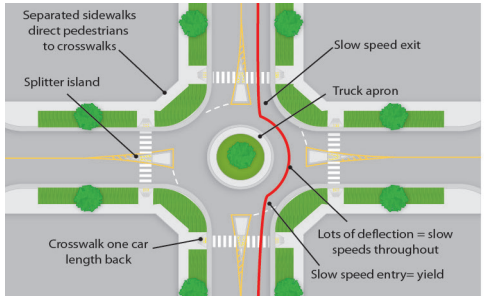
> Reduce side-swipe, rear-end, and left-turning crashes
> Slow traffic as the slowest vehicle sets the pace
> Provide space for bicycle lanes
> Makes it safer and easier for pedestrians to cross the street
> Provide space for pedestrian crossing islands
> Provide space for landscaping
> Can provide space for wider sidewalks or planting strips

APPLICATIONS

> Depending on peak hour traffic, can generally be implemented to reduce four-lane streets with 20,000 ADT to two lanes (with center-turn lane) without reducing capacity
> Depending on peak hour traffic, can generally be implemented to reduce six-lane streets with approximately 40,000 ADT to four lanes (with center-turn lane) without reducing capacity
> Where bike lanes are needed and the width isn't available within the existing street cross section
> On a street that the City wishes to convert to a walkable "main street" environment



ROUNDABOUTS



HSIP SAFETY COUNTERMEASURE

DESCRIPTION

A roundabout is an intersection design that can replace stop signs and some traffic signals. Users approach the intersection, slow down, stop, and/or yield to pedestrians in a crosswalk, and then enter a circulating roadway, yielding to drivers already in the roundabout. The circulating roadway encircles a central island around which vehicles travel counterclockwise. Roundabouts are a FHWA Proven Safety Countermeasure.

KEY DESIGN FEATURES

- Deflections and landscaped visual obstruction in the central island discourage users from entering the roundabout at high speeds
- Central island should not contain attractions
- Splitter islands narrow the approaches and exits
- Truck aprons allow trucks, buses and large vehicles to mount where necessary
- Designed to slow vehicles entering traffic yields
- Approaches are channelized to deflect traffic
- Pedestrian crossings are placed at a point along the splitter islands where the crossing is narrow, visible and motorists are slowed
- Multi-lane roundabouts require accessible pedestrian signals at crosswalks

BENEFITS

- Slow traffic, reduce the number of conflict points, and result in fewer crashes than signalized or stop-controlled intersections
- Slow speeds reduce the severity of crashes
- Have greater capacity than signalized or stop-controlled intersections
- Allow more road diets as capacity increases at the intersection; simplify intersections
- Reduce crossing distance and delay for pedestrians
- Allow bicycles to proceed without stopping

APPLICATIONS

- Can replace most single-lane signalized and stop-controlled intersections
- Require a minimum of approximately 75 feet diagonal corner-to-corner for single-lane roundabouts
- Require a minimum of approximately 150 feet diagonal corner-to-corner for multi-lane roundabouts
- Along streets with road diets
- Intersections with high crash rates
- Intersections with a large number of turning movements
- Complex intersections

RUMBLE BARS

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

Rumble bars, or transverse rumble strips, are used to alert drivers of an unexpected change in the roadway, such as the need to slow down or stop, or changes in the roadway alignment. They are a warning device used to supplement signing and alert drivers of the need to reduce speed.

Rumble bars are a FHWA Proven Safety Countermeasure.

KEY DESIGN FEATURES

> Can be raised bars or grooves placed across the travel lane
> If grooved rumble bars, limit maximum height or depth of ½-inch to minimize the jarring action to vehicles; if thermoplastic materials are used to created raised bars, the material should be white

BENEFITS

> Provide visual and aural cues to alert motorists to slow down and pay attention to changes in the roadway
> Delineate and create awareness of a pedestrian crosswalk

APPLICATIONS

> Apply on approaches leading up to a pedestrian crosswalk or changing roadway conditions

SPEED FEEDBACK SIGNS

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

Alerts motorists when they are going over the speed limit. They are most appropriate where motor vehicles commonly speed and there are pedestrians or bicyclists.

KEY DESIGN FEATURES

> Must be placed in conjunction with speed limit sign
> Should flash "SLOW DOWN" message if driver is going above speed limit

BENEFITS

> Heighten awareness of speed limits
> Can be used to specify lower speed limit during school crossing times
> Alert drivers of their actual speed and posted speed
> Can record traffic counts and speeds

APPLICATIONS

> Place in school zones or corridors where speeding is a known issue

UPGRADE PAVEMENT MARKINGS THROUGH ROADWAY SAFETY PAVEMENT MARKING AUDIT

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

This consists of auditing the current pavement markings. The audit will gather information such as locations, types, and conditions of pavement markings. The pavement markings will be analyzed, and recommendations produced to keep, remove, or replace.

KEY DESIGN FEATURES

- Identification of locations with pavement marking safety deficiencies
- Identification of pavement markings not effective for the conditions present
- Identification of old pavement markings that affect the safety of the roadway

BENEFITS

- Allows the identification of areas that could benefit from increased or changed pavement marking, in addition to identifying pavement markings that do not meet current standards

APPLICATIONS

- Network-wide, which provides the opportunity to avoid spot-treatments and thereby missing similar conditions elsewhere in the network

UPGRADE SIGNING THROUGH ROADWAY SAFETY SIGNING AUDIT

HSIP SAFETY COUNTERMEASURE

DESCRIPTION

This consists of auditing the current regulatory and warning signs. The audit will gather information such as locations, types, sizes, and conditions of signs. The signs will be analyzed, and recommendations produced to keep, remove, or replace.

KEY DESIGN FEATURES

> The signing audit will gather information such as locations, types, sizes, and conditions of signs. The signs will be analyzed, and non-compliant signs removed or replaced to ensure that they are in compliance with the California MUTCD

BENEFITS

> Allows the identification of areas that could benefit from increased or changed signing, in addition to identifying signs that do not meet current standards

APPLICATIONS

> Network-wide, which provides the opportunity to avoid spot-treatments and thereby missing similar conditions elsewhere in the network