

Relationship Between Initial Speed and Speed Inside a Highway Work Zone

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Drivers' speeds in the advance warning area may influence the speeds that they maintain throughout the work zone. The correlations between the speed at the end of the advance warning area and the speed in the work activity area are examined. Vehicles are grouped into six driver categories or subcategories on the basis of their speed profiles. Vehicles were also divided into Fast-, Faster-, Very Fast-, and Fastest-moving groups on the basis of their initial speeds. Vehicles with higher initial speeds, in general, reduced their speeds more than the vehicles with lower initial speeds; however, vehicles in the higher initial speed groups kept higher speeds in the work zone than the vehicles in the lower initial speed groups, even though the former group had larger speed reductions than the latter group. Drivers were classified into the combinations of speed groups and driver categories. The drivers in a category were not distributed uniformly among the four speed groups. Similarly the drivers in a speed group were not distributed evenly among the driver categories. The data showed that the great majority of the drivers who did not reduce their speeds in work zones belonged to the Faster and Very Fast groups. About one-third of the drivers who were "extremely" speeding (Very Fast and Fastest groups) reduced their speeds and kept reducing them as they traveled in the work activity area. However about one-third of those who were "excessively" speeding (Fast and Faster groups) reduced their speeds initially, but increased them in the work activity area and then reduced them when they reached the work space.

Drivers travel at different speeds in the advance warning area, and their speeds may influence the speeds that they maintain throughout the work zone. This paper discusses how the speed of a vehicle at the end of the advance warning area may influence its speed in the work activity area. It examines the correlation between the speed at the beginning of the lane closure taper with the speed inside the one-lane section of the work zone.

The speeds at the beginning of the taper are called initial speeds and are used to group the vehicles into four speed groups: Fast-, Faster-, Very Fast-, and Fastest-moving groups. The initial speeds for Fast, Faster, Very Fast, and Fastest groups are 74 to 87 km/hr (46 to 54 mph), 86 to 103 km/hr (55 to 64 mph), 105 to 111 km/hr (65 to 69 mph), and over 113 km/hr (70 mph), respectively. Depending on the correlation between speeds in the work activity area and the initial speed, one needs to deal with different types of speeding drivers in each speed group.

Furthermore drivers are grouped into four driver categories on the basis of their speed profiles. The four categories include a total of six driver categories and subcategories. Then the distribution of drivers in the speed groups and driver categories are examined. If speed reduction depends on the initial speed, do drivers in one speed group mainly belong to one driver category? The answer to this question would help to determine where the focus of work zone speed control efforts should be.

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The results obtained from the present study will help in the design of more efficient and effective traffic control plans for construction zones. The terminology suggested by Lewis (1) is used whenever possible to identify different locations in a traffic control zone (work zone). According to the terminology a traffic control zone (work zone) is divided into four areas: the advance warning, transition, activity, and termination areas. The activity area is further divided into two spaces: buffer space and work space. It should be noted that the work space is only one small part of a work zone.

It should be noted that initial speed may prove to be an important parameter, but the authors do not believe that speed in the work zone can fully be explained by initial speed alone. Other factors such as type and level of work activities, geometric characteristics, and law enforcement level would influence work zone speed.

STUDY APPROACH

The study approach is based on finding the speed profiles of vehicles in a construction zone and relating them to the speeds at the beginning of the transition area (2,3). The speed of a vehicle was monitored from the time that it entered the study section until the time that it exited it. Two video cameras were used to collect data as the vehicles traveled in the traffic control zone.

Study Site Description

The construction zone was located on a rural section of Interstate 57 near Mattoon, Ill. The highway has two lanes in each direction, but one lane in each direction was closed because of the construction. The traffic control zone was about 5.6 km (3.5 mi) long. The construction crew was repairing the bridge decks over State Route 16 and another bridge about 4.0 km (2.5 mi) to the south of Route 16. The crew was also doing patching, overlay, and shoulder reconstruction work on the ramps of Route 16 and I-57.

The speed limit inside the construction zone was 72 km/hr (45 mph) for all vehicles. However outside the work zone it was 105 km/hr (65 mph) for cars and 89 km/hr (55 mph) for heavy trucks. The traffic control plan (TCP) used in the work zone was one of the Illinois Department of Transportation's standard TCPs which is prepared according to the guidelines given in the *Manual on Uniform Traffic Control Devices* (4). Figure 1 schematically shows the signs used for traffic control in this work zone.

