Abridgment

In-Service Evaluation of Safety Appurtenances: Problems and Solutions

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ABSTRACT

In-service evaluation is the logical final stage of development of new highway safety appurtenances. It is intended to identify and correct unsuspected problems with a new device before its widespread adoption is recommended. Although most highway agencies do evaluate new appurtenances, until recently no guidelines have been available to ensure consistency and uniformity of these efforts. NCHRP Report 230, "Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances," provided such guidelines. By using these guidelines an in-service evaluation plan was developed and tested in conjunction with pilot installations of a self-restoring barrier guardrail at locations in Illinois, Virginia, New York, and Colorado. The evaluation procedures suggested in NCHRP Report 230 proved valid. However, the evaluation process can be significantly improved by soliciting support and involvement from potential users early in the research effort, by selecting appropriate installation sites, by obtaining a specific commitment from those persons monitoring the installation, and by ensuring an effective feedback cycle for further development of the appurtenance based on its actual performance.

An in-service evaluation is a desirable and necessary final step in the development of any new product. Highway safety hardware that has been successfully crash tested under idealized conditions and exhibits potential for performing acceptably in the field should be introduced on a trial basis and extensively monitored for a specified period of time. This action is intended to avoid widespread installation of a device that may have significant design or performance problems that were not detected through controlled crash testing and analysis.

Although highway agencies have performed in-service evaluations of new safety appurtenances in the past, there were no guidelines available that ensured consistency of these efforts. NCHRP Report 230, "Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances" (1), defined the need for effective performance evaluations and provided guidelines to promote a more uniform and thorough examination of new highway safety devices.

Concurrently, the Demonstration Projects Division of the Office of Highway Operations, FHWA, was seeking highway agencies interested in installing and evaluating a recently developed high-performance guardrail: the self-restoring barrier (SERB) (2). By using the guidelines contained in NCHRP Report 230, an evaluation plan was developed for use in this effort.

METHODOLOGY

The in-service evaluation objectives listed in NCHRP Report 230 were reviewed and modified somewhat for use in the SERB guardrail evaluation plan. The major changes were requirements for an interim report as well as a final in-service evaluation report. The interim report, due as soon as possible after installation, would contain information on site selection, installation procedures, and costs that would be of immediate interest and use to other agencies considering pilot installations. This report would also include suggestions for design modifications that would enable research and development engineers to improve the original design (to facilitate construction or reduce initial costs) without sacrificing performance.

The final report is intended to document the in-service performance of the device and to identify any operational or maintenance problems associated with its use. A 1-year period was selected for detailed monitoring because a longer period of time could unduly delay further development of the device and be less palatable to the participating agencies. It was also believed that 1 year's data could provide enough information to make an accurate determination of the effectiveness of the device. However, informal monitoring was to be continued for at least another year.

FINDINGS AND CONCLUSIONS

Additional emphasis on four general areas can result in more effective in-service evaluations. These areas are user involvement, site selection, communications, and reporting. Each of these topics is discussed in some detail in the following sections.

User Involvement

It proved relatively difficult to find highway agencies that were interested in installing and evaluating the SERB guardrail. Many agencies apparently did not believe that they were in need of a high-performance traffic barrier or were unwilling to commit their limited resources to a relatively minor project. Had selected highway agencies been involved in the development of the SERB to some extent from its inception, it might have been much easier to solicit interest in pilot installations.

Site Selection

Once an agency has agreed to participate in a demonstration effort, a carefully selected site is essential if the evaluation effort is to provide useful information. This aspect of the evaluation process is emphasized in NCHRP Report 230, which suggests that "those (sites) with the highest probability for a collision should be selected for the trial installations...." High-volume roadways with adverse geometrics such as horizontal curvature and steep grades, coupled with an active accident history, should be given first consideration.

Although the SERB guardrail was developed and tested as a tangent installation, it was believed that its greatest potential use was on curves of varying sharpness. Thus installation sites were chosen specifically to examine the performance limitations of the SERB in such situations.

Improved Communications

In actual practice, the agreement to participate in the installation and evaluation of a new appurtenance may involve persons from several different sections of a state highway agency. It is essential that one individual accept responsibility for coordinating this effort, and that each participant have a clear understanding of his own role and responsibilities throughout the duration of the evaluation. For example, in one state a pilot installation was initiated by highway officials in the state capitol; it was designed and installed by district office design and construction personnel and monitored by a field maintenance supervisor.

This degree of involvement will probably be typical of many pilot installations. Unless one person is recognized as the focal point and each of the other participants is aware of and committed to his specific duties, the evaluation effort may not result in useful information. One of the weakest links in the process is inspection of the new appurtenance at regular intervals for the duration of the evaluation period.

Feedback to Research Agency

NCHRP Report 230 cautions that no modifications be made in the field to an experimental appurtenance until "their effect on...safety performance is carefully verified through vehicle crash testing or other appropriate means." During the pilot installations, several questions on design details and modifications arose. After discussing these with the original researchers, some immediate changes were made to facilitate construction and also to improve expected performance. However, no major modifications or changes were made, even though the need for some became evident. Unfortunately, there is no quick way to assess the impact of major modifications to a previously crash-tested appurtenance.

