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| KYTC Highway Design | ***Chapter***<br>ROADSIDE DESIGN |
| | ***Subject***<br>Design Elements |

**GENERAL**: AASHTO's *Roadside Design Guide* and engineering judgment should be used for roadside safety design.

The roadside is the area between the outside edge of the usable shoulder and the right-of-way limits. The area between roadways of a divided highway may also be considered the roadside. The roadside is as vital to the safe operation of a vehicle as the pavement itself.

Roadside safety design is a very important component of the total highway design and should be thoroughly considered during the design process. The goal of roadside safety design is to create a "forgiving roadside," which allows for errant vehicles leaving the roadway and supports a roadside design where serious consequences are reduced.

In regard to roadside safety considerations, the designer should follow the suggested options listed below, when feasible:

- Remove the obstacle.
- Redesign the obstacle so that it can be safely traversed.
- Relocate the obstacle to a point where it is less likely to be struck.
- Reduce impact severity by using an appropriate breakaway device.
- Use impact attenuation devices to shield the obstacle and reduce severity of crashes.
- Protect the driver through redirection of the errant vehicle.

**CLEAR ZONE:** An important concept in roadside design is the clear zone. Clear zone is the total roadside area, starting at the edge of the traveled way, available for safe use by errant vehicles. The traveled way is the portion of the roadway for movement of vehicles, exclusive of the shoulders.

Clear-zone width is not a geometric design element and therefore is not subject to the Design Exception Process.

CONT.

**CLEAR ZONE (cont.):**

Clear-zone width is dependent upon traffic volumes, design speed, and roadside geometry. The designer should consider the context of the existing and adjacent roadways and associated crash data when selecting a clear-zone width. The clear zone should be consistent within the project corridor. AASHTO's *Roadside Design Guide* provides specific information.

The clear-zone area may consist of a shoulder, a recoverable slope, a nonrecoverable slope, and/or a clear runout area. Slopes parallel to the flow of traffic may be identified as recoverable, nonrecoverable, or critical.

- A recoverable slope is a slope on which a motorist may retain or regain control of the vehicle. Slopes 4:1 and flatter are generally considered recoverable.

- A nonrecoverable slope is a slope that is considered traversable but on which the errant vehicle will continue to the bottom. Slopes between 3:1 and 4:1 may be considered traversable but nonrecoverable.

- A critical slope is a slope on which the vehicle is likely to overturn. Slopes steeper than 3:1 are generally considered critical.

If an area is not likely to be maintained free of fixed objects, it should not be considered part of the clear-zone area.

In addition to side slopes, there are slopes created by median crossovers, berms, driveways, or intersecting side roads. The *Roadside Design Guide* refers to these slopes as "transverse slopes." These are generally more critical to errant motorists than foreslopes or backslopes because they are typically struck head-on by run-off-the-road vehicles. Transverse slopes of 6:1 or flatter are suggested for high-speed roadways.

Another important consideration when evaluating clear zone is configuration of the roadside ditches in cut situations. The designer should refer to AASHTO's *Roadside Design Guide* for specific information concerning suggested foreslope and backslope combinations of proposed ditches.

**ROADSIDE BARRIERS:**

The goal of the road designer is to provide an adequate clear zone. It should be noted that barrier protection is a hazard in and of itself. A barrier should be used when the clear zone is not obtained and when the barrier is less of a hazard than the object itself. Barriers should comply with the National Cooperative Highway Research Program (NCHRP) Report 350 guidelines.

