Traffic Engineering & Highway Safety Bulletin

Military Surface Deployment and Distribution Command Transportation Engineering Agency

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Safety Audits

WHAT IS A SAFETY AUDIT?

Safety audits are a procedural approach to evaluating roadway safety. Roadway corridors are reviewed with the focus on the following:

- Pedestrian accommodations
- Signing and pavement markings
- Drainage
- Roadside hazards

Safety audits are commonly conducted as part of a State Department of Transportation's program. On military installations, SDDCTEA engineers identify safety issues that installation officials should address. Recommendations are most often low cost.

Not all deficiencies are as obvious as those shown here.

IN THIS ISSUE:

WHY PERFORM A SAFETY AUDIT?

Military installation crash statistics, presented in Figure 1 (page 2) are alarming and indicate a serious problem that must be addressed. Safety audits are the first step. Some deficiencies may be obvious, while others may not be so evident or may seem minor. For a visitor or newcomer, these deficiencies could turn into serious problems. SDDCTEA engineers have performed many safety audits. They typically audit an installation's primary and secondary roadways in a day or two, noting the types of problems that could contribute to a crash. Immediate action to address the types of hazards identified during a safety audit can reduce crash potential and save lives.

CRASH DATA EVALUATION

Safety audits can be performed without crash data but accurate crash data can bring greater benefits from a safety audit's results. If engineers are able to review detailed crash data, deficiencies that may otherwise not be evident can be identified. For example, a safety audit conducted during a week of dry weather may not reveal that a certain intersection approach becomes slick when wet, or that a roadway ponds with water because of poor drainage. Detailed crash records can provide insight to these problems. Another example is a cluster of crashes occurring at a specific location along a roadway corridor. This suggests a problem that engineers

Figure 1

would attempt to determine by focusing on that area during the audit. When preparing crash data, the following minimum detail should be recorded for each incident.

- *Crash type* – Common types include angle, rear-end, and fixed-object.
- *Time of crash*.
- *Vehicle direction before impact*.
- *Crash severity* – Crashes are categorized as property damage only (PDO), injury, and/or fatality.

SDDCTEA CAN HELP!

SDDCTEA can perform a safety audit at your installation at no cost with funding available from FHWA. These audits can typically be completed within two days.

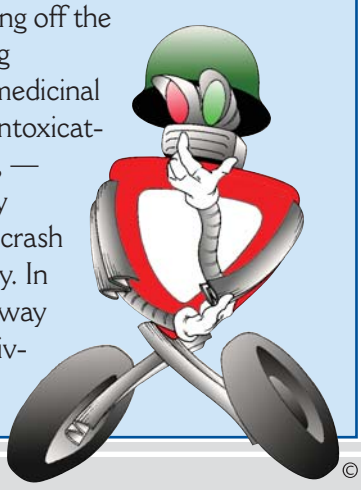
CAN YOU FIND THE PROBLEM?

The pages that follow provide a brief description of common deficiencies for each safety audit component, along with guidance on how to address common problems. Photos of deficiencies are provided for you to identify the problem. Answers and solutions accompany each photo.

YOU SHOULD KNOW

SDDCTEA publicizes highway safety because of the high number of deaths and injuries that occur on military installations each year. Highway crashes and their severity are caused by one or more of the highway system elements: the roadway, the vehicle, and/or the driver. Many times, law enforcement officials tend to blame crashes directly on the driver. Even if the driver was at fault, the road or roadside environment may have contributed to the severity of injuries or property damage costs. Too often, the driver alone takes the blame, while other causative factors remain hidden. The driver is expected to compensate for inadequate highway design and control measures in his/her driving tasks. Transportation engineers know a definite correlation exists between crashes or crash severity and substandard design or inadequate control measures. Crash causes and their destruction intensity must be clearly defined and related to the highway system elements.

Frequently, fatal and serious injury crashes occur because motorists encounter highway hazards. Even though the crash cause is listed as driver error — such as running off the road, speeding, driving under the influence (medicinal drugs), driving while intoxicated, falling asleep, etc., — there are contributory factors surrounding a crash that affect the severity. In other words, the highway features are not "forgiving" or crashworthy.



PEDESTRIANS

The misuse of pedestrian crosswalks is widespread. Common problems include multiple crosswalks over a short distance and mid-block crosswalks where no pedestrian activity is evident. Inconsistent use of standard pedestrian signs and the absence of signs where they are required are often evident. Other problems include lack of sidewalks and nonstandard pavement markings.