The study section contained one noticeable crest vertical curve that was approximately 854 m (2,800 ft) long. It started 122 m (400 ft) before the DeWitt Road overpass and ended 61 m (200

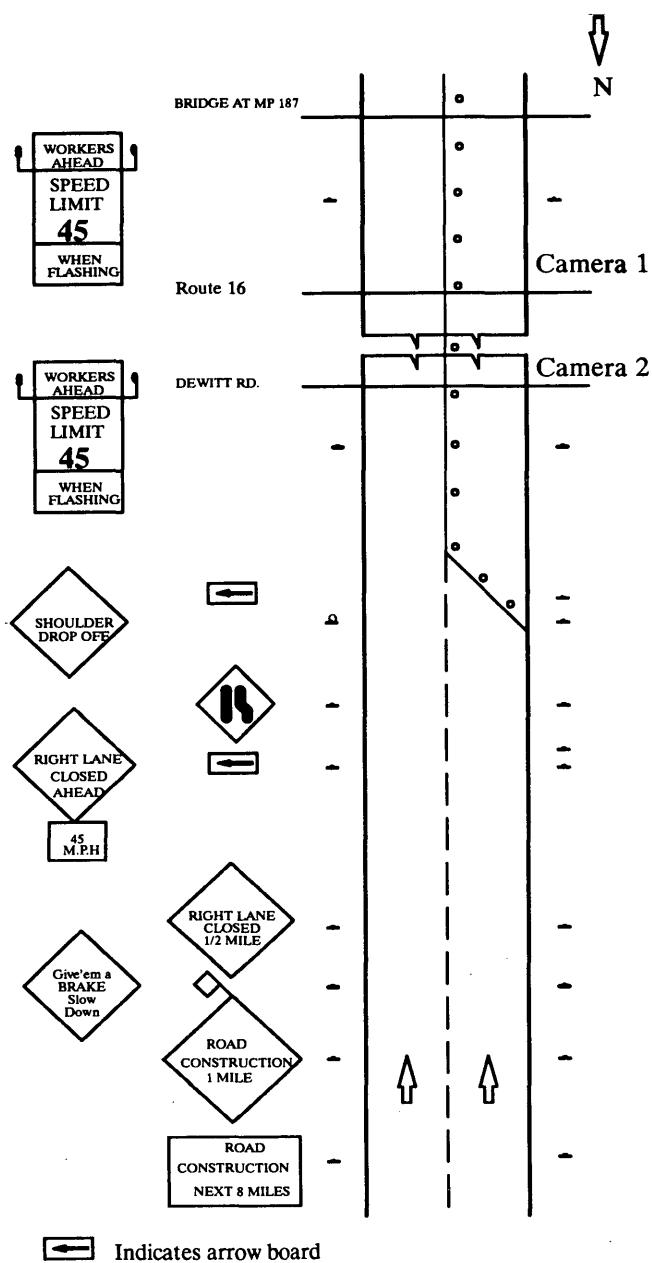


FIGURE 1 Signs on I-57 during speed profile study.

ft) before Route 16. Before the DeWitt Road overpass there is a very short section with a 3 percent upgrade slope. The speed reduction owing to the uphill section, if any, would be noticeable for trucks but not cars (5).

Data Collection

The study section was about 2.4 km (1.5 mi) long and was divided into smaller intervals of 122 to 214 m (400 to 700 ft) in length. The speed in each interval is represented by a speed station that is located approximately at the midpoint of the interval. There were 17 different speed stations. Data were collected during week-

days under normal weather conditions and when the construction crew was working. Vehicles that were in the free flow of traffic at the beginning of the study section were videotaped. Two video cameras followed each vehicle from the time that it entered the study section until the time that it exited it. A total of 208 vehicles were videotaped during the 3 days of data collection. The average daily traffic on this section of the freeway was about 12,000 vehicles, with approximately 22 percent being heavy commercial vehicles (6).

The speed of a vehicle in each interval was computed on the basis of distance and time information. The actual distance that a vehicle traveled between the two markers was computed by using data on the divergence angle and the locations of the markers from a camera location. The time that a vehicle took to travel this distance was obtained from the videotapes. Then the speed for that interval was computed as the ratio of the distance to time. For more detail on speed calculation, refer to Benekohal et al. (2,3,7).

Data Reduction

A vehicle was labeled as *influenced* if it was slowed down by another vehicle in front of it or exited from the ramp; otherwise it was labeled as *uninfluenced*. The uninfluenced vehicles were in free-flow traffic traveling at their desired speeds in the traffic control zone. Of 208 vehicles, 57 vehicles were tagged as influenced vehicles. The remaining 151 vehicles were labeled as uninfluenced. The findings of the present study are based on the speed characteristics of the uninfluenced vehicles. The uninfluenced vehicles were divided into two vehicle groups: the Autos group and the Trucks group.

