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## Driver Performance on Approach to Crossbuck and STOP Sign Equipped Crossings

### SUMMARY

In order to improve safe driving behavior at grade crossings, it is important to understand driver actions at or on approach to those areas. Thus, in order to gain a better understanding of the problem, the Federal Railroad Administration (FRA) Office of Research and Development funded a project to study driver activities at or on approach to grade crossings. The findings are discussed in the FRA report titled *Driver Behavior Analysis at Highway-Rail Grade Crossings using Field Operational Test Data—Light Vehicles* (<http://www.fra.dot.gov/eLib/details/L04573>).

The analysis presented herein is based on follow-on research related to the findings discussed in the aforementioned report. The analysis focused on studying the effect of crossbucks only and crossbucks with STOP signs on driver behavior by examining braking activity and speed profiles on approach to such crossings.

The analysis was performed using recently collected data on drivers' activities at or on approach to grade crossings from the Integrated Vehicle Based Safety Systems (IVBSS) Field Operational Test (FOT) sponsored by the National Highway Traffic Safety Administration (NHTSA). The FOT included 108 participants and 16 research vehicles. Figure 1 shows a research vehicle on approach to a crossing equipped with crossbucks.

The IVBSS light vehicle FOT contained 4,215 grade crossing events, or instances, in which the research vehicle traversed a grade crossing. Of those, 211 events occurred at passive crossings equipped with crossbucks only or crossbucks and STOP signs at which there were no vehicles in front of the research vehicle. The analysis of this data set indicates that speed reductions are much greater and occur sooner at crossings equipped with STOP signs than at crossings equipped with crossbucks only. Older drivers (60–70 years old) approached crossings more slowly and slowed down more than younger (20–30 years old) and middle-aged (40–50 years old) drivers. Results showed no gender difference.

Braking activity analysis revealed that almost all drivers applied brakes on approach to crossings equipped with STOP signs compared with 56 percent at crossings equipped with crossbucks only. Male and middle-aged drivers applied brakes slightly more often than their counterparts on approach to crossbucks only crossings.



Figure 1. Video Data of Research Vehicle on Approach to Grade Crossing



## BACKGROUND

The Volpe Center grade crossing research team recently conducted a study on driver behavior at grade crossings using the NHTSA sponsored IVBSS FOT. The main objective was to collect and analyze drivers' activities and driver behavior at or on approach to grade crossings. The results were presented in the FRA report titled *Driver Behavior Analysis at Highway-rail Grade Crossing using Field Operational Test Data—Light Vehicles*.

The research team identified several items within that effort that warranted further research; for example, the effectiveness of crossbucks-only (referred to in this paper as *crossbucks*) and crossbucks with STOP signs (referred as *STOP signs*) on driver behavior on approach to such crossings.

## OBJECTIVES

The main objective of this study was to use data recently collected from the IVBSS FOT to assess driver speed profiles and braking activities on approach to grade crossings equipped with crossbucks and STOP signs.

## METHODS

The evaluation methodology consisted of identifying and obtaining numerical data (latitude, longitude, speed, brake count, etc.) from the IVBSS FOT data for grade crossing events that occurred at crossings equipped with crossbucks and STOP signs. The speed and brake count data were analyzed to evaluate driver performance on approach to grade crossings.

The IVBSS FOT consisted of video and

numerical data sets. The video data was used to record the timestamp when a research vehicle arrived at the advanced warning pavement marking (t1), arrived at the crossing line (t2), and cleared the crossing (t3). The raw field test data obtained from the University of Michigan Transportation Research Institute (UMTRI) were not synchronized. The research team manually synchronized the video data with the numerical data using research vehicle geo-location and crossing location.

## RESULTS

There were 244 grade crossing events that occurred at crossings equipped with crossbucks or STOP signs. Of those, the research vehicle was the lead vehicle on the crossing approach on 211 occasions. Those events occurred at 58 unique grade crossings, of which 13 were equipped with STOP signs and 45 were equipped with crossbucks. Table 1 shows the distribution of the 211 events by gender and age group (as defined in the IVBSS FOT).

**Table 1. Grade Crossing Events by Gender and Age Group**

	Young		Middle-aged		Old	
	Male	Female	Male	Female	Male	Female
Crossbucks	21	4	25	2	10	13
Stop Sign	32	14	3	0	79	8
Total	71		30		110	

For the purposes of this analysis, braking activity was measured by whether a driver applied a brake on approach to the grade crossing between t1 and t2. Figure 2 illustrates the distribution of grade crossing events by brake application for the two crossing configurations. As can be seen from the chart, almost 100 percent of the drivers applied brakes on approach to crossings equipped with STOP signs regardless of age group or gender.