RECOMMENDATIONS

User Involvement

Before beginning formal research on a new safety appurtenance, state highway agencies should be informally canvassed to identify those specifically interested in the new device. Persons from states showing the greatest interest should be invited to participate in the effort, with the understanding that successfully crash-tested devices will be installed and evaluated by their respective agencies. A design (or construction) engineer would be a good candidate for this type of involvement.

This procedure would almost certainly guarantee candidate sites for pilot installations and, perhaps more important, ensure that each site is monitored by a highway agency representative who is familiar with the device and the various considerations that went into its development. Soliciting active involvement from user agencies up front should significantly reduce the period of time between the development of new safety hardware and its use in the field.

Site Selection

The site selected for a pilot installation should be chosen to guarantee hits, insofar as this is possible. It is particularly important to select a site where the new appurtenance is in fact the best device currently available for that particular location. It is further suggested that its expected performance limits be approached, but not exceeded. Because most crash testing is done under ideal conditions, new safety hardware should be field tested at those locations where it will most likely be used by highway agencies if proven successful.

It also aids the evaluation effort significantly if the test site is readily accessible to those persons who must monitor its performance during the evaluation period.

Improved Communications

Before any work at a particular site, all persons involved with any phase of the project should be briefed on its purpose, extent, and duration, and on their specific responsibilities, particularly in regard to data collection (accident and repair costs). Law enforcement agency representatives should also be invited to attend this briefing session. A narrated film showing the details of the new device and its crash-test performance is recommended as one end product of all significant research efforts.

The importance of complete and accurate data collection cannot be overlooked. The person(s) assigned the task of monitoring must be aware of the need for conscientious inspection and reporting. A simple form for recording the time and date of the inspection and any noteworthy observations should be used to formalize the monitoring process. This information should be forwarded on a monthly basis to the inspector's supervisor and summarized at least quarterly for the research sponsor.

In the case of devices that are hit repeatedly, the technique of painting over scuff marks after recording the hit is probably the best way to keep track of the impacts. Appropriate paint should be made available for this purpose.

Feedback to Research Agency

As noted previously, minor changes to the crash-tested appurtenance can safely be made in many cases after discussing the proposed modifications with the research engineers. Major changes, however, must be analyzed in detail and may require further crash testing. Currently, no means of additional testing is readily available. Future research contracts might provide some reserve funding for additional developmental testing of modifications based on in-service performance.

SUMMARY

Traditionally, it has taken several years for experimental highway safety devices to evolve into operational roadside hardware. The recommendations contained in this paper are intended to shorten that period significantly and to produce quality in-service evaluations that result in improved roadside safety hardware.

In early 1984, the Demonstration Projects Division of FHWA announced that separate federal funding was available to state highway agencies to evaluate the field performance of experimental highway safety hardware. Additional information on this program can be obtained through FHWA's division office in each state.

REFERENCES

1. J.D. Michie. Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances. NCHRP Report 230. TRB, National Research Council, Washington, D.C., March 1981, 42 pp.
2. M.E. Bronstad, C.E. Kimball, Jr., and C.F. McDevitt. SERB: A New High-Performance Self-Restoring Traffic Barrier. In Transportation Research Record 796, TRB, National Research Council, Washington, D.C., 1981, pp. 50-56.

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Guidelines for Placement of Longitudinal Barriers on Slopes

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ABSTRACT

This research was undertaken to investigate the impact performance of longitudinal barriers when placed on sloping terrain. Tasks performed included (a) a determination of typical conditions for which longitudinal barriers are placed on sloping terrain, (b) an evaluation of the impact behavior of widely used barrier systems when placed on sloping terrain, and (c) the development of guidelines for selection and placement of barriers on sloping terrain. Crash tests and the HVOSM computer program were used to evaluate impact behavior and to develop guidelines. Factors considered in the guidelines include roadway and shoulder cross slope, cut and fill slope, barrier offset, and barrier type. It was found that W-beam and Thrie-beam barriers are more sensitive to the effects of sloping terrain than are cable barriers.

Impact behavior of a longitudinal barrier is dependent on a number of factors, including size and spacing of posts, size and mounting height of rail or beam, offset of beam from posts, embedment conditions, and roadside conditions between the edge of the traveled way and the barrier. Little is known about the effects of the latter factor, although it may have the greatest influence on performance. In general, barriers have been designed and tested for flat terrain conditions, even though roadside and median barriers are commonly placed on side slopes or behind curbs. With regard to placement of barriers on slopes, the 1977 AASHTO barrier guide (1) recommended the following:

> As a general rule, a roadside barrier should not be placed on an embankment if the slope of the embankment is steeper than 10:1. In addition, a barrier should not be placed on an embankment if the difference between the shoulder slope rate and side slope rate is greater than approximately 0.10.

Tasks performed in this study were as follows: (a) a determination of typical conditions for which longitudinal barriers are placed on nonlevel terrain, (b) an evaluation of the impact behavior of widely used barrier systems when placed on nonlevel terrain, and (c) the development of guidelines for selection and placement of barriers on nonlevel terrain. Barriers evaluated included widely used roadside and median longitudinal barriers identified in the 1977 AASHTO barrier guide (1). Nonlevel terrain considered in the evaluation concerned sloping embankments, ditches, and superelevated roadway sections.

The results of the study are summarized in this paper. Complete details can be found in a three-volume final report (2-4).

REVIEW OF CURRENT PRACTICE

At the inception of this study the researchers traveled to several states to survey current barrier placement practices and to solicit input from various state transportation personnel. It was found