Abridgment

Effectiveness of Flashing Beacons in Reducing Accidents at a Hazardous Rural Curve

MICHAEL S. JANOFF and J. GRAHAM HILL

ABSTRACT

There is extensive literature that describes the effect of flashing beacons on such driver behavior as speed adjustment, but none has been identified that presents the effect of such beacons on the frequency of accidents. The results are presented of an accident analysis that was conducted to determine the effect of a flashing beacon on the frequency of accidents at a dangerous high-speed rural curve. A before-and-after accident analysis was conducted using 2 years of "before" data and 2 years of "after" data. The analysis revealed a 50 percent reduction in total accidents but a 91 percent reduction in accidents of the speed/lost-control/fixed-object type--the type expected to be most directly affected by the installation of a flashing beacon. Benefit-cost ratios in excess of 50:1 were demonstrated for this flashing beacon installation, and the cost of the beacon was saved within 2 months by the elimination of almost all the lost-control type of accidents.

The objective of this paper is to report on the effectiveness of a flashing beacon in reducing accidents at a severe curve on a four-lane rural high-speed highway.

Accident data were obtained for a 2-year period before installation of the flashing beacon and for a similar period after installation. The accidents were classified by type and a before-and-after analysis was performed to determine the effect of the flashing lights on all accidents and on specific types of accidents.

The background for the use of flashing beacons is presented next, followed by a description of the specific roadway location and the reasons that the flashing beacon was installed. The before-and-after accident analysis is presented next and then the conclusions pertaining to the effectiveness of the flashing beacon, which were drawn from the before-and-after accident analysis.

BACKGROUND

The use of flashing beacons to warn drivers of potentially hazardous roadway situations and to induce them to modify their behavior (e.g., reduce their speed) has been studied in a number of different situations (1-5).

For a sight-restricted rural intersection, flashing beacons to supplement warning signs caused a 1.6- to 3.2-mph (2.6- to 5.1-kph) speed reduction compared with only a 0.8-mph (1.3-kph) speed reduction without the flashing beacons (3).

Flashing beacons used to draw attention to signs warning of short work zones on rural highways resulted in a 3- to 4-mph (4.8- to 6.4-kph) greater speed reduction than that obtained from signs alone; at long work zones a 7.5-mph (12.0-kph) improvement was obtained (4).

Flashing beacons used with school-zone speed restriction signs resulted in an average speed reduction of 3.6 mph (5.8 kph) across all sites (5). On roads with speed limits of 55 mph (88 kph), a 10-mph (16-kph) reduction was obtained.

When flashing beacons were used to warn of wet-weather skidding hazards on high-speed roads, a 9 percent speed reduction was obtained (2). All motorists--including the fastest drivers--reduced their speed when flashing beacons were used, whereas without flashing beacons the fastest quartile did not reduce their speed. The signs that were supplemented by flashing beacons were found to be more likely to be observed, properly identified, and complied with.

It may be concluded that where flashing beacons are used and the hazard is not obvious, regardless of the accompanying sign, a speed reduction of at least 2 to 3 mph (3.2 to 4.8 kph) may be realized. Where the nature of the hazard is more clearly identified by the sign, the speed reduction is likely to be greater, and the motorist's attentiveness is likely to be heightened. Where the nature of the hazard is obvious, as in the case of a curve in the rain, flashing beacons are likely to be most effective in warning drivers to reduce their speed and be more attentive (1). The key studies are summarized in Table 1.

No studies were found through the Transportation Research Information Services (TRIS) or other sources on the effect of flashing beacons on the frequency or rate of traffic accidents.

STUDY SITE

The study site was a section of FM 2100 in Harris County, Texas. This section is now a four-lane undivided rural highway 62 ft wide with a sharp horizontal curve (approximately 45 degrees).

Originally (before 1979) this highway had two lanes, but because of repeated complaints by citizens concerning drivers that were speeding and failing to control their vehicles at the curved section, the

M.S. Janoff, JMJ Research, P.O. Box 144, Newtown, Pa. 18940. J.G. Hill, Hill, Parker, Franklin, Cardwell and Jones, 5300 Memorial, Suite 700, Houston, Tex. 77007.