The Autos group had 102 vehicles, which included 74 passenger cars and 28 vans and pickup trucks. The speed characteristics of the cars group were compared with those of the vans group, and it was determined that there were no significant differences. Thus the cars and the vans were combined into the Autos group. The Truck group had 49 tractor semitrailer trucks.

For each vehicle several sources of errors were identified and their effects on speed were calculated. In general the computed speed could be influenced by 1.6 km/hr (1 mph) or less as a result of these errors. For additional details on data collection and data reduction, refer to Benekohal et al. (2,3,7).

Influence Points

Throughout the construction zone there were traffic control signs and roadway features that may influence the speed of a vehicle. An influence point (IP) is defined as a location within the construction zone that may have such a sign or roadway feature. Thirteen IPs, labeled a through m, were identified in the study. The IPs and their distances from the beginning of the study section are listed in Table 1. The layout and traffic control plans in this work zone were typical of those for a one-lane closure on interstate highways. The speed of a vehicle at these IPs was determined by using the speed profiles.

Examination of the speed profiles indicated that the upgrade section did not significantly reduce the speeds of the cars. After the construction work was completed, adjustment data were collected to determine the speed reduction effects of the upgrade section (2). The mean speed reduction was 1.6 km/hr (1 mph) for

TABLE 1 IPs and Their Distances from Beginning of Study Section

INFLUENCE POINTS	LOCATION IN WORK ZONE	DISTANCE(ft) ^a
a	Beginning of the taper	600
b	End of the taper	1600
c	Before 1st speed limit signs	2100
d	At 1st speed limit signs	2600
e	After 1st speed limit signs	3100
f	Near the end of upgrade section	4300
g	1200 feet before Rt. 16 bridge	4800
h	600 feet before Rt. 16 bridge	5400
i	At Rt. 16 bridge (work space)	6000
j	500 feet after Rt. 16 bridge	6500
k	1000 feet after Rt. 16 bridge	7000
l	400 feet before 2nd speed limit signs	7900
m	Second speed limit signs and end of the study section	8300

^a 1 foot = 0.305 meter (m)

cars and 8 km/hr (5 mph) for trucks. The speed changes were concentrated between -1.6 and +3.2 km/hr (-1 and +2 mph) for the Autos group and between -4.8 and -9.7 km/hr (-3 and -6 mph) for the Trucks group.

SPEED PROFILE PATTERNS

Certain speed reduction patterns are repeated by many drivers. The drivers were grouped into four general categories on the basis of their speed profile patterns. Figure 2 shows the typical speed profiles for the Autos group. The criteria for the classification were the visual examination of the speed change patterns and a quasi-quantitative measure of the speed change. Vehicles that showed similar speed profiles were grouped into one category. If the speed change over a significant portion of the study section was less than 8 km/hr (5 mph) for the Autos group and less than 6 km/hr

(4 mph) for the Trucks group, it was attributed to expected speed fluctuation and was not used as a criterion in the classification. Brief descriptions of these categories are given below.

Driver Category 1

Category 1 represents the drivers who reduced their speeds at around the first set of speed limit signs. About 58 percent of Autos group and 68 percent of Trucks group drivers belonged to this category. Some drivers in this category reduced their speeds further at the work space (over the Route 16 bridge). The drivers in Category 1 are further divided into three subcategories.

Driver Category 1.1

Category 1.1 represents the drivers who decreased their speeds at around the first work zone speed limit signs and reduced their speeds further at the bridge. Usually the latter speed reduction was greater than the former one. Approximately 24 percent of Auto group drivers and 25 percent of Truck group drivers belonged to this category.

Driver Category 1.2

Category 1.2 represents the drivers who slowed down (sharply) at both the first speed limit signs and the bridge, but who increased their speeds between these two points. Their speed profiles resembled a W shape. About 23 percent of Auto group drivers and 20 percent of Truck group drivers were placed in this category.

Driver Category 1.3

Category 1.3 represents the drivers who reduced their speeds at around the first speed limit signs and kept traveling at the reduced

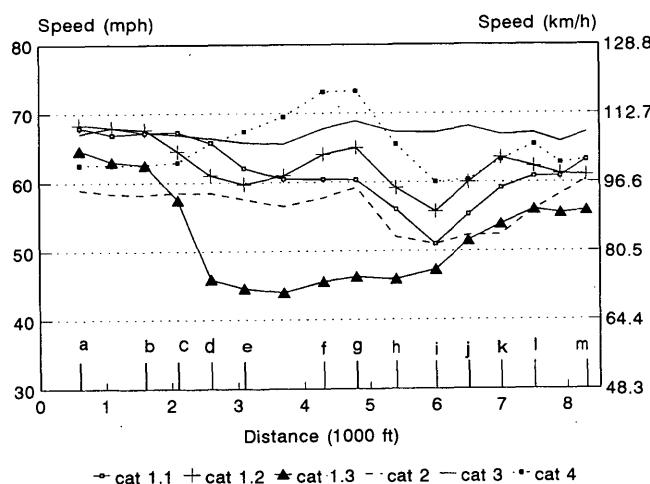


FIGURE 2 Typical speed profiles for Autos group, Categories 1 through 4.

speed until they passed the bridge. After passing the bridge some drivers in this group increased their speeds. About 11 percent of Auto group drivers and 23 percent of Truck group drivers belonged to this category.