PROBLEM: *Multiple crosswalks are present over a short segment of roadway. The crosswalks also lack standard signing.*

SOLUTION: *Eliminate unwarranted crosswalks and install proper signing (see March 2004 SDDCTEA* Pedestrian Safety Bulletin *for more information).*

PROBLEM: *STOP bar marking is placed after the crosswalk, creating a hazard for pedestrians.*

SOLUTION: *Required STOP bar placement is a minimum of four feet prior to the crosswalk. With such placement vehicles should stop short of the crosswalk.*

Guidance

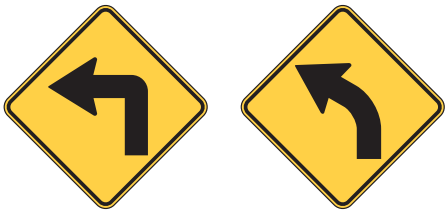
Generally, crosswalks should be provided at locations where a school crossing guard is present, and only at intersections and mid-block crossings that satisfy minimum vehicle and pedestrian volume guidelines (see *Pedestrian Safety Bulletin*). At signalized intersections with pedestrian activity, crosswalks and pedestrian push buttons and signal heads should be provided.

SIGNING

Signs should conform to standards set forth in the *Manual on Uniform Traffic Control Devices (MUTCD)*. Common signing problems include incorrect color and size; nonstandard messages; unrelated signs mounted on single posts; improper mounting heights; and poor visibility resulting from faded signs and overgrown vegetation.

PROBLEM: *A regulatory sign used for designating lane usage on an intersection approach is inappropriately used to warn motorists of a curve in the road.*

SOLUTION: *Install one of the appropriate curve warning signs shown below (see May 2001* Highway Safety Driver-Aid Treatments Bulletin *for more information).*



W1-1 W1-2

PROBLEM: *Top sign is nonstandard and redundant in meaning to sign below it.*

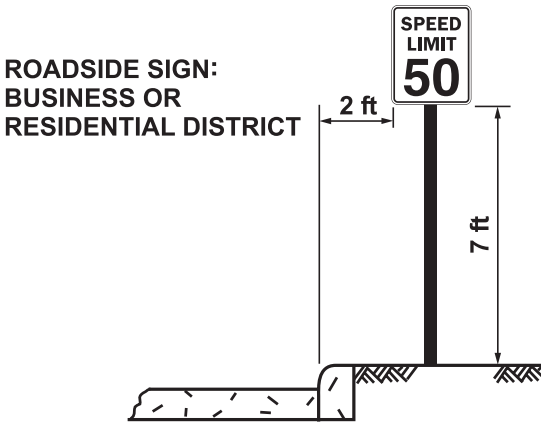
SOLUTION: *Remove the top sign.*

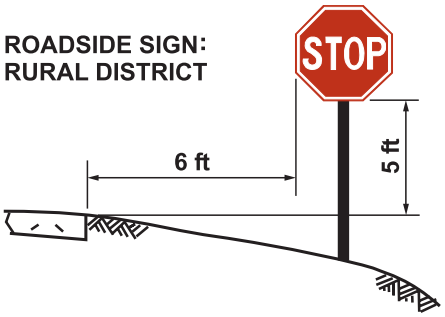
(Signing continued on page 5)

SIGNING (con't)

PROBLEM: *Inconsistency in sign mounting heights.*

SOLUTION: *Follow* MUTCD *standards shown below for proper sign mounting heights.*





Guidance

Standards are presented in the *MUTCD* that relate to size, message, color, and retroreflectivity. These elements are essential for signs to be effective. Nonstandard signs or even signs in poor condition breed disrespect and can affect conformance with signs elsewhere. Specific considerations include:

- Mounting signs at proper height
- Using standard sign color
- Mounting only related signs on the same post

PAVEMENT MARKINGS

The improper use of single, broken yellow centerlines in lieu of double, solid yellow centerlines occurs on nearly all installations. This marking allows for passing, which would generally be an unsafe movement where it is typically used. Other common pavement marking deficiencies include nonstandard single, solid yellow centerlines, missing edgelines, faded markings, and those which do not exhibit sufficient nighttime retroreflectivity.

