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EFFECT OF INCREASED LIGHT FLASH FREQUENCY ON GRADE CROSSING GATE COMPLIANCE

SUMMARY

Under the direction of the Federal Railroad Administration's (FRA's) Train Control and Communication Research Division, the Volpe National Transportation Systems Center (Volpe) conducted a study to evaluate adding a 4.5 Hz strobe effect on top of the existing, alternating flash pattern of grade crossing flashing lights, specifically its effectiveness on driver compliance with active warning devices at grade crossings.

The gate-mounted flashers were replaced with rapid flashers on November 3, 2023, and the results were published previously (Bedini, 2024). The post-mounted flashers were replaced in November 2024 and post-installation video data was collected in January 2025.

Researchers found a significant reduction in grade crossing violations after strobing the grade crossing warning lights. The number of violations per grade crossing activation (violation rate) decreased by 43 percent after the installation of strobing post-mounted flashers. More significantly, the violation rate while the gates were descending decreased by 85 percent. There were no broken gates during the observation period after the installation. These results indicate that the rapid flashers improved drivers' awareness of and compliance with the active warning devices.

BACKGROUND

FRA initiated this research study in 2023 in collaboration with the Massachusetts Department of Transportation (MassDOT), Massachusetts Bay Transportation Authority (MBTA), Federal Highway Administration (FHWA), Keolis Commuter Services, and Railway Equipment Company (RECO). MassDOT received approval from FHWA for this research consistent with Section 1A.10 of the Manual of Uniform Traffic Control Devices.

The team selected a grade crossing location on Washington Street in Canton, MA (U.S. DOT# 546 729P). This is a public, at-grade crossing originally equipped with 8-inch post-mounted flashers and 4-inch gate-mounted flashers on each of the two approach lanes. It was selected for this study due to the relatively high frequency of broken gates by vehicles at this crossing.

Figure 1 shows a vehicle violating the descending gates on 09/18/23 at the study crossing, which resulted in a broken gate.

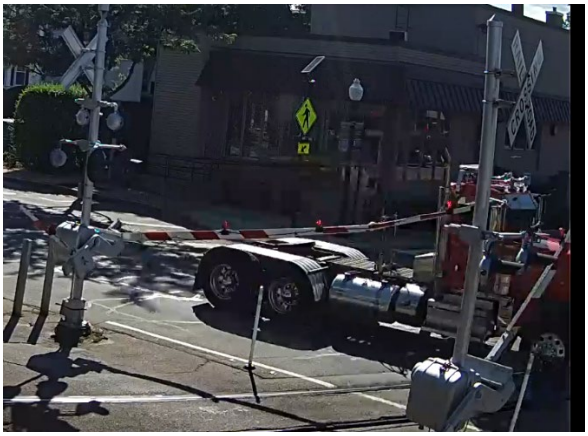

Figure 1. Crossing Gate Violation Example (Crossing ID# 546 729P)

Normally there are two flashing lights, with each light energized alternately about once per second. Researchers increased the flash rate of each light to 4.5 Hz when the light is energized (for a strobe effect) during the initial phase of the activation.

OBJECTIVE

The objective of this study was to evaluate adding a 4.5 Hz strobe effect on top of the existing, alternating flash pattern of grade crossing flashing lights, specifically its effectiveness on driver compliance with active warning devices at grade crossings.

METHODS

Researchers used an experimental design methodology to assess the effectiveness of flashers operating at an increased frequency. The team used a before-and-after approach to evaluate their impact on motorist compliance with grade crossing warning devices.

Vehicles were recorded at the subject crossing to measure driver compliance with the grade crossing warning devices. The team used two main performance measures: violation rate (i.e., the number of events per activation in which a driver continues through the grade crossing while the warning devices are activated) and the time of each violation (i.e., the time elapsed between when the lights begin flashing at the onset of the activation and when the front of the vehicle passes the crossing gates). These two measures were compared before and after the implementation of the rapid flashers.

Data Collection and Analysis: The subject crossing is a public, at-grade crossing equipped with gates and lights on each of the two approach lanes. It also has pedestrian gates.

The research team collected data via two video cameras connected to a digital video recorder and mounted to a utility pole on the northwest corner of the crossing. Grade crossing violations were classified into three types:

- Type I: Vehicle traversed the crossing while the lights were flashing but before the gates started descending, within the first four seconds of initial activation.
- Type II: Vehicle traversed the crossing while the gates were descending, within the next eight seconds.
- Type III: Vehicle traversed the crossing while the gates were horizontal.

RESULTS

Grade crossing violations were collected and analyzed as follows:

Pre-Installation (Pre): For the pre-installation period, vehicular movements at the crossing were analyzed for 20 weekdays over a 4-week period between May 30, 2023, and June 26, 2023. A total of 720 grade crossing activations and 544 vehicle violations were observed; 315 of these violations were Type I, and the remaining 229 violations were Type II. Four Type III violations were observed in this period but were removed from the analysis. Those four events occurred during two late night activations on the same night with no trains present, each lasting about 12 minutes.

Post-Installation Period 1 (Post 1): The existing flashers on the roadway gates were replaced with rapid flashers on November 3, 2023. The effectiveness results from the gate-mounted rapid flashers are documented in (Bedini, 2024).