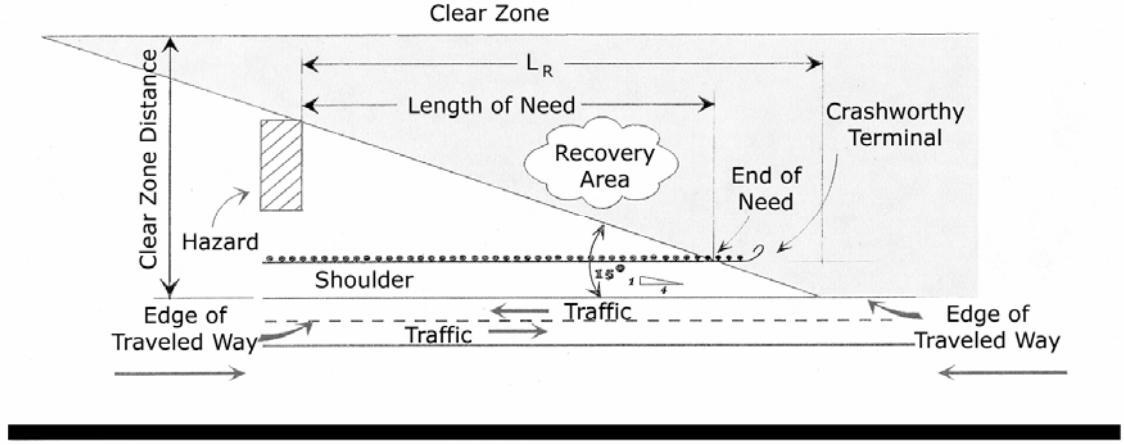
CONT.

**ROADSIDE BARRIERS (cont.):**

A roadside barrier is a longitudinal barrier used to shield motorists from either natural or manmade obstacles located along either side of the traveled way. There are occasions when barriers may be used for reasons other than shielding the motorists from obstacles, for example, road closure barricades and barriers protecting pedestrians and/or sensitive areas.

Every highway should be designed, through judicious arrangements and balance of geometric features, to preclude or minimize the need for barriers or other protective devices. When it is determined that a barrier is to be utilized, the designer can refer to the Transportation Cabinet's *Standard Drawings* and to AASHTO's *Roadside Design Guide* for specific information concerning lateral offsets, barrier deflection, terrain effects, flare rates, and length of need. KYTC's *Standard Drawings* also shows specific details concerning barriers utilized.

When determining the placement of a roadside barrier, the designer should note that the Transportation Cabinet utilizes a fixed vehicle encroachment (divergence) angle of 15 degrees from the edge of the traveled way to the obstacle. This calculation derives the "Length of Need" for the barrier. It should be noted that "Length of Need" begins with the first nonbreakaway portions of the barrier. The following figure is an illustration of "Length of Need":




Length of Need

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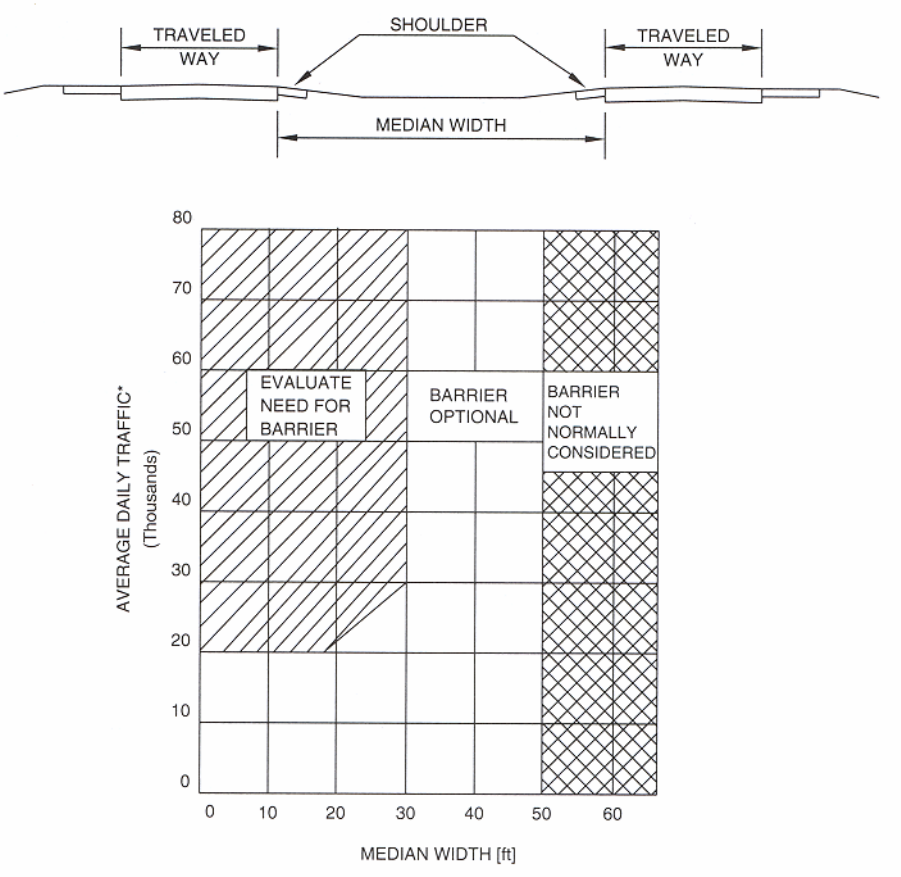
**CURBS:** It should be noted that, except for impacts at very low operating speeds, curbs typically have no redirectional qualities. When a curb is adjacent to the traveled way, the minimum operational clearance shall be two feet. For roadways with design speed ranging between 30 and 45 mph and with a curb adjacent to the traveled way, the berm should be free of obstacles. The use of guardrail within the berm area should be carefully evaluated. If guardrail is utilized in the berm area, it should present less of a hazard that the obstacle being shielded.