(Above) PROBLEM: *Absence of yellow edgeline at left road edge to delineate opposing directions of travel.*

SOLUTION: *Install yellow edgeline on left edge of roadway, in both directions.*

(Above) PROBLEM: *Single broken yellow centerline is used in lieu of double, solid yellow. Broken yellow centerlines would permit passing through this intersection, which would be a hazard.*

SOLUTION: *Install double solid yellow centerline pavement markings.*

(Left) PROBLEM: *Nonstandard, single solid yellow centerline is used in lieu of double, solid yellow.*

SOLUTION: *Install double solid yellow center line pavement markings.*

Guidance

- To ensure markings do not become faded and are visible at night, use retroreflective markings and enact a regular maintenance program in which markings are repainted at least twice a year.
- Where inappropriately used, replace single, broken yellow centerlines with double, solid yellow lines.
- Install white edgelines along all uncurbed areas.
- Ensure all single, solid yellow centerlines are modified to double, solid yellow.

DRAINAGE

Outdated drainage systems are common at most installations. Problems are caused when endwalls or ditches are too close to the roadway and are left unprotected. This type of application results in an "unforgiving roadside." If a motorist were to run off the road, it would be difficult for him to recover. Protruding drainage structures and ditches with severe slopes are some examples of common hazards.

PROBLEM: *Protruding endwall for a cross-drainage structure can be impacted by a run-off road vehicle.*

SOLUTION: *Eliminate headwall and use tapered end section (see below).*

PROBLEM: *Drainage inlet covered by raised concrete manhole. The bollard to protect the manhole is in itself a hazard.*

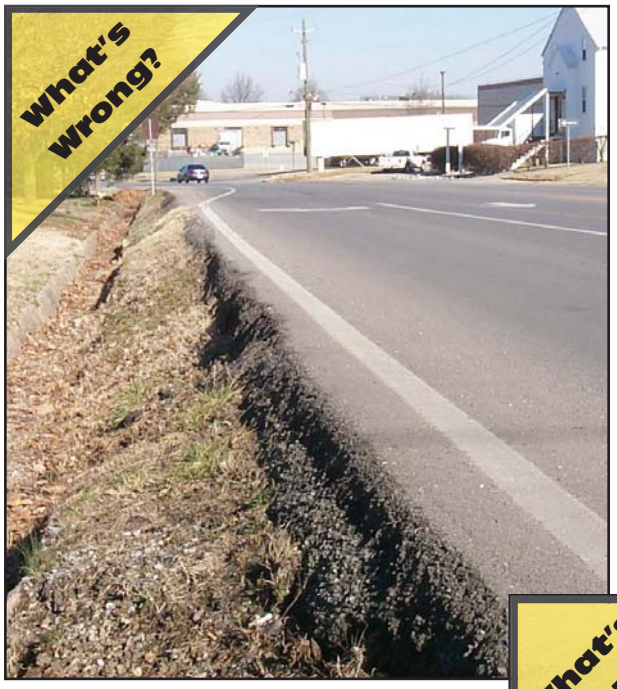
SOLUTION: *Remove bollard and concrete manhole. Install traversable metal drainage grate.*

Guidance

- Install a subsurface drainage system where practical.
- The use of a rounded flat-bottom ditch provides the best combination of safety and drainage. If nontraversable ditches must exist, protect with barrier or guardrail.
- Redesign drainage systems when necessary. For example, culvert openings should be traversable. Metal end sections and concrete culverts with wing walls can accomplish this.
- Extend the drainage structure to outside the clear zone so it is less likely to be impacted.
- If none of the above can be accomplished, install guardrail or other suitable barrier as protection.

ROADSIDE HAZARDS - EDGE DROPOFFS

Edge dropoffs form over time as the shoulder erodes and is not stabilized. They can also result when a roadway is resurfaced and the slope is not regraded to meet the new pavement elevation. If a vehicle were to run off the road or even pull off the shoulder, a severe jolt to the vehicle could cause the driver to lose control.



(Left) PROBLEM: *Pavement edge dropoff combined with steep sideslope results in almost no chance of vehicle recovery if a driver loses control and runs off the road.*

SOLUTION: *Dropoff appears difficult to stabilize due to adjacent steep slope. This leaves guardrail protection as the best solution.*

(Right) PROBLEM: *Junction box improperly placed, resulting in substantial edge dropoff and potential hazard for an errant vehicle.*

SOLUTION: *Relocate junction box to outside the shoulder or raise the junction box and pave around it. Grade with suitable material that will eliminate the edge dropoff and will not erode.*

Guidance

- Install stable material along shoulder that will eliminate dropoff and not erode once in place.
- For dropoffs that are difficult to stabilize because of an adjacent steep roadside, installation of guardrail may be the only option.
- Perform regular maintenance to eliminate any dropoffs that may form over time.