Driver Category 2

The criteria for Category 2 were that the drivers traveled faster than the speed limit and had speed reductions of less than 8 km/hr for the Autos group and 6 km/hr for the Trucks group before IP e [152 m (500 ft) after the first speed limit signs]. This means that they basically ignored the first speed limit signs but began to slow down when they arrived at the bridge. Nearly 17 percent of Auto group drivers and 8 percent of Truck group drivers were placed in this category.

Driver Category 3

Category 3 includes those drivers who ignored both the first speed limit signs and the construction activities over the bridge. They drove through the work zone at almost a constant speed that was greater than the 72-km/hr (45-mph) speed limit. The Auto group drivers maintained a speed of approximately 97 km/hr (60 mph) or greater, and Truck group drivers maintained speeds of between 81 km/hr (50 mph) and 97 km/hr (60 mph). The speed fluctuation for this group was very small, 8 km/hr (5 mph) or less. About 11 percent of Auto group drivers and 10 percent of Truck group drivers were grouped in this category.

Driver Category 4

The fourth category is called *others*, which includes those drivers who could not be classified into Categories 1 to 3. Some of the drivers in Category 4 reduced their speeds at the first speed limit signs but did not slow down at the bridge. Some of them even increased their speeds while passing the work space. About 14 percent of Auto group drivers and 14 percent of Truck group drivers belonged to Category 4.

EFFECTS OF INITIAL SPEED ON SPEED REDUCTION

Concept and Motivation

Drivers travel at different speeds in advance warning areas, and their speeds there may influence the speeds that they maintain throughout the work zone. This paper discusses how the speed of a vehicle at the end of the advance warning area influences its speed in the work activity area. It also examines the correlation between the speed at the beginning of the lane closure taper and the speed inside the one-lane section of the work zone.

The speeds at the beginning of the taper are called *initial speeds* and are used to group the vehicles into four speed groups: Fast-, Faster-, Very Fast-, and Fastest-moving groups. The numbers of Auto group drivers in the Fast, Faster, Very Fast, and Fastest groups were 16, 33, 37, and 16, respectively. There were 12, 34, and 3 Truck group drivers in the Fast, Faster, and Very Fast

groups, respectively. The Very Fast group had only three trucks; thus the characteristics of this group are not discussed in detail. The drivers in the Fast group had speeds of between 74 and 87 km/hr (46 to 54 mph) when they passed IP a (beginning of the taper). The drivers in the Fast group drove 2 to 14 km/hr (1 to 9 mph) over the speed limit of 72 km/hr (45 mph).

The drivers in the Faster group had initial speeds of 86 to 103 km/hr (55 to 64 mph); thus their speeds were 16 to 31 km/hr (10 to 19 mph) faster than the speed limit. The Very Fast group had initial speeds of 105 to 111 km/hr (65 to 69 mph). The Fastest group includes all the drivers who had an initial speed of 113 km/hr (70 mph) or greater at the beginning of the taper (IP a).

If speed reduction depends on the initial speed, do drivers in one speed group exhibit similar speed reduction profiles? If so then one needs to deal with one type of speeding driver in each speed group. Consequently the speed reduction efforts will mainly be targeted to these four types of drivers. However if drivers in one speed group belong to different driver categories, then it is more difficult to deal with this situation because 24 possible types of speeding drivers are involved (combinations of four speed groups and six driver categories and subcategories).

The drivers in one driver category were not distributed uniformly in these four speed groups. Moreover the drivers in one speed group were also not evenly distributed in the driver categories. This means that to some degree the driver categories are related to the speed groups. These issues are examined for the Autos and the Trucks groups in the following sections.

Speed Characteristics in Speed Groups

In general all speed groups exceeded the 72-km/hr (45-mph) speed limit, and different speed groups showed similar speed reduction trends. Figures 3 and 4 show the average values of the excessive speeds for the four speed groups for the Autos and Trucks groups, respectively. It is clear that the average speeds gradually decreased before the bridge (IP i) and increased after that for all speed groups. The trend for all speed groups shows that vehicles with higher initial speeds had greater speed reductions at the bridge.