Post-Installation Period 2 (Post 2): The existing flashers on the gate posts were replaced with rapid flashers on November 23, 2024. A period of six weeks was allowed to account for the novelty effect of this improvement. The post-installation period consisted of 20 weekdays over a 4-week period between January 6, 2025, and February 3, 2025 (excluding the January 20th holiday). A total of 700 grade crossing activations and 299 vehicle violations were observed (267 Type I and 32 Type II). Two Type III violations were observed in this period but were removed from the analysis since they occurred from an adjacent driveway and not from the main road.

Comparative Analysis: Although the difference between the total number of activations between the Pre and Post 2 periods was only about 3 percent, the total number of violations was about 45 percent less in the Post 2 period (544

violations Pre period vs 299 violations Post 2 period). As shown in Table 1, violation rates between the two periods decreased from 0.76 violations per activation in the Pre period to 0.43 in the Post 2 period, a decrease of about 43 percent.

Table 1. Violation Counts and Rates for the Pre and Post Periods

	Count		Violation Rate
Period	Activations	Violations	
Pre	720	544	0.76
Post 1	702	415	0.59
Post 2	700	299	0.43

Figure 2 shows the violation rates for Type I and Type II violations for all three periods. The Type I violation rate decreased by about 14 percent between the Pre and Post 2 periods, from 0.44 to 0.38 violations per activation. The Type II violation rate showed a more dramatic decrease between the periods, from 0.32 to 0.05 violations per activation, a decrease of about 85 percent.

For observed violations, the average time of violation (measured by time elapsed since grade crossing activation) was 3.4 seconds for the Pre period. For the Post 2 period, the average time of violation decreased by 32 percent to 2.3 seconds. This means that violations tended to occur earlier in the activation once the rapid flashers were installed.

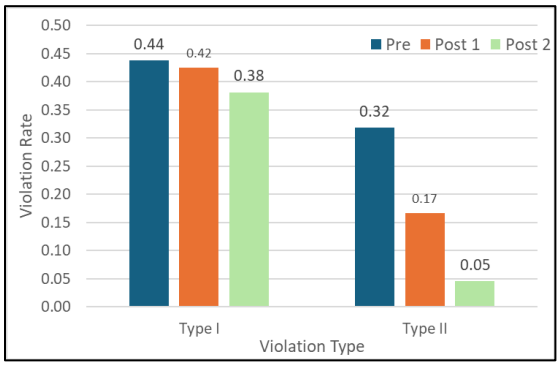

Figure 2. Violation Rates Between the Pre and Post Periods

Figure 3 shows the cumulative distribution percentage of violations by elapsed time from grade crossing activation for all periods. This figure shows that in the Post 2 period, after the installation of the rapid flashers, fewer violations occurred later into the activation. About 27 percent of all violations in the Pre period occurred while the gates were descending (Type II). In the Post 2 period, only about 6 percent occurred while the gates were descending, while over 94 percent occurred before the gates started descending.

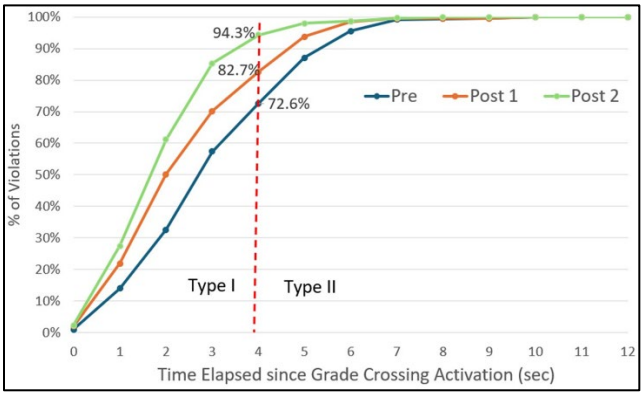

Figure 3. Percentage Cumulative Distribution of Violations by Time Elapsed Since Activation

To account for the day/night seasonal difference between the three periods, researchers compared the violation rates for daytime and nighttime separately. As shown in Table 2, results for nighttime violations for all periods (8:30PM-5:00AM) showed a significant decrease in violation rates for both violation types (about 42 percent overall between the Pre and Post 2 periods).

Table 2. Nighttime Violation Rates

	Violation Rate per Violation Type	
Period	Type I	Type II
Pre	0.15 (21 viol. /137 activ.)	0.08 (11 viol. /137 activ.)
Post 1	0.10 (12 viol. /120 activ.)	0.05 (6 viol. /120 activ.)
Post 2	0.13 (16 viol. /118 activ.)	0.00 (0 viol. /118 activ.)

Type II violations also decreased to zero in the Post 2 period. However, due to the very small nighttime sample size, a statistical analysis of the results is not appropriate, and the results should be interpreted with caution.

CONCLUSIONS

Results indicate that strobing each flasher at the Washington Street grade crossing improved driver compliance with its active warning devices. The overall violation rate decreased by about 43 percent after the installation of the new flashers. More significantly, the violation rate while the gates were descending (Type II) decreased by about 85 percent. Though these results seem to indicate that this treatment may be an effective way to increase safe behavior, it has only been studied at one crossing. Additional field testing is recommended before recommendations for wider use can be made.

FUTURE ACTION

This grade crossing will undergo several additional improvements in the near future involving changes to the approaching roadway and to the location of the warning devices. Researchers will review data after these improvements to assess any additional benefits.

REFERENCES

Bedini Jacobini, F. (2024). Efficacy of Increased Flash Rate of Railroad Gate Flashers (RR 24-10). Washington, DC: Federal Railroad Administration.

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