**MEDIAN BARRIERS:** A median barrier is a longitudinal barrier used to separate traffic on a divided highway and prevent an errant vehicle from crossing the highway median. Although similar to roadside barrier designs, most median barriers are designed to redirect vehicles striking either side of the barrier. As with all other types of traffic barriers, a median barrier should be installed only if the consequences of striking the barrier are expected to be less severe than if no barrier existed. Median barriers should comply with NCHRP Report 350 guidelines. AASHTO's *Roadside Design Guide* has guidelines for median barrier application. The following figure shows suggested guidelines for median barriers on high-speed roadways:




**Suggested guidelines for median barriers on high-speed roadways**

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**MEDIAN BARRIERS (cont.):**

When it is determined that a median barrier is to be utilized, the designer can refer to the Transportation Cabinet's *Standard Drawings* and to AASHTO's *Roadside Design Guide* for placement guidelines. KYTC's *Standard Drawings* also provides median barrier selection guidelines.

**BARRIER END TREATMENTS & CRASH CUSHIONS:**

Barrier end treatments and crash cushions are frequently used to minimize the severity of impacts with fixed objects by gradually decelerating an impacting vehicle to a stop or redirecting it around the object of concern. Barrier end treatments and crash cushions should comply with NCHRP Report 350 guidelines.

A barrier end treatment or terminal is normally used at the end of a roadside barrier where traffic passes on only one side of the barrier and in one direction only. A crashworthy end treatment is considered essential if a barrier terminates within the clear zone or is located in an area where it is likely to be struck by an errant motorist. A "crashworthy" feature is one that has been proven acceptable for use under specified conditions either through crash-testing or in-service performance.

When selecting a leading-end barrier end treatment, the designer should consider the following guideline hierarchy:

- Barrier anchored in backslope—When properly designed and located, this type of anchor provides full shielding for the identified hazard, eliminates the possibility of an end-on impact with the barrier terminal, and minimizes the likelihood of the vehicle passing behind the rail.

- Flared terminals—A flared breakaway guardrail end treatment with adequate clear zone behind the gating device is used to provide recovery.

- Straight-line terminals—A straight-line delineated breakaway end treatment with adequate clear zone behind the gating device is used to provide recovery.

The grading between the traveled way and the terminal and the approach in front of the terminal should be essentially flat (typically this is the shoulder slope extended). The grading behind any gating end treatment should be properly addressed to allow errant vehicle recovery.

When considering various end treatments for the trailing end of guardrail, the designer should also consider the potential of vehicles traveling in the opposite direction and impacting the guardrail. KYTC's *Standard Drawings* provides details on typical guardrail installations and general applications for end treatments.

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**BARRIER END TREATMENTS & CRASH CUSHIONS (cont.):**

Guardrail End Treatment Type 7 shall not be used on the interstate system. Guardrail End Treatment Type 7 can be considered on low-speed/low-volume facilities when an adequate recovery zone is unavailable and/or where conditions preclude the desired performance of other end treatment types. Appropriate justification should be retained in the project file anytime Guardrail End Treatment Type 7 is included on a project.