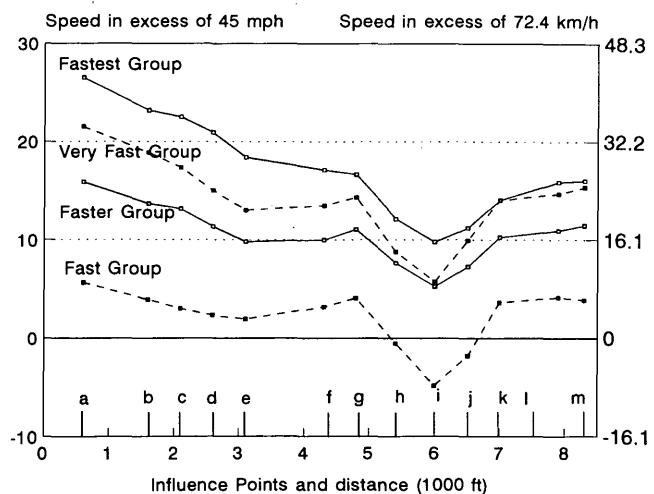
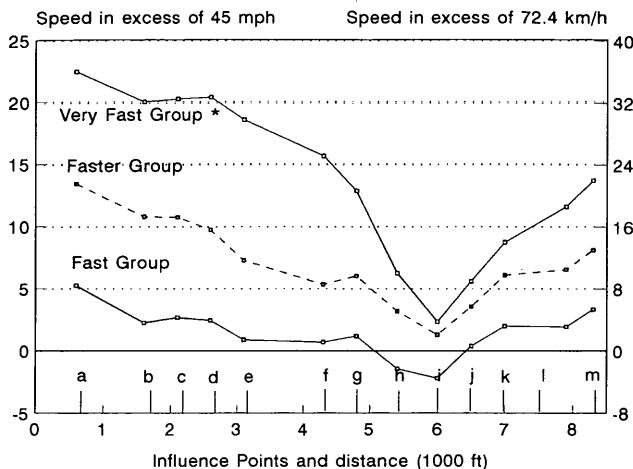


FIGURE 3 Average speed profiles for Autos group (1 ft = 0.305 m).



* Very Fast group had only 3 vehicles

FIGURE 4 Average speed profiles for Trucks group.

However throughout the work zone they still traveled at higher speeds than the vehicles with lower initial speeds.

Excessive Speeds and Ranges

The ranges for 90 percent of the excessive speeds for each speed group are shown in Figures 5 and 6 for the Autos and Trucks groups, respectively. For each speed group these boundaries were obtained by discarding the top and bottom 5 percent of the speed reductions at each IP. These ranges show that the upper bound of a range for a higher initial speed group is always greater than the upper bound of a range for a lower initial speed group. For example the upper bound of the Fastest group is always higher than the upper bound of the Very Fast group, the upper bound of the Very Fast group is always higher than the upper bound of the Faster group, and so on.

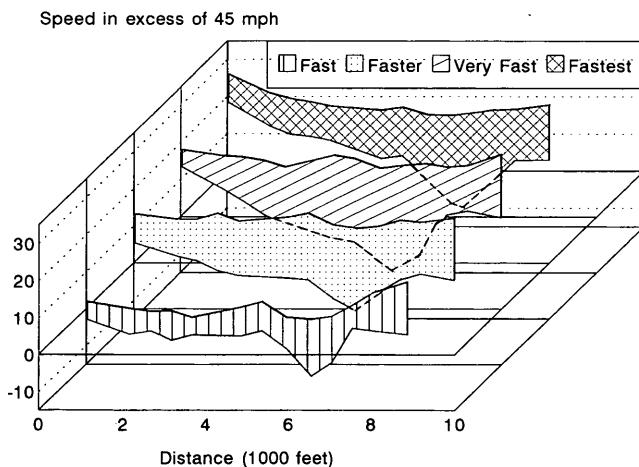
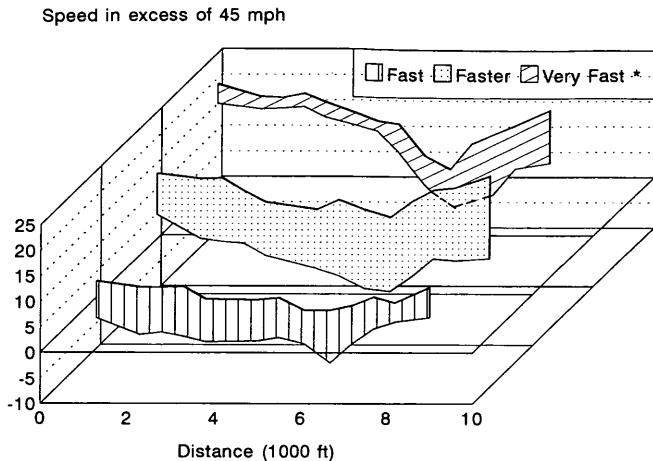


FIGURE 5 Speed bounds for 90 percent of observations in each speed group for Autos group (1 mph = 1.61 km/hr).