TABLE 1 Research on Flashing Beacons

Research	Results
Lyles *(3)*	Speed reduction of 1.6 to 3.2 mph at sight-restricted intersections
Lyles *(4)*	Speed reduction 3 to 4 mph greater in short work zones and 7.5 mph greater in long work zones (compared with signing alone)
Zegeer *(5)*	Speed reduction of 3.6 mph for all school zones and 10-mph reduction for school zones on 55-mph roads
Hanscomb *(2)*	Speed reduction of 9 percent at skid-prone sites on high-speed roads (5 mph at 55 mph) Reduction below critical (potential skidding) speeds by all motorists (without flashing beacons, fastest 25 percent of drivers did not reduce their speed below critical speed)
Freedman et al. *(1)*	Speed reduction of 1.6 to 10 mph, most effective on high-speed roads; speed reduction by all drivers

Note: 1 mph = 1.6 kph.

state posted signs for a lower speed limit (reduced from 35 to 25 mph), delineated the curve with edge and center markings and pole-mounted reflectors, remarked part of the road, and widened the remainder to four lanes. None of these improvements reduced the speeds at the curve, the frequency of out-of-control drivers or the frequency of lost-control accidents. The site is shown in Figure 1.

The state decided in 1980 to install a single flashing beacon at the curve, mounted on a pole on the side of the highway. This installation was completed on October 23, 1980. The selection of such a warning device was based on its effectiveness in promoting increased conspicuity of the speed limit sign and resulting speed reductions, as revealed by past research.

ACCIDENT ANALYSIS

Accident data were obtained for a 22-month period before installation of the beacons (Jan. 1, 1979 through Oct. 22, 1980) and a similar 22-month period after installation (Oct. 23, 1980 through Aug. 31, 1982). Table 2 summarizes the raw accident data.

During the before period there were 14 accidents, of which 11 (79 percent) were of the speed/lost-control, fixed-object, or head-on type. During the after period there were 7 accidents, of which 1 (14 percent) was of the speed/lost-control, fixed-object, or head-on type. The before-and-after data are summarized in Table 3.

The effect of the installation of the flashing beacon was a decrease from 14 to 7 accidents. However, for the speed/lost-control type the reduction was from 11 to 1, whereas other types of accidents (side swipe, angle, lane change) increased by 3.

Over the entire 4-year time period, other types of accidents fluctuated between one and four per year, whereas the speed/lost-control types were drastically reduced from 6 to 0 in a period of 1 year before to 1 year after installation and from 11 to 1 in a period of 2 years before to 2 years after the installation. The decrease in speed/lost-control type accidents is significant at better than a 0.01 level.

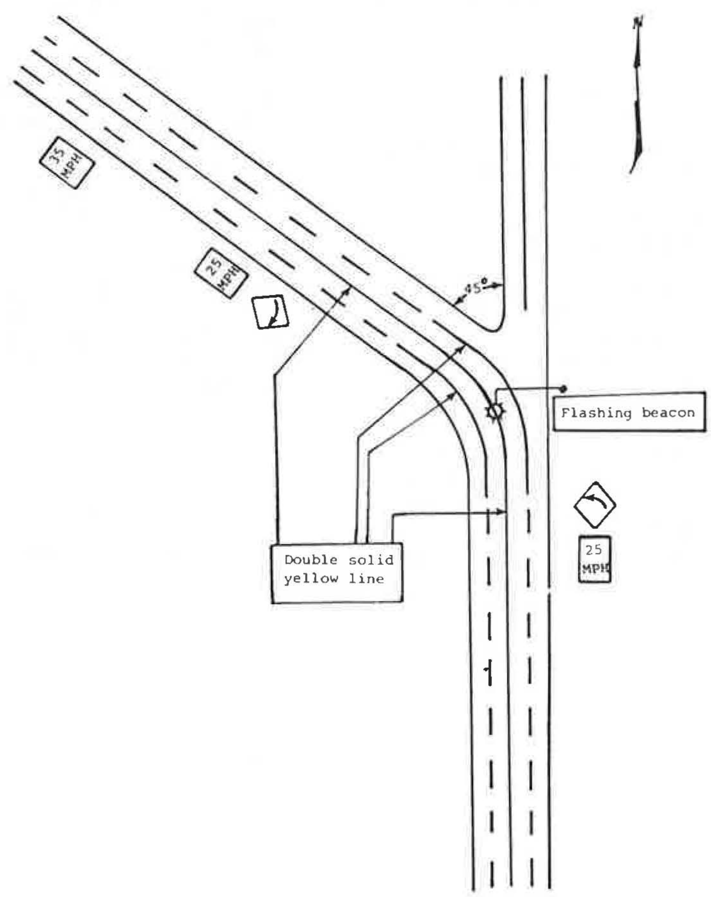

FIGURE 1 Study site.