A crash cushion is normally used to shield the end of a fixed object. Its function is to gradually decelerate a vehicle to a safe stop or to redirect a vehicle away from the object.

When providing a crash cushion to be installed on paved surfaces, Crash Cushion Type VI is preferred. This device requires a concrete pad and a bolt-down system, as detailed in KYTC's *Standard Drawings*.

Crash Cushion Type IX or IXA is preferred on earth surfaces. This device requires posts and soil tubes, as detailed in *Standard Drawings.*

At-median piers (depressed medians) use a Crash Cushion Type IX attached to a concrete backup with a concrete wall between the piers.

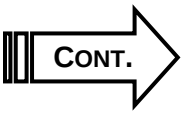
AASHTO's *Roadside Design Guide* provides specific information concerning barrier end treatments and crash cushions. *Standard Drawings* gives specific details and applications of commonly used barrier end treatments and crash cushions*.*

**ALTERNATIVE BARRIERS:**

Standard guardrail in Kentucky is Strong Post W-Beam. Standard barrier wall in Kentucky is New Jersey-shape concrete barrier. New Jersey-shape concrete barrier may be used as a roadside barrier. Other approved systems may be used where appropriate and justified by the project team. AASHTO's *Roadside Design Guide* provides specific information for alternative barriers.

**ROADSIDE DESIGN IN WORK ZONES:**

The forgiving roadside concept as promoted early in this chapter should also be applied to all work zones as appropriate for the type of work being done and to the extent existing roadside conditions allow. Because of the limited horizontal clearance available and the heightened awareness of motorists through work zones, the clear-zone requirements may be more flexible than those for normal conditions.



**ROADSIDE DESIGN IN WORK ZONES (cont.):**

Engineering judgment must be used in applying the clear zone to work zones. Depending on site restrictions, it may be feasible to provide only an operational clearance. Thus, determination of the width of a work zone's clear zone should be on a project-by-project basis, considering traffic speeds and volumes, roadway geometrics, available right-of-way width, and duration of work.

Larger clear-zone space consistent with that used on the overall project should be utilized for work zones where roadside space is available. The location of collateral hazards such as idle equipment and material storage should be controlled and subjected to greater clear-zone widths. AASHTO's *Roadside Design Guide* provides specific information for determining clear-zone width for work zones.

Pavement edge drop-offs may occur during highway work. When not properly addressed, drop-offs may lead to an errant vehicle's losing control, with a high potential for a serious accident.

No vertical drop-off greater than two inches should occur between adjacent lanes where the traffic is expected to cross in a lane-change maneuver. Warning signs should be placed in advance of the area in accordance with the *Manual on Uniform Traffic Control Devices (MUTCD)*.

When contending with pavement edge drop-offs in construction zones, the designer should consider the following guidance:

- **Less than two inches—**no protection required

  Warning signs should be placed in advance of and throughout the drop-off area.

- **Two to four inches—**plastic drums, vertical panels, or barricades every 100 feet on tangent sections for speeds of 50 mph or greater

  Cones may be used in place of plastic drums, vertical panels, or barricades during daylight hours. For tangent sections with speeds less than 50 mph and for curves, devices should be placed every 50 feet. Spacing of devices on tapered sections should be in accordance with the *Manual on Uniform Traffic Control Devices (MUTCD)*.

- **Greater than four inches—**positive separation or wedge with 3:1 or flatter slope needed

  If there is five feet or more of distance between the edge of the pavement and the drop-off, then plastic drums, vertical panels, or barricades may be used. If the drop-off is greater than 12 inches, positive separation is strongly encouraged. If concrete barriers are used, special reflective devices or steady burn lights should be used for overnight installations.

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**ROADSIDE DESIGN IN WORK ZONES (cont.):**

For temporary conditions, drop-offs greater than four inches may be protected with plastic drums, vertical panels, or barricades for short distances during daylight hours while work is being done in the drop-off area.

Flare rates for temporary barriers should be selected to provide the most cost-beneficial safety treatments possible. Benefit/cost analyses of temporary concrete barriers indicate that total accident costs appear to be minimized for flare rates ranging from 4:1 to 8:1.

AASHTO's *Roadside Design Guide* and the Transportation Cabinet's *Standard Drawings* provide specific information about roadside design in work zones.