* Very Fast group had only 3 vehicles

FIGURE 6 Speed bounds for 90 percent of observations in each speed group for Trucks group.

The minimum speed reductions for each speed group decreased as the vehicles neared the work space. The minimum reductions for the Fast group were less than those for the Faster group. The reductions for the Faster and Very Fast groups were, for the most part, very similar, but they were less than the minimum reductions for the Fastest speed group.

This indicates that in general the vehicles in the higher-speed group would travel faster throughout the work zone than those in the lower-speed group. The ranges became wider as vehicles in all four speed groups got closer to the work space (the bridge). After passing the bridge the ranges were shrunk to almost the same level as those before the bridge.

Maximum Speed Reductions in Speed Groups

For each speed group the maximum speed reduction was computed by subtracting the lowest mean speed from the initial mean speed. For example drivers in the Fastest Auto group exceeded the speed limit by 42.7 km/hr (26.5 mph) at the beginning of the taper (IP a) and by 15.8 km/hr (9.8 mph) at the bridge, so the maximum speed reduction for this group was 26.9 km/hr (16.7 mph). The maximum speed reductions for the Fast-, Faster-, Very Fast-, and Fastest-moving Auto groups were 16.9, 17.1, 25.4, and 26.9 km/hr (10.5, 10.6, 15.8, and 16.7 mph), respectively. The maximum speed reduction increased as the initial mean speeds increased. This trend indicates that on average the vehicles with higher speeds at IP a reduced their speeds more than the vehicles with a lower initial speed.

The maximum speed reductions for the Fast- and Faster-moving Truck groups were 11.98 km/hr (7.44 mph) and 19.61 km/hr (12.18 mph), respectively. Drivers in the Faster Truck group exceeded the speed limit by 1.6 to 21 km/hr (1 to 13 mph), although the trucks in that group had a maximum speed reduction of 19.61 km/hr (12.18 mph). In comparison drivers in the Fast Truck group exceeded the speed limit by only 8 km/hr (5 mph) at the beginning and traveled 3 km/hr (2 mph) below the speed limit at the bridge, but had a maximum speed reduction of 11.98 km/hr (7.44 mph).

The drivers in the higher initial speed groups kept higher speeds in the work zone than the drivers in the lower initial speed groups, even though the former group had greater speed reductions than the latter group. The drivers in the Very Fast Auto group exceeded the speed limit by 10 to 35 km/hr (6 to 22 mph), although they had maximum speed reductions of 25.4 km/hr (15.8 mph). In comparison drivers in the Fast Auto group exceeded the speed limit by only 8 km/hr (5 mph) and traveled 8 km/hr (5 mph) below the speed limit at the bridge, but had a maximum speed reduction of 16.9 km/hr (10.5 mph), which is less than 25.4 km/hr (15.8 mph) reduction for the Very Fast group.

Driver Categories and Speed Groups

Drivers were classified into the combinations of speed groups and driver categories. Figure 7 shows the percentage of Auto group drivers in a given driver category who belonged to each of the speed groups. Figure 8 shows the percentage of Auto group drivers in each speed group who belonged to each driver category. The drivers in one driver category were not evenly distributed among the four speed groups. Similarly the drivers in one speed group were not evenly distributed among the driver categories. This seems to imply that some drivers are over- or underrepresented in certain speed groups or driver categories. These characteristics are examined in the following section.

Speed Group Distribution in Driver Categories

For each driver category the percentages of drivers who belonged to a speed group are shown in Figure 7. The sum of the percentages for each category in Figure 7 should be 100 percent. The great majority of the Auto group drivers who did not reduce their speeds in work zones belonged to the Faster and Very Fast groups. About 91 percent of the drivers in Category 3 belonged to the Faster and Very Fast groups, where the speed was as high as 111 km/hr (69 mph) and as low as 89 km/hr (55 mph), and most of them were driving faster than 97 km/hr (60 mph). The remaining 9 percent of drivers were all in the Fastest group, who drove faster than 113 km/hr (70 mph). Since these drivers traveled at almost constant speeds throughout the work zone, their speeds would need to be reduced before they enter the transition area. Thus to

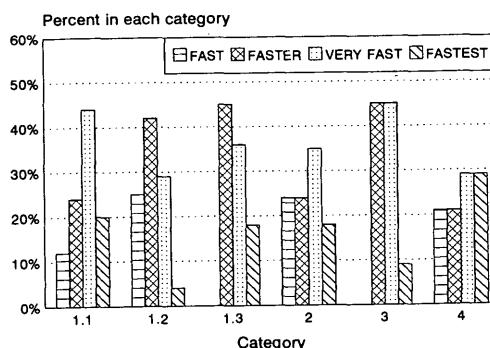


FIGURE 7 Proportions of speed groups in each driver category for Autos group.