ROADSIDE HAZARDS - SLOPE PROTECTION

Unprotected steep slopes are quite common on military installations, particularly those in the southern U.S. where roadside slopes are part of open drainage ditch design required for heavy rainfall. Where slopes are protected, guardrail is sometimes improperly installed, or nonstandard guardrail is used.

(Left) PROBLEM: *Steep embankment is "protected" only by a metal railing which will do almost nothing to stop an errant vehicle.*

SOLUTION: *Install guardrail with proper end treatments.*

(Right) PROBLEM: *Separate runs of guardrail are located a short distance from each other resulting in multiple blunt-end hazards.*

SOLUTION: *Connect each run of guardrail to create one continuous run, eliminating the multiple blunt-end hazards.*

(Left) PROBLEM: *Guardrail offset brackets (circled) are steel, which do not allow for adequate deflection of W-beam rail, should it be impacted.*

SOLUTION: *All new guardrail installations should utilize offset brackets consisting of wood or composite material.*

Guidance

- Guardrail should be used to shield hazards that cannot be mitigated.
- Runs of guardrail should be continuous with proper end treatments and hardware installed.
- Guardrail should be installed at the proper mounting height and distance from the hazard to provide adequate deflection distance in the event of impact.

ROADSIDE HAZARDS - FIXED OBJECTS

In 1998, one-third of motor vehicle deaths in the U.S. involved vehicles leaving the roadway and hitting fixed objects. Examples of common fixed object hazards include sign posts of non-breakaway design, trees, light/utility poles, and bollards used to protect hazards that become fixed objects in themselves.

PROBLEM: *Sign with large concrete base is installed in the roadway where it can be impacted.*

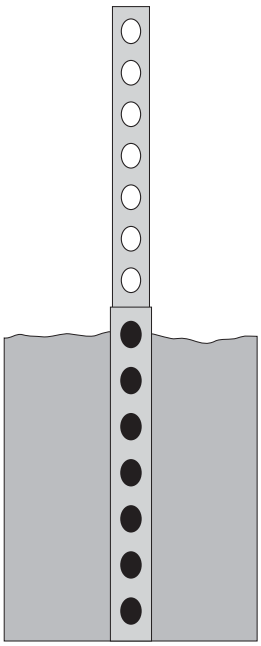
SOLUTION: *Remove sign and base. A speed limit sign is mounted behind curb in background. If speeds are a concern, oversized signs can be used but signs should not be installed in the roadway.*

PROBLEM: *Utility pole on intersection corner radius is "protected" by two bollards, both of which are fixed object hazards in themselves.*

SOLUTION: *The bollards were likely placed as a result of large turning vehicles impacting the pole. Relocate the pole outside the turning path and remove the bollards.*

PROBLEM: *Although this is a breakaway sign base, it is installed improperly and would not allow the sign to break away from the base if impacted.*

SOLUTION: *Sign pole base is only breakaway if just above ground surface. Pole base should be reinstalled as shown at right.*



(Roadside Hazards - Fixed Objects continued on page 11)

ROADSIDE HAZARDS - FIXED OBJECTS (con't)

PROBLEM: *Guardrail is present on both sides of the roadway but is located behind utility poles. A vehicle exiting the roadway and impacting the guardrail could be redirected into a utility pole.*

SOLUTION: *Guardrail could be relocated in front of poles but only if a sufficient deflection distance is provided behind it. Utility poles should otherwise be relocated behind the guardrail.*

PROBLEM: *Multiple concrete bollards, which are essentially fixed objects in this example, have been used to protect a utility pole.*

SOLUTION: *Remove bollards and replace with guardrail. Guardrail must have appropriate end treatments and provide sufficient deflection distance to pole.*

Guidance

There are five options to mitigate roadside hazards. In order of preference these are:

- Remove the hazard.
- Relocate the hazard.
- Reduce the severity if removal or relocation is not possible. This can be accomplishing by using breakaway supports where signs, luminaires, or signals are the hazard. Breakaway supports are a type of device that yield when impacted by a vehicle.
- Shield the hazard using guardrail or barrier.
- Delineate the hazard with object marker signing.

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