By comparison, 56 percent of the drivers applied the brakes at grade crossings equipped with crossbucks. Male drivers were slightly more likely to apply brakes than female drivers. When analyzed by age group, middle-aged drivers (40–50) were 63.0 percent likely to apply brakes compared with 56.5 percent for older drivers (60–70) and 48.0 percent for younger drivers (20–30).

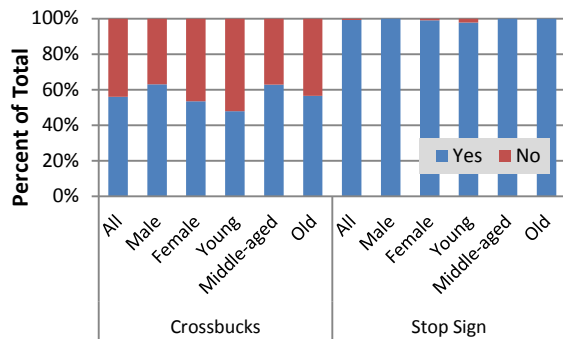


Figure 2. Distribution of Grade Crossing Events by Brake Applied on Approach to Grade Crossing

Figure 3 illustrates the average speed profile by warning devices on approach to grade crossings. The speed data are expressed as percentages of the speeds at t1. As can be seen from the chart, speed reductions were much greater and occurred sooner at STOP sign equipped grade crossings than at grade crossings equipped with crossbucks. In fact, drivers reduced their speed by approximately 81 percent on average over their initial speed at grade crossings equipped with STOP signs compared with the approximately 26 percent at grade crossings equipped with crossbucks.

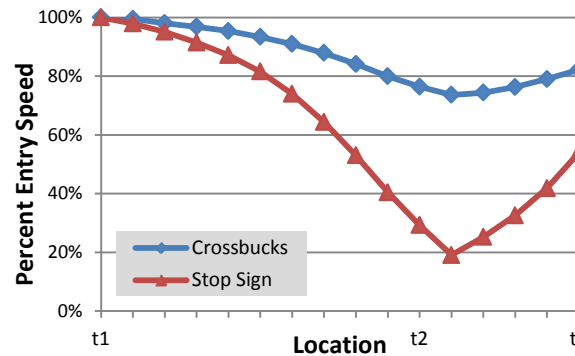


Figure 3. Speed Profiles by Warning Devices on Approach to Grade Crossing

Drivers' average speed profile on approach to the two crossing configurations by age-group is shown in Figure 4. As the chart illustrates, older drivers' speed reductions were greater and occurred sooner than that of younger or middle-aged drivers. There was no clear difference in speed approach based on gender.

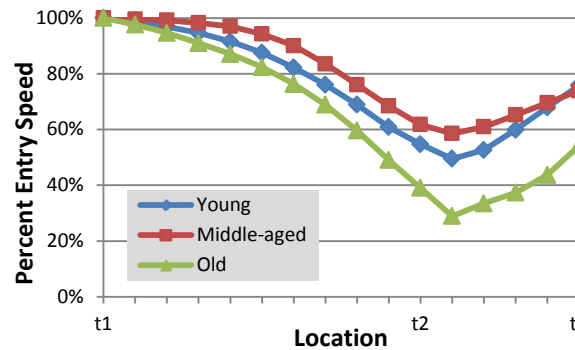


Figure 4. Speed Profiles at Crossbuck and STOP Sign Equipped Crossings by Age Group

The research team also examined 5 years of accident history (2008–2012) for the two crossing configurations. For the entire United States over the 5-year period, there were 8,974 incidents at public at-grade crossings. Of those, 24.7 percent occurred at crossings equipped with crossbucks, and 9.9 percent occurred at



crossings equipped with STOP signs. When analyzed per 1,000 crossings, the rate was 15.3 at crossings equipped with STOP signs compared with 9.1 for crossings equipped with crossbucks.

For the State of Michigan, where more than 98 percent of the passive grade crossing events occurred in the IVBSS FOT, the rate of accident per 1,000 crossings was 5.4 at crossings equipped with STOP signs compared with 8.4 at crossings equipped with crossbucks over the same 5-year period.

## CONCLUSIONS

The analysis of driver behavior (speed profile and braking activities) on approach to highway-rail grade crossings reveals that speed reductions are much greater and occur sooner at crossings equipped with STOP signs than at crossings equipped with crossbucks only. Older drivers tend to approach crossings more slowly and slow down more than younger and middle-aged drivers. There were no noticeable gender differences.

The analysis of braking activities reveals that almost 100 percent of drivers applied brakes on approach to crossings equipped with STOP signs compared with 56 percent at crossings equipped with crossbucks. Male and middle-aged drivers applied brakes slightly more often than their counterparts on approach to crossings equipped with crossbucks. No clear gender or age-group differences were observed on approach to crossings equipped with STOP signs.

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## KEYWORDS

highway-rail grade crossings, driver behavior, field operational test, safety

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