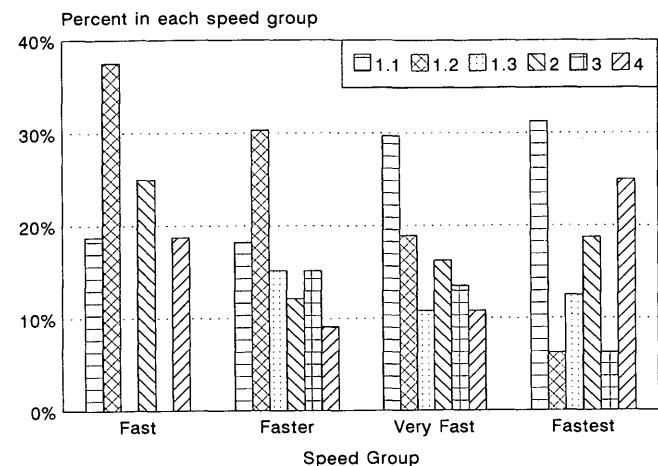


FIGURE 8 Proportions of driver categories in each speed group for Autos group.

reduce the speed of this group the speed reduction stimulus, whatever it might be, should be located before the transition area.

The Faster and Very Fast groups dominated Driver Categories 1.2 and 1.3. Two observations can be made about them. First the speeds were high at the beginning of the transition zone even for a large portion of drivers in Categories 1.2 and 1.3. Second these drivers reduced their speeds in the work activity area because of some stimulus, mainly a roadway feature and traffic control devices. Thus if their speeds before entering the work activity area can be reduced, the additional speed reduction patterns that they have exhibited may bring their speeds to reasonable levels. Therefore these groups should be encouraged to reduce their speeds further before they get into the work activity area.

It should be noted that all speed groups are represented almost evenly in Category 4. This implies that those drivers who did not follow a particular speed reduction pattern did not come from a particular speed group.

Driver Distribution in Speed Groups

For each speed group the percentages of drivers in different driver categories are shown in Figure 8 (the sum of the percentages for each speed group is 100). In the Fast and Faster groups about one-third of Auto group drivers belonged to Category 1.2. However, in the Very Fast and Fastest groups about one-third of the Auto group drivers belonged to Category 1.1. This indicates that about one-third of the drivers who were extremely speeding (Very Fast and Fastest groups) reduced their speeds and kept reducing them as they traveled in the work activity area. However about one-third of those who were excessively speeding (Fast and Faster groups) reduced their speeds initially but increased them in the work activity area and then reduced them when they reached the work space.

It should be noted that the proportion of drivers in Category 1.1 increased as the initial speeds of the vehicles increased. Thus with a larger data set one can correlate the likelihood of having a given speed reduction profile to the initial speed of that vehicle. Also about one-fourth of the drivers in the Fastest group belonged

to Category 4. This indicates that for one-fourth of the Fastest-moving vehicles the speed reduction pattern was unknown. They may be the main source of complaints by construction crews about "flying vehicles" in work zones.

Unlike the Autos group drivers, Category 2 Truck drivers almost did not exist in the Fast and Faster groups (there was only one driver in Faster Truck group). About 10 percent of Trucks in both speed groups were in Category 3 and basically traveled at constant speeds. A higher proportion of trucks in the Faster group than in the Fast group belonged to Category 1.1. This also supports the discussion presented earlier that the speed of vehicles should be reduced before they get in the work activity area.

Statistical Analyses

This section discusses the adequacy of sample size for studying the mean speeds and the results from analysis of variance and Tukey's multiple comparison tests. The sample size used in the present study provides enough accuracy for statistical analysis of the mean speeds. By using the standard deviations of the initial speeds [10.9 km/hr (6.8 mph) for the Autos group and 8.2 km/hr (5.1 mph) for the Trucks group], it was determined that the sample sizes used in the study would allow the mean speed of Autos and Trucks to be estimated to an accuracy of 2.30 km/hr (1.33 mph) and 2.14 km/hr (1.43 mph), respectively. This accuracy is adequate for the purposes of the present study, although a large sample size would increase the accuracy of finding the mean speeds. If more accuracy is needed data from a large sample should be collected.