TABLE 2 Raw Accident Data

Period	Type of Accident	Date
Before[a]	Speed/lost control	2/23/79
	Head on	4/14/79
	Right angle	5/15/79
	Speed/lost control	5/25/79
	Lane change	9/23/79
	Lost control	11/28/79
	Lost control	12/6/79
	Failed to yield	3/24/80
	Speed/lost control	3/30/80
	Speed/lost control	6/21/80
	Fixed object	8/23/80
	Speed/lost control	8/25/80
	Fixed object	9/29/80
	Speed/lost control	10/5/80
After[b]	Right angle	11/6/80
	Left turn	9/17/81
	Rear end	10/6/81
	Right angle	12/31/81
	Right angle	1/17/82
	Fixed object	7/25/82
	Side swipe	8/18/82

[a]Jan. 1, 1979 through Oct. 22, 1980 (22 months).
[b]Oct. 23, 1980 through Aug. 31, 1982 (22 months).

TABLE 3 Before-and-After Accident Summary

Type of Accident	No. of Accidents by Time Period		Change	
	Before	After	No.	Percent
All	14	7	-7	-50
Speed/lost-control, head-on, and fixed-object type	11	1	-10	-91
Other	3	6	+3	+50

INTERPRETATION OF RESULTS

The types of accidents classified as "other" are related to turning, overtaking, and passing maneuvers, which would not be expected to be affected by the flashing beacon. This was shown to be true because their absolute numbers did not change monotonically during the entire 4-year period but rather fluctuated up and down.

The installation of the flashing beacon, however, reduced speed/lost-control accidents from 6 to 0 and from 11 to 1 as mentioned previously. It is these types of accidents that would be expected to be reduced by such a flashing beacon.

There were no significant changes in either traffic volumes or weather during the entire 44-month study period. Before-and-after speed data were not taken, but on the basis of the accident analysis and results reported in the literature, it is suspected that at least the fastest drivers (those most prone to lost-control accidents) were slowed by the flashing beacon.

CONCLUSIONS: ECONOMIC ANALYSIS

The installation of the flashing beacon at this severe curve has nearly eliminated the speed/lost-control type of accident but has had no significant effect on other types of accidents.

Using the original installation cost of $1,540 for this flashing beacon (1980 cost) and 1980 NHTSA costs of approximately $2,050 per accident (this is a conservative estimate of actual per-accident costs for speed/lost-control/fixed-object types, which normally involve injuries and fatalities) (6), the benefit/cost ratio far exceeds 1.0. In fact, for a discount rate of 10 percent and an average reduction of five accidents per year (based on 10 eliminated in 2 years) the benefit/cost ratio exceeds 50:1. The beacon would thus pay for itself in only 2 months and return $50 in benefits to the public for each $1 invested.

For this specific road, it is clear that the installation of the flashing beacon was very beneficial, both from the viewpoint of reducing the total frequency of speed/lost-control accidents and from an economic viewpoint.

Even with the increased maintenance costs associated with such flashing beacons (e.g., cleaning and lamp replacement), the economic benefits far outweigh the costs.

REFERENCES

1. M. Freedman et al. Limited Sight Distance Warning for Vertical Curves, Vol. 2. FHWA, U.S. Department of Transportation, Nov. 1984.
2. F.R. Hanscome. Evaluation of Signing to Warn of Wet Weather Skidding Hazard. In Transportation Research Record 600, TRB, National Research Council, Washington, D.C., 1976, pp. 20-27.
3. R.W. Lyles. An Evaluation of Signs for Sight Restricted Rural Intersections. Report FHWA/RD-80-002. FHWA, U.S. Department of Transportation, Feb. 1980.
4. R.W. Lyles. Alternative Sign Sequences for Work Zones on Rural Highways. Report FHWA/RD-80/163. FHWA, U.S. Department of Transportation, May 1981.
5. C.V. Zegeer. The Effectiveness of School Signs with Flashing Beacons in Reducing Vehicle Speeds. Report 429. Division of Research, Kentucky Bureau of Highways, Frankfort, July 1975.
6. The Economic Cost to Society of Motor Vehicle Accidents. NHTSA, U.S. Department of Transportation, Jan. 1983.

Publication of this paper sponsored by Committee on Traffic Control Devices.