Multiple comparison tests were run for all IPs. At each IP pairwise comparisons of average speeds were made. The multiple comparison tests were run to determine whether the average speeds were significantly different for a pair. Tukey's test was used because it is less conservative than Scheffe's multiple comparison tests and the experimentwise error rate is controlled (8). The results of Tukey's multiple comparison tests, with a confidence level of 90 percent, are presented in Table 2. Table 2 shows that speeds for most of the pairs were different except for three pairs around IP i (bridge). For those pairs similar speeds were expected to be seen near the bridge. The test results indicated that at most of the locations the speeds were different for various speed groups.

An attempt to correlate the driver categories to speed groups was made. This cross classification resulted in 24 combinations of driver categories and speed groups. A chi-square test was run to examine the distributions of drivers on these cells. However the observations in some of the cells were not adequate for such a detailed level of analysis. It was then decided to combine the Fast group with the Faster group (calling them *excessively speeding*) and the Very Fast group with the Fastest group (calling them *extremely speeding*). A chi-square test was run to compare the distributions of the two speeding groups into six driver categories. The results indicated that there is a correlation between driver category and the two speed groups. However the distributions of the drivers in the two speed groups and six driver categories were not statistically different than the expected values (chi-square, 5.0). This indicated that when drivers are grouped into 12 combinations there was not an under- or an overrepresentation of a speed group in a driver category.

TABLE 2 Multiple Comparison Test Results (Tukey's) for Mean Speeds of Different Speed Groups

IP	Speed Groups Compared						
	Autos						Trucks
	Fast-Faster	Fast-Very Fast	Fast-Fastest	Faster-Very Fast	Faster-Fastest	Very Fast-Fastest	
a	No	No	No	No	No	No	No
b	No	No	No	No	No	No	No
c	No	No	No	No	No	No	No
d	No	No	No	No	No	No	No
e	No	No	No	No	No	No	No
f	No	No	No	No	No	No	No
g	No	No	No	Yes	No	Yes	No
h	No	No	No	Yes	Yes	Yes	No
i	No	No	No	Yes	Yes	Yes	No
j	No	No	No	Yes	Yes	Yes	No
k	No	No	No	No	No	Yes	No
l	No	No	No	No	No	Yes	No
m	No	No	No	No	No	Yes	No

Yes: Indicates average speeds are similar
No: Indicates average speeds are different

CONCLUSIONS

Vehicles were divided into Fast-, Faster-, Very Fast-, and Fastest-moving groups on the basis of their speeds at the beginning of the transition area. For all speed groups the average speeds gradually decreased before the work space and increased after passing it. The speed of a vehicle in a work activity area seems to be related to its initial speed. Vehicles with higher initial speeds in general reduced their speeds more than the vehicles with lower initial speeds; however, vehicles in the higher initial speed groups kept higher speeds in the work zone than the vehicles in the lower initial speed groups, even though the former group had larger speed reductions than the latter group.

Drivers were classified into the combinations of speed groups and driver categories. The drivers in a category were not distributed uniformly among the four speed groups. Similarly the drivers in a speed group were not distributed evenly among the driver categories. The data showed that the great majority of the drivers who did not reduce their speeds in work zones belonged to the Faster and the Very Fast groups. These drivers should be encouraged to further reduce their speeds before they get into the transition area.

About one-third of the drivers who were extremely speeding (Very Fast and Fastest groups) reduced their speeds and kept reducing them as they traveled in the work activity area. However about one-third of those who were excessively speeding (Fast and Faster groups) reduced their speeds initially, but increased them in the work activity area and then reduced them when they reached the work space.

RECOMMENDATIONS

An attempt was made to use a chi-square test to determine whether one driver category is under- or overrepresented in a speed group. However this could not be done statistically because of the large number of combinations of driver categories and speed groups. A larger sample size is needed for such a statistical analysis. However for certain combinations of driver categories and speed groups the data showed that a correlation exists between

the initial speed of a vehicle and its speed profile. A much larger data set is needed to study this correlation for other combinations. Such a study is needed, and it will provide very useful information on traffic control in work zones. It is recommended that a large-scale study be conducted for this purpose.

ACKNOWLEDGMENTS

The findings presented in this paper were based on research report results of Project HR-014—Investigation of Speed Control Methods in Work Zones. The study was sponsored by the Illinois Department of Transportation and FHWA, U.S. Department of Transportation.

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Publication of this paper sponsored by Committee on Traffic Safety in Maintenance and Construction.